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Armature Windings of the Closed Circuit Type, W. Cramp; Supplement, Nov. 3, vii.
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Cement and Concrete, L. C. Sabin; Supplement, Oct. 6
Chains for Lifting and Hauling, The Use and Care of, H. Adams; Supplement, Dec. 6
Concrete Steel, W. N. Twelvetrees; Supplement, Oct. 6
Die Elektrische Bogenlampen deren Prinzip. Konstruktion und Anwendung, J. Zeidler; Supplement, Oct. 6
Electric Railways, S. W. Ashe and J. P. Kelly; Supplement, Dec. 8
Electric Traction, Prof. Smith; Supplements Oct 6 and Nov. 3
Electrical Calculations, Elementary, W. H. N. James and D. L. Sands; Supplement, Dec. 8
Electrical Examinations, A Guide to, F. H. Taylor; Supplement, Dec 8
Electrical Wiring, Practical, C. C. Metcalfe; Supplement, Dec 8
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Theorie der Elektrizitaet, Dr. M. Abraham; Supplement, Nov. 3, vii.
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THE

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NOTES.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice president in the chair. Baroness Gray was elected a member. The special thanks of the members were returned to Sir Andrew Noble, K.C.B., F.R.S., for his donation of £100 to the fund for the promotion of experimental research at low temperatures, and to Mr. Rollo Appleyard for his gift of a portrait of the late Prof. J. D. Everett, F.R.S., M.R.I.

Wireless.—It is reported from Halifax (Nova Scotia) that wireless communication between Halifax and Sable Island has been established. It is also reported that the Anglo-American Cable Company will abandon its stations in Newfoundland on account of the Government tax and establish itself in North Sydney (Cape Breton Island). The Newfoundland Government propose to lay a cable to Canso (Nova Scotia), and there connect with the Canadian Pacific Telegraph Company's system in order to compete with the Anglo-American Company's local business. Arrangements have been made with the Commercial Cable Company for the laying of this cable.

New Publications.—"The Central": The volume, dated June, issued by the Central Technical College Old Students' Association contains articles on "Suction Gas Producers," by A. T. Larter; "The Manufacture of Acetone," by A. Marshall; "Glimpses of the Americans," by R. Seligman; "The Manufacture of Paper," by A. R. Reed; and others. There has been issued from the American Department of Commerce and Labour Nos. 1 and 2 of the *Bulletin* of the Bureau of Standards, which contain a number of interesting papers. Several of these are already known, having been read at the St. Louis Convention, but the volumes form an excellent collection.

Tramways and Light Railways Association.—In the official circular for June notice is given that Sir Herbert Jekyll, on behalf of the Board of Trade, has arranged to receive representatives of the Tramways and Light Railways Association and of the Municipal Tramways Association for the discussion of certain questions in regard to tramways—viz.: (1) the incidence of cost of guarding new Post Office wires crossing existing tramway lines; (2) the memorandum on details of construction and equipment issued by the Board in January, 1905; (3) the proposed monthly inspection of each separate insulator on the overhead equipment. The pamphlet also contains a paper by Mr. R. W. Western upon "The Rationale of Accounts," in which he deals with the subject of balance-sheets in a lucid style.

London Traffic Commission.—The report of the Royal Commission on London Traffic was signed on Monday of last week, and has been presented to the King. The text of the report is expected to be published in a day or two. Meantime it is understood that the Commissioners advocate the creation of a traffic board, whose special duty would be the consideration of all applications made by local and other authorities to street locomotion. This, it is held, will tend to create uniformity in the laying down of new lines, and at the same time obviate much of the inconvenience at present arising from the irregular and haphazard method of breaking up the London streets. The composition of this body would probably include "a man of affairs," a lawyer, and an engineer. Another recommendation of the Commissioners deals with the necessity for a comprehensive scheme of street widening, and the development and linking up of the existing tramway systems.

Trees as Antennæ.—We referred some time ago to the experiments conducted by Major G. O. Squier, of the United States Army, regarding the use of trees as antennæ in wireless telegraphic operations, particularly for military purposes. These experiments gave promise of considerable utility, and Major Squier, with the approval of the United States Government, has been extending them. The results appear to be distinctly favourable, as messages are stated to be readily received over a distance of 32 miles, using a very simple form of apparatus, which can be carried by a soldier on his person. As illustrating the facility with which communication is established the report of an officer in the Signal Corps is interesting. This states that as the messages were arriving with marked efficiency the officer suddenly changed the site of the receiving station to a spot 100 yards distant, and in three minutes fresh communication was established. Major Squier's tests suggest that for condensed news it is now possible to transmit messages from a central station to any number of other stations within a radius of 100 miles with very simple apparatus. It also promises to be of service for temporary installations, as the expense of erecting a permanent mast is disposed of. Although we gather that certain trees interposed between the points at which Major Squier conducted his tests, they do not seem to have caused any appreciable interference.

The Underground.—The fates were inimical to the District and Metropolitan Companies on Saturday, when the electrical services between Ealing and Whitechapel and on a portion of the Circle were due to be inaugurated. The trains started off well enough, but on approaching Hammersmith it was found that the torrential rains of the early morning had submerged the track and impaired the insulation of the conductor rail. These floods have often been a bugbear to the steam locomotives, and it was supposed that the improved drainage resulting from the pumping station lately erected in Lot's road by the County Council would have obviated repetitions of the nuisance; but presumably the downpour on this occasion was too heavy to be dealt with readily. Under the circumstances it was decided to give the steam-engines another show or the day, although on the Metropolitan portion of the Circle electric trains were running during Saturday afternoon.

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Arrangements have, however, been made with a view to preventing a recurrence of the flooding, and the Ealing to Whitechapel electrical service was in satisfactory operation on Monday. In regard to the Inner Circle it appears that the collecting-shoe of the Metropolitan Company's rolling stock is not adapted to the District line. The District trains effect contact with the conductor rail by a 5in. shoe located midway between the extremities of the train, while the Metropolitan trains are equipped with a 3in. shoe at the end of every carriage. It was found that the pressure of the second shoe had displaced the conductor rail. It will therefore be necessary for the Metropolitan equipment to be altered in that respect before the through service over the District section of the Circle can be resumed.

The Tantalum Lamp.—In his paper read before the Denver meeting of the American National Electric Light Association, Dr. Louis Bell described some tests he had made with 10 25-Hefner 110-volt tantalum lamps. Amongst these we notice some stroboscopic tests to determine whether at, say, 25 cycles there was a specially violent fluctuation of light. These tests were decided upon on account of the initial resistance of the tantalum being low and the thermal inertia small, owing to its small mass and low specific heat, this being apt to conduce to rather violent heating up. The result of the tests showed that the light fluctuation at this frequency was somewhat but not much more pronounced than in a carbon filament. The lamp behaved, in fact, similarly to a 10-c.p. carbon-filament lamp. Even a 75-c p. carbon-filament lamp, however, shows perceptible variation under this test. At 60 cycles the fluctuation, while still perceptible, was trivial both in the tantalum and carbon lamps. It appears probable that the final break in the tantalum filament occurs just where one of the lamps has reduced the cross-section of the wire beside it. Placing aside questions of detail, the author sums up the position by stating that the results of the tests demonstrated that the tantalum type provides a *bona fide* two-watt lamp having a light fairly comparable with the carbon-filament lamps now in use. Moreover, it is a competitor with these socket by socket, and not as a substitute with particular requirements, as in the case of the Nernst lamp or very small arcs. There is some doubt as to the life of the tantalum lamp when exposed to unusual vibration, which may exclude it at present from special purposes; but for the every-day work of the central station it seem likely to be generally applicable.

Incorporated Municipal Electrical Association.—At the annual meeting of this association held in Edinburgh on Friday last, Mr. J. E. Edgcome (Kingston-on-Thames), the hon. secretary of the association, was unanimously elected president for 1906, and it was agreed that the conference next year should be held in London. The following gentlemen were also elected: Mr. S. E. Fedden (Sheffield) and Mr. C. D. Taite (Salford) as vice-presidents; Alderman G. Pearson (Bristol), hon. solicitor; Mr. J. H Rider (London), hon. treasurer; and Mr. H. Faraday Proctor (Bristol), hon. secretary. Of the retiring members of council, Alderman Bruce (Sunderland), Alderman E. Elvy Robb (Tunbridge Wells), Alderman J. P. Smith (Barrow-in-Furness), Bailie Willock (Glasgow), and Councillor Sinclair (Swansea) were re-elected, and the remaining vacancies were filled by Mr. R. A. Chattock (Birmingham), Mr. W. Lackie (Glasgow), and Mr. Day (Bolton). The question of loans for electricity supply purposes was then discussed, and the following resolution passed: "That this meeting views with serious apprehension the recent action of the Local Government Board in reducing the already short periods allowed for the repayment of loans for electricity undertakings, and is convinced that such alteration is not only unnecessary, but threatens seriously to handicap legitimate municipal enterprise; it therefore enters its protest against the very short period now being allowed, and hereby empowers the council to take such steps as they may think necessary to bring about a more equitable and uniform treatment." Twenty-five years is the minimum period desired. Votes of thanks were passed to the Corporations of Edinburgh, Glasgow, and Aberdeen for their hospitality, and to Mr. Newington for his labours as president.

The Institution —The annual conversazione was held at the Natural History Museum, South Kensington, on the 29th ult., when over 1,400 guests were received by the President and Mrs. Siemens and the President-Elect and Mrs. Gavey. Numbered among them were: the Hon. Sir W. Arbuckle, Mr. J. Ardron, Sir A. R. Binnie, Colonel G. F. O. Boughey, R.E., C.S.I., Sir D. Brandis, the Hon. Sir H. B. Buckley, Prof. H. L. Callendar, F.R.S., Mr. T. O. Callender, Mr. A. Campbell, Mr. W. G. Cavendish-Bentinck, Sir C. P. Clarke, C.I.E., Captain E. W. Creak, R.N., F.R.S., Sir W. Crookes, Mr. W. Duddell, Mr. S. Z. de Ferranti, Mr. R. K. Gray, the Hon. W. C. Gully, Mr. Robert Hammond, Mr. C. Hawksley, Mr. J. S. Highfield, Mr. Hugo Hirst, Sir R. Hunter, Captain H B. Jackson, R.N., F.R.S, Mr. J. E. Kingsbury, Sir J. N. Lockyer, K.C.B., F.R.S, Sir H. C. Mance, C.I.E., Mr. W. M. Mordey, Sir H. T. Maxim, the Hon. Richard Oliver, Major W. A. O'Meara, R.E., C.M.G., Mr. W. H. Patchell, Mr. S L. Pearce, Prof. J. Perry, F.R.S., Sir W. H. Preece, K.C.B., F.R.S., Sir W. Shelford, K.C.M.G., Mr. H. Babington Smith, C.S.I., Mr. C. E. Spagnoletti, Lord Strathcona and Mount Royal, G.C.M.G., Sir J. W. Swan, F.R.S., Mr. Jas. Swinburne, Prof. S. P. Thompson, F.R.S., Sir J. I. Thornycroft, F.R.S., Major-General Sir A. Turner, K.C.B, Prof. W. C. Unwin, F.R.S., Mr. R. W. Wallace, K.C., Mr. A. J. Walter, Colonel Sir C. M. Watson, K.C.M.G., C.B., Mr. C. H. Wordingham. A varied musical programme was rendered by the string band of the Royal Engineers and the Leoni Ladies' Quintette, and altogether a highly agreeable evening was spent. In the Reptile Gallery the visitors had the privilege of beholding a gigantic specimen of the Diplodocus Carnegii, which created mingled admiration and awe. It is to be regretted that the date of the conversazione again coincided with the annual convention of the Municipal Electrical Association. This prevented practically all municipal engineers from attending the conversazione, and rendered it a less representative gathering.

Selective Wireless Telegraphy.—A demonstration was given last week by Mr. A. T. M. Johnson at West Kensington of his system of selective wireless telegraphy and telephony, which he has christened the Johnson Multitonophic system, and of which a description has already appeared in this journal. The inventor claims that by the use of his selective reed interception of messages is impossible. A miniature sea was provided in the garden, and a room at the rear of the house was fitted up as a transmitting station, a small shed at the opposite end of the garden being utilised as a receiving station. The transmitting apparatus used on this occasion consisted of a Ruhmkorff coil, on the base-plate of which was mounted a multitonophonic reed disc, supported on a sliding pillar. To the reed disc armatures with suitably weighted heads were attached, in proximity to which tuning reeds were adjusted, electric contact being effected in the usual manner. The receiving instruments consisted of permanent magnets situated in metallic cases, the action of the permanent magnets being increased by the aid of electromagnets suitably adjusted, immediately above which steel reeds, tuned in unison or octaves to those situated on the trans-

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mitting disc, were secured. The operator revolves the reed disc of the transmitter until both the tuning reed and its accompanying speaking reed are situated immediately in front of the centre core or cores of the electromagnet. He then turns the screw of the contact pillar until the end touches the platinum contact in the speaking reed, closes the circuit by turning the commutator to the right or left, and turns the contact screw backwards or forwards till the speaking reed synchronously causes the tuning reed, which is the indicator, to vibrate also. When the tuning or indicating reed vibrates the operator knows that the receiving station with a similarly tuned reed is getting the message through, as it is compelled to vibrate in unison by the law of syntonic synchronism. The object of the tuning or indicating reed is to show the operator whether the reed at the receiving station is acting or not. The responses obtained last Friday with the experimental apparatus, both in regard to telegraphy and telephony, were fairly satisfactory, and we shall await with interest the result of the operations which we understand are about to be conducted on a practical scale at sea.

The Administrative County of London Bill.—The debate on the second reading of this Bill in the House of Commons was expected to take place last night, and recent incidents suggest that the proceedings were of a lively character. The promoters feel aggrieved, and not altogether without reason, at the action of the London County Council in addressing metropolitan M.P.'s, urging them to vote against the measure and so dispose of it at an early stage, instead of the matter being investigated in committee. In their circular letter the Council gave a list of objections to the scheme, and in response to this the promoters forwarded a letter of protest to the Council, accompanied by categorical replies to the latter's objections. Amongst these the company state that their scheme would break a vast quantity of new ground, instead of interfering with the existing undertakings. It is pointed out that the maximum prices chargeable are lower by half than the average prices at present ruling in the Metropolis for power, and that the charges are subject to revision by the Board of Trade. In response to the Council's assertion that the case for the Bill is based entirely upon estimates of what the company will be doing in 1910, and to a large extent ignores the fact that the existing electrical undertakers are making strenuous endeavours to develop their business, the company reply that they have undertaken to set to work on the Bill being passed, and that their low prices would come into immediate operation. While acknowledging the endeavours of the existing undertakings to increase their field, the company point out that their efforts have only resulted in securing 4 per cent. of the total power used in the industrial district, and state that the promoters of the Bill would enable the existing companies, by sharing the benefits of concentration, to develop power supply without further capital outlay. Regarding the fact that the Bill does not contain a purchase clause, the promoters point out that the Legislature, when framing the enactment relating to electric lighting, did not contemplate making such a provision in the case of power companies. Reference is also made to the fact that the County Council did not call a single witness in support of their contentions when the matter was before the Lords Committee. The document concludes by emphasising the great benefit to the community which would result from a cheap power supply. Taken all round, the promoters at least make out a case for a reference to committee so that the merits of the scheme may be thoroughly threshed out. We understand that the company have already entered into a number of provisional contracts with local authorities.

Birthday Honours.—The list of honours issued last week in celebration of his Majesty's birthday shows that Lord Rayleigh is to be created a privy councillor. His lordship's achievements are so well known that nothing remains but to congratulate him. Knighthoods are bestowed upon Prof. A. B. W. Kennedy, Mr. J. Clifton Robinson, and Mr. J. C. Lamb. Quite apart from the good work which Sir Alexander Kennedy has done in connection with the University College, he for years has been looked up to as a leading consulting engineer on electrical matters. He has been responsible for the design and management of many of the most successful electrical supply undertakings, and did most valuable pioneering work as the engineer-in-chief of the Westminster Electric Supply Corporation. His work in connection with the London County Council tramways is also well known, and he was responsible for the electrical equipment of a number of the tube railways. His work in this respect now includes an important equipment for the Great Western Railway, which is expected to be the beginning of a large electrification scheme. No doubt Prof. Kennedy's work for the Admiralty in connection with the historic boiler trials is also recognised in the honour conferred upon him, which is highly appreciated by all electrical engineers. He is a Fellow of the Royal Society, and in 1894 the University of Glasgow conferred upon him the honorary degree of doctor of laws. How the London United Tramways have progressed and become a great public boon under Mr. Robinson's management needs no recapitulation. His work also in connection with the Bristol tramways and other large undertakings is marked by an individuality which few engineers can equal. Mr. J. C. Lamb receives the well-merited honour of knighthood in recognition of his valuable services at the Post Office. He was, in fact, engaged in this department ever since the telegraph system was transferred to the State, and assisted in the accountancy side of the transfer. He was one of the British delegates to the Submarine Cables Protection Conferences held in Paris in May and December, 1886, and in 1889 he was appointed assistant secretary to the Post Office. Subsequently he participated in several international conferences, and was appointed a Royal Commissioner on electrical communication with lighthouses and lightships. He organised the trunk telephone system of the Post Office, and conducted the purchase of the lines from the company. In 1896 he became third secretary to the Post Office, and in 1897 second secretary. Honours have been conferred upon him by foreign Governments.

The National Physical Laboratory.—A meeting was held on Tuesday afternoon at the House of Commons to consider the question of obtaining increased State aid for the National Physical Laboratory. Mr. R. B. Haldane, K.C., took the chair, and others present were Mr. A. Chamberlain, Sir R. Jebb, and Dr. Glazebrook. Mr. Haldane, in introducing the subject, explained that the laboratory, which was only supported by the State to a very small extent, was doing valuable work. Its object was to place the highest science at the disposal of the technical industries. The scientific knowledge and skill required was such that it was beyond the reach of the individual manufacturer, and he must look to some great organisation supported by the State to provide it. The National Physical Laboratory at Teddington was of immense use in the direction of testing in a scientific manner the products of industry, o carrying out experiments for manufacturers, of undertaking enquiries designed to obtain accurate standards, and dealing with scientific problems by which new processes might be developed. Its equipment was of the best, and the most eminent men were engaged in the work which was being carried on. Dr. Glazebrook, as director of the laboratory,

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gave an account of its aims and working, remarking that in this respect we were far behind the Germans, who not only realised the advantages of science, but endeavoured in every possible way to apply that science to the most modern industrial developments. English agencies, on the other hand, were imperfectly supported, or the machinery placed at their disposal was found to be hopelessly inadequate. Mr. Chamberlain remarked that in his judgment the great educational problem of the future was not how to improve our elementary or even our secondary, but how to deal with our highest education. Looked at purely as an investment, it was from higher education that we should gain the largest return. The National Physical Laboratory was performing a most valuable service, but it appeared to him that the modern universities were doing much the same kind of work. He was all in favour of State aid for any such institution, and quite agreed that the amount at present accorded was far too little, but he suggested that the best plan would be for the various bodies to make a united application to the Government. The following resolution was then adopted unanimously: "That this meeting, being satisfied of the necessity of further State aid to the National Physical Laboratory at Teddington, as regards both equipment and maintenance, requests the chairman and convenors of this meeting to prepare and present a memorial to the Chancellor of the Exchequer asking for such additional aid, and that the memorial be signed by the members here present, or who, being absent, may be in sympathy with its object."

Electric Cars versus Motor 'Buses.—At the Municipal Tramway Conference on Wednesday, Mr. W. A. Luntley, of the Wolverhampton Corporation tramways, made a contribution to the electric tram *versus* motor-'bus question, his paper, though comparatively brief, containing an excellent review of the general position. He approached the subject from two aspects—cost and quality of service. The usual difficulty confronted him in obtaining statistics as to the motor 'bus, few figures being yet available. Following expert opinion, he estimates the working charges, including depreciation at about 20 per cent., to be quite 11½d. per mile, and quotes an instance where the figure reached 1s. 6d. Taking the average working cost of the electric car at 9¾d. per mile, he shows a substantial margin in favour of the latter. Regarding maintenance and renewal of tyres, which is such a heavy item in the motor-'bus account, he remarks that the original cost of something over 2d. per mile has been reduced by the makers guaranteeing the life of the tyre, but he also points out that this arrangement may not last. Then, in regard to petrol, he suggests that the enormous quantity now being consumed may have the effect of enhancing the price, so that the motor-'bus proprietor is threatened with trouble in regard to two most important factors. Another point that Mr. Luntley directed attention to was the allowance for depreciation. This has generally been assumed at about 20 per cent., but with the rough work the 'buses will be called upon to perform Mr. Luntley thinks this figure may prove inadequate, especially as the vehicles are not so substantially constructed as trams. Regarding capacity, he emphasises the fact that a bogie car has almost double the accommodation of a motor 'bus, so that the earning power of the latter would be relatively smaller, and it would be necessary to proportionately increase the number of 'buses to cope with the traffic. Touching upon the reliability of the two services, Mr. Luntley, while agreeing that it is early to pronounce an opinion regarding the motor 'bus, indicates that the complicated mechanism of the latter renders it more susceptible to breakdowns. In regard to speed, the author considers that, though the motor 'bus may score in narrow thoroughfares owing to its elasticity, the tram will show a better average result. He also predicts that the tram will have the better of it in respect of accidents, as skidding on a greasy rail may be more than counterbalanced in the case of the motor 'bus by side-skids, over which there seems to be no control. The author sums up much on the lines of the leading article we published on this subject a few months ago, as, while he recognises that the motor 'bus has a most useful sphere of influence in catering for districts where the traffic is not decidedly heavy, he holds that the electric tram possesses distinct advantages in thickly-populated localities.

Municipal Trading—Lord Avebury's remarks on municipal trading before the Industrial Freedom League on the 30th ult. were prefaced by a general statement that "the portentous and rapidly-growing increase both of municipal and national expenditure has roused the anxiety of all thoughtful citizens." He illustrated his point by the London County Council's tramway system, concerning which he said "that the Council, having secured a most valuable property far below its real value, it would have been difficult not to make a profit. The profit had amounted to £293,000, but, as Sir Melvill Beachcroft had pointed out, over £200,000 had been received from the northern system under the lease, while the southern system, worked by the Council, had given only £80,000, and last year the profit claimed on the southern system was only £7,054 on a capital of £2,400,000. It seemed clear that if the London County Council had leased the southern system, instead of working it themselves, there would have been an advantage of over £120,000 to the London ratepayers. If the County Council had not prevented private enterprise from undertaking the operation of the tramways, but had granted facilities under stringent regulations as to the proper conduct of the service, the ratepayers would have profited by the arrangement without being involved in any risk, and the load of debt now incurred would not have stood in the way of other improvements." It is not the first time that Lord Avebury has commented upon the County Council's tramways, and each time he has done so he has judged the success of the undertaking by the profits that have been made. We pointed out before, and do so again now, that this method of comparison between company and municipal management is quite a fallacious one. In fact, Lord Avebury himself emphasises this by a statement further on in his address with reference to the Manchester gas undertaking. He said it had been claimed that Manchester reduced its rates in 1900-01 by 7d. in the £ through municipal trading. This was how it was done. The Corporation wanted a subsidy of £50,000 in relief of rates from the gas undertaking, and as there was no surplus, the price of gas was raised 3d. per 1,000ft. in order to yield it. This was quoted as a profit. It is clear from this that an increase in price to obtain a profit is deprecated by Lord Avebury, and yet he condemns the management of the London County Council tramways because they have so reduced the fares and increased the remuneration of drivers and conductors that the trams are worked without making a large profit. It is rather the value of the actual service rendered by a municipal undertaking than to the undistributed profit that attention should be drawn. At the recent meeting of the Municipal Electrical Association at Edinburgh the Lord Provost of Glasgow was most emphatic on this point, and deprecated any municipal undertaking making a profit for the reduction of rates.

London's "Charlottenburg."—A little while ago there was some apprehension as to the progress of the

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scheme for establishing a British technical foundation on the lines of Charlottenburg. The committee appointed by Lord Londonderry have just issued a preliminary report, which is prefaced by the observation that: "In considering the problem laid before us by the Government, we are impressed by the fact that the most urgent need in scientific education is the establishment of a centre in which the specialisation of the various branches of study and the equipment for the most advanced training and research should be such as ultimately to make it the chief technical school of the Empire." The report proceeds to state that it has evolved a comprehensive scheme for the purpose, but as private co-operation is essential to its realisation a series of preliminary conclusions have been formulated. If the various suggestions are found to meet with support, the committee anticipate that they will then be able to rapidly design a definite scheme. The conditions held to be necessary to the success of the project are as follows: "(1) The gift of a large capital sum (say not less than £100,000) for buildings and initial equipment; (2) the gift of a considerable additional site (say not less than four acres) at South Kensington; (3) the willingness of the Board of Education to allow their college at South Kensington to be brought into a scheme of common government and administration; (4) the similar willingness of the City and Guilds of London Institute in respect of their college at South Kensington; (5) the continuance of the Government contribution, including the necessary provision for the maintenance of the new laboratories and other buildings of the Royal College of Science, now approaching completion; (6) the continuance of the support given by the Corporation and livery companies of the city of London to the Central Technical Collge; (7) the provision (in the proposed College of Applied Science at South Kensington) of instruction is certain departments of engineering either by new foundation or by transfer and enlargement of part of the work of some existing college or colleges—*e.g.*, University College or King's College; (8) the co operation of the University of London; (9) the assurance of a sufficient maintenance fund." The committee then express confidence that private munificence will be prepared to provide a capital sum in excess of the minimum which the committee consider necessary, and that the additional site will also be forthcoming. The Board of Education have already announced their willingness to allow the Royal College of Science (including the Royal School of Mines) to be brought into the scheme under a common government and administration, and Lord Londonderry recently signified that the Chancellor of the Exchequer would probably see his way to extend financial support to the proposed institution. Several general suggestions are made as to the functions of the new institution, and the importance of a fully equipped school of mines is emphasised. The proposals are more or less in the embryonic stage at present, but the committee intimate that the scheme in view may be expected to result in the "establishment of an institution which will be pre eminent in its combination of advanced teaching in certain branches of applied science, with instruction in pure science also developed to a very high standard." The auguries now seem favourable to the realisation of a scheme which will provide Britain with a technical university that will compare with any foundation in the world, and the combination of State and private enterprise indicated above strikes us as a decidedly happy one.

The Telephone Transfer.—On the resumption of this enquiry on Monday by a committee of the House of Committee the municipal witnesses had another innings. Mr. H. E. Haward, comptroller of the London County Council, while admitting the force of the Post Office contention that without this agreement the company would be able to dictate terms in 1911, pointed out that the company would have been in a much greater difficulty by being in possession of property useless as a going concern to anyone but the Post Office. Moreover, the Post Office had the alternative of estaliahing at once a system which should between now and 1911 compete with the company either by way of unrestricted competition or limited competition, as it now prevailed in the London area, and in 1911 be ready to take over the company's subscribers. There would have been difficulties in the adoption of this course, but the Post Office would after 1911 have been in possession of a more modern and better equipped undertaking than would be probable if it purchased the company's plant and equipment. No evidence had been given to show that the Post Office would effect any substantial saving in purchasing the company's undertaking in the manner proposed, instead of establishing a new system. He considered that the agreement treated the company too liberally, and that the conditions of sale were not really mere "tramway terms." Mr. A. C. Morton, chairman of the Streets Committee of the Corporation of London, held that in order to justify the agreement it should be demonstrated that it would result in a thoroughly efficient service at a much reduced rate. Under such circumstances he should favour the transfer, but he had not heard any evidence that would encourage such a belief. Sir Wollaston Knocker, town clerk of Dover, stated the position of the Association of (non-telephone owning) Corporations, which through its Law Committee had passed a resolution approving of the Government's proposal, with a view to the early reduction of telephone charges, but urged that the Postmaster-General should make all necessary provision for safeguarding the general interests of municipalities with regard to wayleaves and to the breaking up of streets. On Tuesday Mr. W. E. L. Gaine, general manager of the National Telephone Company, was recalled, and replied to the case put forward on behalf of the municipalities owning telephonic systems. He alluded to the views of various witnesses that the company should be prevented from undercutting rates. But in every instance, he stated, the corporations had started undercutting by offering the service at lower rates than the company's. He condemned the internal plant employed in the municipal systems as being without exception obsolete. Dealing with the main claims put forward in behalf of the municipalities, he asserted that it was not open to the Postmaster-General to renew a municipal license and not at the same time renew the company's license in the same area. With regard to the claim of the municipal witnesses to local intercommunication between the company's system and those of the competing corporations, and that terminal fees should be abolished, he submitted that neither claim could be given effect to without disturbing parliamentary contracts. Competition in the telephone service was impossible if regard was to be had to efficiency and economy of working. In regard to the question of friction between competing local authorities, he stated that many difficulties would arise from the fact that in almost every case the telephone area comprised a large number of local authorities, the Manchester telephone area, for example, comprising the districts, in whole or in part, of 38 separate local authorities. As to the question of tariffs, he remarked that no comparison was of much value unless the local conditions were carefully examined and regard was had to the monetary standards of value in the various countries. Mr. John Gavey, engineer-in-chief to the Post Office, then gave his views in regard to technical questions that had arisen.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(*Concluded from page 913, Vol. XXXV.*)

WEDNESDAY, JUNE 28.

The second day of the convention involved a visit to Glasgow, where the members were welcomed by the Lord Provost (Sir John Ure Primrose) and the convener of the Electricity Committee (Bailie Willock).

The LORD PROVOST, in his speech, referred to past achievements in electrical engineering as wonderful, but thought we were at the day dawn of further progress. Electric power distribution would do much to purify the atmosphere and render factories possible in semi-rural districts. After a few remarks on municipal trading, he said that the sure way not to succeed was to depreciate the value of municipal service. He thought that the rewards offered by municipalities to those controlling their undertakings should be such as to attract the best men in commercial circles.

Bailie WILLOCK also welcomed the convention to Glasgow, after which a hearty vote of thanks was passed to these two gentlemen on the motion of the president.

Mr. HAMILTON KILGOUR, before reading the following paper, regretted that owing to ill-health the same was not completed. He also acknowledged the great help Mr. Faraday Proctor had rendered him in the preparation of the same.

Notes on Costs and Tariffs for Electric Supply.

BY HAMILTON KILGOUR, CHIEF ELECTRICAL ENGINEER, CHELTENHAM.

When an electric supply undertaking has but a single class of customers, as was generally the case a few years ago, a comparatively simple analysis of the costs of supply is all that is necessary in order to determine upon a suitable tariff; nowadays, however, most electric supply undertakings have at least two distinct classes of customers, and some have as many as four, with the result that a more detailed analysis of costs is essential if an appropriate tariff is to be established for each class. Some 12 months ago somewhat extensive inquiries were made as to the scales of charges obtaining in various towns for energy supplied for traction and as to the governing conditions which determined the agreed upon scales, and, through the kindness of brother engineers, a considerable amount of useful and instructive information was obtained. A study of the data disclosed not merely very considerable differences between the tariffs, which was quite natural, but also very considerable differences of opinion among engineers as to the proper allocations of the costs of supply as between, for instance, traction and general supply; and several engineers suggested, or acquiesced in the suggestion, that a meeting of those interested in traction supply should be held in order that a general interchange of ideas *re* traction cost allocations and tariffs should take place; it was, however, found impracticable to arrange for this last year.

The annual convention of the I.M.E.A. offers an eminently suitable opportunity for the discussion of such a subject as "cost allocations and tariffs," because, although certain important premises depend on purely technical bases, others—equally important—and the deductions to be made from all the premises depend on purely business considerations—thus, the subject is one for discussion by committee delegates quite as much as by engineers. Several very interesting and useful papers on costs of supply, tariffs, and methods of charging have been contributed from time to time by members of this association: but, mindful of the adage, *Omnia mutantur, nos et mutamur in illis*, and of the vital importance of the subject to all concerned with the management of electric supply undertakings, the submission of another paper is thought justified, and these notes have, therefore, been written in the hope that a full and useful discussion may result therefrom. To every student of the relation between costs and tariffs the question, "On what do costs of supply mainly depend?" will inevitably present itself at an early stage; and a knowledge of the correct answer, together with a proper understanding of all that the answer connotes, is an essential preliminary to any further (useful) study of the matter. The correct answer to the foregoing question is, "Costs of supply depend, in general, almost entirely upon the liabilities undertaken, and but little upon the actual supply given." The liabilities undertaken are twofold in character, since acceptance of anyone as a customer renders it obligatory to provide the necessary plant, mains, etc., for giving him supply at the greatest rate he chooses to name in his application, and also to so run the plant that the customer may have supply as and when he requires it—subject only to his not exceeding the rate of supply applied for as a maximum.

The capital expenditure upon an electric supply undertaking is, of course, absolutely determined by the total liabilities undertaken, or thought to have been undertaken, by the acceptance of customers; hence all annual charges upon capital, whether compulsory or optional, are similarly determined and are quite independent of whether supply is, or is not, actually given to customers. The compulsory annual charges are those for interest and sinking fund, and the optional those for insurances in respect to property. The revenue expenditure* of an electric supply undertaking, or its annual cost as a going concern, is obviously divisible into two distinct parts—viz., that dependent upon the liability undertaken to give supply as and when required by the customers, and that dependent upon the extent to which customers avail themselves of their opportunities for taking supply; these two kinds of costs are often called the "cost of getting ready to give supply" and the "running cost" respectively, and the former plus the annual charges on capital is usually called the "stand-by cost." No one of these three terms is very aptly descriptive of the cost to which it refers, but pending agreement as to a more appropriate nomenclature, it will be convenient to employ them. The "cost of getting ready to give supply" clearly includes all costs of distribution, of meter reading and maintenance, and of management (in fact, all costs except those of rates and taxes and of labour and materials employed at the works), since these solely depend upon the number and kinds of customers connected, and upon their topographical distribution; it is indisputable also that a part of the works' costs is due to the undertakers' obligation to be always ready to give supply, *i.e.*, to have an adequate quantity of machinery running and an adequate number of men on duty at every moment of every day. The quantity of plant (boilers, engines, dynamos, and auxiliaries) in use, and the quantity of labour in attendance thereon, at any particular instant in a works are determined entirely by the expectation of load proper to that instant; if the expectation is realised energy will be supplied, and coal and water used, at certain rates; if the expectation is not fully realised energy will be supplied, and coal and water used, at less rates; and in the extreme case of the expectation being wholly falsified by the load falling to zero, no energy will be supplied, and coal and water will be used at the minimum rates consistent with adequate provision for coping with the expected load. As regards items of expenditure other than those for labour (attendance and supervision), coal and water, it makes, in general, very little difference whether the expectation of load is fully realised or wholly falsified, or, in other words, whether the plant runs loaded or light, according to a given time-table of use. The effect of a load may be to slightly increase the quantities of oil and sundries used, the quantity of boiler scale formed, and the repairs and maintenance required; but since the total costs of these items are small compared with the total costs of labour and coal, small variations in them may be regarded as unimportant, especially in cases of bad load factor.

The usual method of ascertaining the average value of the "running cost" per unit generated is to subtract the total works cost of the six light-load months from the total works cost of the six heavy-load months, and to divide the remainder by the difference in the numbers of units generated in these two periods; not infrequently and more properly, as appears from what has been already stated, engineers take for this purpose the costs of coal and water alone instead of the total works' costs. Each of these two methods will usually give too large a value for the "running cost" aforesaid, in spite of the fact that in most works plant is run under less economical condition—*i.e.*, at lower average plant load factors—during the six light-load months than during the six heavy-load months. For works in which it is customary to make periodic steam consumption tests on each unit of plant (including auxiliaries), and in which the coal required per hour is known (approximately) for each boiler (*a*) at full steam pressure—stop valve closed, (*b*) banked; the average value of the "running cost" per unit generated can be obtained directly from the performance records (log sheets or summaries of them) of the various units of plant. In a modern works with fairly large units the average value of the "running cost" per unit generated should not exceed ½d., unless the circumstances are peculiarly adverse. At the Cheltenham works, which have been running for more than 10 years, and which have rather small units in consequence of both alternating and continuous current supply being given, the average value of the "running cost" per unit generated in a certain year was 0·25d. according to the second method of estimation described, and 0·23d. according to the third; the author believes the latter value to be the more nearly correct.

* Exclusive of that incurred for and reimbursed by customers on account of materials and labour supplied for their installations; this expenditure includes that for carbons, trimming, etc., of street lamps, which are virtually installations belonging to the public lighting authority.

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The works' "cost of getting (or keeping) ready to give supply" during a particular period is, of course, the difference between the total works' costs for that period and the total "running cost" of the energy generated therein; in general, it will be found that the ratio of the works' "cost of getting ready to give supply" to the total works' "running cost" for any year ranges from about 3 to 1 for a bad load factor and a small output, up to about 1 to 1 for a very good load factor and a fairly large output. The total "cost of getting ready to give supply" is, as stated earlier, the corresponding works' cost plus the costs of distribution, of meter reading and maintenance, and of management; and the "stand-by cost" is the total "cost of getting ready to give supply" plus the charges on capital. It is, therefore, obvious that the "stand-by cost" of an undertaking must, in general, be very much larger than its total "running cost." The annual charges against an undertaking for rates and taxes are totally different in character from any of the costs and charges previously considered. Thus, local rates are supposed to be proportional to the rent a hypothetical tenant would be willing to pay for the undertaking, and income tax is proportional to the gross profit less an allowance for depreciation. Virtually, therefore, both rates and taxes depend on the actual, or—as the case may be—the presumably possible trading results, and should be regarded as first charges upon the profits rather than as elements in the cost of working: for this reason it appears not merely convenient, but also correct to take no account of them when considering costs—they have, of course, to be allowed for when settling tariffs.

With reference to the undertaking as a whole—and so far this aspect of it has alone been considered—the conclusions arrived at may be summarised as follows: (1) The total annual costs are divisible into two distinct parts—(*a*) "stand-by costs," or costs entirely dependent upon liabilities; (*b*) "running costs," or costs entirely dependent upon the quantity of energy actually generated. (2) The profits of the undertaking are subject to an annual charge for rates and taxes, and should, therefore, be at least sufficient to defray this charge. In general it is quite impossible to ascertain precisely the actual cost of the supply given in any particular year to any particular customer; and were it possible to ascertain the supply cost of every single customer of an undertaking, the expense of the work involved would be prohibitive. It follows, therefore, that it is quite impracticable to frame a tariff which is equitable in the sense that it will ensure that every customer is charged his supply cost plus a fixed percentage. If, however, the customers be grouped into a few distinct classes, each with well-defined characteristics in respect to the liabilities of the undertaking towards it, and different supply costs of the different classes can often be approximately ascertained, and a tariff, or set of tariffs, can be determined which will ensure that each class pays its supply cost plus the same percentage. The tariff for each class may take the form of a flat rate, which has the great advantage of simplicity and the great disadvantage of discouraging the profitable and encouraging the unprofitable customers, or of a sliding scale based, for instance, on either the Hopkinson or the Wright system.

Every method by which it is sought to divide the total annual costs of an undertaking equitably among certain different classes of customers must comprise three principal operations—viz., (1) the allocation of the energy wasted in distribution, and of the energy used in the works, offices, etc., between the different classes of customers, so that the number of units *generated* for each class—and, therefrom, its total "running cost"—may be known; (2) the allocation of the total capital expenditure between the different classes of customers so that the annual capital charge proper to each may be known; (3) the allocation of the total "cost of getting ready to give supply between the different classes of customers." And when these allocations have been more or less satisfactorily made, it remains to allocate the annual charge for rates and taxes. Now, each of the three operations mentioned may be regarded as comprising two subsidiary and distinct operations—viz., the allocation of energy wasted or used, or, as the case may be, of cost incurred, specifically in connection with a particular class of customers, and the allocation of energy wasted or used, or of cost incurred, without special relation to any particular class; the former kind of allocation is simple and generally quite easy, the latter is very difficult and sometimes exceedingly laborious.

Until comparatively recently the author thought, as he believes many do still, that it was desirable to attempt an equitable allocation of the total annual costs of an undertaking between such different classes of customers as those taking electric supply of private lighting, motors, public lighting, and traction; also, that by comparing the allocated cost of each class with the income derived from it some useful conclusions might be arrived at; he has since become convinced, however, that equity has nothing to do with the matter. The proper way of viewing the question is to recognise that the total annual costs of an undertaking include a general establishment charge besides the actual annual costs of the different classes of customers—the actual annual cost of any given class of customer being defined as the amount by which the total annual cost of the undertaking would have been less had the class of customers never existed and had no provision, therefore, been made for giving supply to it. It is necessary to add that, under certain circumstances, the actual annual cost (as before defined) of a particular class of customers may increase abnormally—that is to say, the precise duplication of every individual customer may cause the actual annual cost of the class to be more than doubled; for instance, at a particular epoch in an undertaking's history it may easily happen that, had a certain class of customers never existed, the capital expenditure (and, as a consequence, the capital charges) would not have been less to any appreciable extent, and, therefore, that the actual annual cost for the said class of customers may be surprisingly small. It may also happen that at the epoch considered it may be possible to distribute the bulk of the general establishment charges among the other classes of customers, and so to offer specially favourable terms to a particular class without immediate loss resulting therefrom. Now it is not unlikely that the favoured class of customers will grow at a much more rapid rate than the remaining classes, and it is possible that it may become more important (in respect to its use of energy and to its maximum rate of use of energy) than all the other customers taken together, with the result that the actual annual cost of this class may increase very considerably, and, unless the tariff be revised, may lead to supply being given at an absolute loss. The moral is that not merely the actual annual costs of the present, but also those reasonably probable in the future, should be considered when settling tariffs and the reference is to day-load (motor) customers.

Just as the total annual cost of an undertaking is influenced mainly by the liabilities undertaken for giving supply as and when the customers generally require it, so in regard to any particular class of customers the cost of supply is mainly determined by the liabilities assumed with respect to it, and it may be well to briefly discuss now some of the characteristics in regard to liabilities of the four classes of customers previously mentioned—viz., those for private lighting, motors, public lighting, and traction. The liability of an undertaking towards an individual customer or towards a class of customer depends on (1) the maximum demand—possible and probable; (2) the time or times at which the maximum demand occurs; (3) the duration of the maximum demand or of a demand nearly equal to the maximum; (4) the degree of knowledge possible with reference to the variations of the demand with time; and (5) the periods, if any, during which supply may be discontinued. In the case of ordinary customers for lighting experience has proved that the maximum demand, or greatest actual rate of supply, of almost every customer is considerably less than the demand possible with his installation; also that the maximum demands of all these customers are by no means simultaneous; the net result being that the maximum load, or maximum demand, on the works is from 45 to 65 per cent. of the maximum possible load—thus, the actual liability, in respect to provision of plant (and, in a lesser degree, of mains, etc.) and in respect to capacity of running plant, is very much less than the apparent liability. Again, with regard to the predicated class of customers, experience has demonstrated that the time-load curves of one year are very similar, except, perhaps, in the first two or three years, to those of another, and that a time-table of actual liability can be drawn up with a fair amount of accuracy; such a time-table will show, of course, a relatively small liability, except during a few hours daily, in which the liability will rapidly increase to a maximum (variable with time of year), and then more slowly diminish. Discontinuity of supply to private customers for lighting is usually possible without these suffering inconvenience in the hours of broad daylight, but is not possible during the hours of heavy load; hence work on mains is easily arranged for, but spare plant is necessary at the works, and, on account of the period during which the load on the works exceeds 90 per cent. of its maximum value lasting for some three hours in winter, the plant capacity cannot be taken at an overload rate.

Mr. H. FARADAY PROCTOR, of Bristol, opened the discussion, and disclaimed the credit given him by the author. He had wished to help, but business had prevented him from doing more than discuss the question with Mr. Kilgour. He thought the paper would do much to educate committees and chairmen on the reasons for different charges being necessary to various classes of consumers. The great difference even between the lighting of churches and the lighting of streets showed the need for such a variation in charges. He agreed with the author's method of ascertaining the running costs. The result obtained of about $\frac{1}{2}$d. per unit agreed well with that given in Councillor Sinclair's paper read on Tuesday. The method described of dealing with rates and taxes in dividing up the costs was reason-

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able. A system of different charges which varied with the class of consumers was the best.

Mr. C. E. C. SHAWFIELD, of Wolverhampton, differed from the author in his classification of rates and taxes amongst the running charges. These had to be paid even if no profits were made. A flat rate was not fair to different classes of consumers, as, for instance, public-houses and offices. He thought that they should have power to make higher charges to consumers at a distance from the power-house. Rather too much was made of calculation of the works' costs of supply when fixing tariffs. They should rather take courage and fix their prices to compete with rival undertakings, and then so organise their works that the costs were reduced to the desired amount.

Alderman IRVINE, of Blackpool, said that the maximum demand system met the case, but that, owing to the difficulty of explaining this to consumers, he preferred the flat rate charge. Committees had to consider the electors when discussing this question.

Mr. R. B. LEITCH, of Farnworth, did not consider the maximum demand system satisfactory. A flat rate with discounts in proportion to the load factor would be more readily understood by consumers. This was what gas companies did.

Alderman ELVEY ROBB, of Tunbridge Wells, thought it a difficult matter to find a satisfactory alternative to the demand indicators. It was a mistake to ask consumers to use apparatus involving calculations to determine charges. He believed that a flat rate would meet ordinary cases, and that special terms should be given to exceptional consumers. He believed that under the Acts they had power to make such special agreements.

Mr. J. F. C SNELL, of Sunderland, agreed with the maximum demand principle, and it could be applied, generally, by flat rates to different classes of consumers. In fixing tariffs a tortuous method of calculation from present costs was apt to frighten committees. He thought it a good method to first ascertain the standing charges and works' costs as at present, then to calculate what these would be a few years hence, and fix the tariff between the two limits, taking reasonable care to be on the right side. He did not agree at all with the author in his statement that equity had nothing to do with the matter. He needed to take every effort to get an equitable system of charging different consumers.

Alderman PEARSON, of Bristol, advised all chairmen to take their engineers' opinions on tariff as they would do on methods of working. He had found flat rates with discounts up to 30 per cent. for light and 20 per cent. for power satisfactory. As regards special charges, the present town clerk of Bristol considered that they had powers under their provisional orders to give special rates to individual consumers. Both the distance of the consumer from the station and his hours of use should be considered when fixing special rates.

Alderman KEMP, of Aberdeen, said that all classes of consumers should get fair play, and that the demand indicator offered the fairest system of charging. As chairman of both the Gas and Electricity Committees of Aberdeen, he was only concerned in seeing that people got the best light by either system at the lowest cost. It was not feasible to vary the charge with the distance from the works.

Mr. KILGOUR reserved the most of his reply, but said that any system of varying charges with the position of the consumer would be unfair. The location of the works was determined for engineering reasons, and all within the area should be treated alike.

The Supply of Electricity in Industrial Areas from a Municipal Point of View.

BY COUNCILLOR WILLIAM HODGSON, DEPUTY CHAIRMAN OF SALFORD CORPORATION ELECTRICITY COMMITTEE.

In the compilation of any up-to-date issue of an encyclopædia, the article under the title "Electricity" will require a very lengthy, technical, and comprehensive description to convey fully the varied uses, recent developments, and capabilities of this subtle force. Those interested have only to compare the heading under "Electricity" in the "Encyclopædia Britannica" recently reprinted by the *Times*, to note the very great and rapid changes which have taken place since 1879, before which year the electrical industry was unknown. The unprecedented and striking progress made in 25 years in what may be called "commercial electricity" has been very marked and significant, a progress much more rapid and extensive than has been accomplished by any previous engineering or scientific change, not excepting even the great invention and introduction of the steam-engine of a century ago, which produced such a complete revolution in the commercial and manufacturing industries of this and other countries. To this very pronounced and momentous change and the far-reaching and important effect it has and will have upon municipal electrical undertakings may be attributed the appearance of this paper. If it is the means of creating increased interest by all concerned and of assisting them in dealing with the important issues involved, the author will be well repaid.

Electric tramways and railways are recent illustrations of the practical application of electricity, but their advent is only of minor importance compared with the "upheaving" throughout the world which the extensive varied commercial and industrial use of electric power is now forcing into prominence. Electricity is now generally acknowledged to be the most controllable and versatile form of energy yet discovered by man. The near future will *demand* a supply of cheap electric power to be available whenever and wherever it is wanted, and whilst making no attempt at prophesying, the author is strongly of the opinion that the direct use of steam power will wane and become in a few years probably as "ancient" as water mills are now. It is this new and unforeseen condition of things, coupled with the clearly demonstrated and increasing demand (and to which there seems no limit) of recent years for electricity for *all* purposes, which puts additional responsibility upon the committee entrusted with the carrying out of the electricity "order" of municipalities which have already undertaken the generation, supply, and distribution of electricity for light and power to private consumers and energy for their tramways, and they must, therefore, give it the careful thought and consideration it demands. Experience has already shown that even in so short a time most committees are finding themselves compelled by these changes which have been forced upon them to decide—if their undertaking is to be of a progressive nature and having regard to the size and capacity of plant already installed, which in consequence of steady and increasing demand is rapidly approaching its maximum output—whether a further extension on a comprehensive scale of such plant or works is desirable.

To arrive at a sound conclusion, the members of the committee are called upon to consider not only *their* direct responsibility to carry out the "order" for their corporation to supply electricity within the area named, and in accordance with the general conditions of such "order," but whether they, as representing for the time being the general body of ratepayers, who find the capital and whose pockets are affected, and who are seriously concerned in both present and future prospects—should encourage and promote a further and increased application and development of electricity for *all* industrial demands. They must also guard against what seems to be the tendency of the present time—viz., to unduly increase municipal liabilities—by taking care that any scheme or extension they recommend for adoption shall not only have full consideration, but that there must be some reasonable prospect of an adequate return from such outlay, and that it will not become an additional charge upon the already overburdened ratepayers. It is obvious that engineering, commercial, and financial policy enter into the question, and each in turn must have full consideration by committees when determining conclusively a sound future line of action upon which so much depends. Electricity works are not now placed under the category of "scientific experiments." They have entered into the running of commercial enterprises, and the first consideration now is whether they can be successful from what is called a "business" or "will-it-pay" standpoint, which, after all, is of paramount importance, and any new development or extension will have to answer *this* test. The engineering, scientific, and technical section of the undertaking must act in harmony and sympathy with, and to a large extent be controlled by, enforced commercial and financial considerations, these two latter being often by their supreme importance placed in front of engineering achievements.

It is universally admitted that the use of electricity for almost all purposes has made enormous advances in recent years, and there is no sign of the rate of progress slackening. In fact, this admission, so very apparent along with definite and conclusive figures which could be given if necessary, declares undoubtedly in favour of its still increasing extension. The electrical world seems to have entered upon a new and vigorous phase, opening up new possibilities and imposing new or altered conditions, and it is incumbent upon those responsible to realise and grasp intelligently the new state of things, and to lay themselves out for coping with this new but pronounced

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demand, by either adding to their present stations or making provision for others on the most economic "up-to-date" lines. These conditions being acknowledged, the committee having charge of this important branch of municipal work cannot assume a passive indifference, and, Micawber-like, wait for "something turning up." They must perforce also take seriously into their notice the fact that recent events are revealing the tendency of bringing into being large power companies in different parts of the country with practically unlimited capital, whose schemes involve the putting down of immense plant with the object of supplying current for all purposes cheaply in manufacturing and residential districts. These power companies covering vast areas are now in evidence, and have in some cases commenced operations, and they are offering prices for a combined lighting and power supply such as the municipalities have not even thought of—for instance, in the neighbourhood of Manchester, contracts are being made by a power company at prices varying between ½d. and ¾d. per unit. There are also other projected companies now seeking parliamentary powers to supply in areas already covered by "orders" granted to municipal authorities.

With these facts before them, and having in view the prospect of competition, electricity committees would be unwise in adopting a "dog-in-the-manger" policy; they must now face the situation imposed upon them, and act in and for the interests of their constituents, and at the same time arrive at a clear and definite policy for future working. It must be borne in mind that, in order to obtain consumers, the power companies have frequently to transmit their power several miles, involving heavy capital outlay on cables, and an appreciable maintenance charge. If the power companies can afford to supply at the low figure mentioned in spite of the distance over which the power has to be transmitted, surely the municipalities, with the demand for energy at their very door, can do so even better. What, then, is the reason that municipalities have not yet been in a position to offer the low rates for power such as the power companies are now contracting for? The answer seems to be two-fold: (*a*) they have not realised the possibilities of power supply on a large scale, and are consequently not prepared for it; (*b*) they have hitherto hesitated to lay out the large sums of money required for adequately dealing with the problem.

With regard to the first reason, it is now evident that there is a demand for cheap electrical power, and that the demand can be met and consumers supplied at a reasonable profit from power stations designed on broad lines, but with strict regard to economy in both buildings and equipment, such a station would probably be designed for high-voltage plant on account of the heavy powers to be dealt with, but it would work economically in conjunction with a low-tension station, such as is usually found in most industrial areas. It would probably be possible to shut down the power station altogether during certain hours of the night, the supply being maintained from the low-tension station. In the next place, with regard to the financial problem involved in a general power supply, the Legislature has placed upon corporations certain clearly defined responsibilities—in fact, in their areas they have, generally speaking, been given "for better or for worse" a monopoly of the supply of electrical energy. It is, therefore, the duty of municipalities to see that the privileges and advantages which the power companies are offering the country districts are available also for town areas; in other words, the municipalities, having been given a monopoly within their area of the public supply of electricity, are bound to undertake the supply of power on a sufficiently liberal scale to ensure the town manufacturers, often large ratepayers and employers of labour, the same facilities as will shortly be available in the country, and should they fail in their duty in this respect, they must not be surprised if the Legislature curtails the present monopoly and grants to power companies the rights to supply power to users in municipal areas.

Large towns, probably towns of 100,000 inhabitants and upwards, can undoubtedly deal with the problem themselves in a highly economical manner, but it is quite possible that small towns may find it advisable to take power in bulk from a power company, but local conditions may largely enter into the question, and must be carefully considered in each case. It must not be overlooked, and may at once be conceded, that ratepayers requiring power have also rights and privileges which must be recognised and ought not to be set aside, and municipalities should learn that it is inexpedient to stand between such ratepayers and a cheap supply of electricity for power purposes, which would probably mean the increased development of the district. This fact ought to induce them to adopt a sound progressive policy, or give facilities to a power company to provide what they are either unwilling or unable to furnish—*i.e.*, electrical power at the lowest rates. Municipalities have many advantages over companies. They have compact areas, goodwill, financial strength, and the necessary parliamentary powers; all that is required is for them to meet the exigencies of the situation and cater for the demand which has undoubtedly arisen; failing the adoption of this course, it is their duty to assist and not prevent others who are prepared to do so from carrying out the work. With plant rapidly approaching its full capacity, electricity committees are now, therefore, faced with the question, and must answer it: Is new additional plant to be put down by them with a view to affording manufacturers a cheap supply of electrical power with a probable small margin of profit to the corporation? or is the alternative to be adopted—viz., to maintain the present comparatively high price of current, with its tendency to discourage large consumers, and so render further extensions unnecessary, or, in other words, contribute to their own extinction? The author has no doubt that the right decision of the committee would be to answer the question in the affirmative and determine upon a progressive policy.

The trend of financial, expert, and progressive opinion is to make or produce electricity so cheap that no one will be able to do without it. This may be a high and laudable ambition, but if that application can only be realised, we cannot tell what advantages it may bring to both industrial and residential areas. It is more than an aspiration, it is a probability, and its accomplishment would mean the providing of cheap power for trains as well as trams. It would operate docks and canals, it would dispense with the unsightly tall factory and works chimneys for ever belching forth dense black smoke, it would shut down the thousands of chimneys of dwelling-houses through which the air-polluting domestic fires emit their poisonous atmosphere, and which are so largely responsible for the fogs experienced in our large cities and towns; in their place we should have cheap light, power, and heat, besides other apparent advantages, the description of which is outside the scope of this paper.

In summarising the subject, the leading or principal factors which municipalities are bound to give their attention to seem to be: (1) the demand on all sides for *cheap* electricity; (2) the recognised and acknowledged use of electricity as an economic agent in the transmission of energy; (3) its coming universal application; (4) the claims of their own ratepayers; (5) the effect of the new and increased demand upon present generating stations; (6) the advent of large power companies and possible competition; (7) the course of action of those responsible under the new conditions.

Alderman PEARSON, of Bristol, opened the discussion, and said that the Corporation of his city recognised that the electrical future of the city was in their hands. They had no idea of allowing a power company to come in to compete with them. The means they took to prevent it was to so conduct their undertaking that they could not be competed with. They had no fear of incurring a proper outlay in extensions, and did not look upon this outlay as an additional indebtedness, but rather as a municipal investment. As long as they could raise money so much cheaper than a company, he felt sure that their district was safe. He thought, however, that if a municipal undertaking could not supply power at about 1d. per unit, they had failed to fulfil their duties, and must be prepared to accept competition. In their case, within six months of the power company's Bill being passed £125,000 was voted for new machinery to supply power consumers. It was true that they now had to pay about 3½ per cent. for their money, but companies could not get it for that. The recent return made to Lord Camperdown's Committee showed that out of 23 Power Bills which had been passed only six of the companies were in active operation. He thought that a great number of the proposed companies would never be heard of again. The reason was that it was cheaper to supply power to consumers who were reasonably near together than when they were scattered over a large area. This favoured the municipal undertaker. A cheap supply of power also tended to attract manufacturers to a town.

Alderman IVEY, of West Ham, said that there was no monopoly conferred on the holder of a municipal order. He quoted the case of Finchley to show that by means of overhead wires a supply could be given without statutory powers. He thought it was the fault of the municipal authorities that there was a risk of their losing the sole right to supply electrical energy in their districts, and also that certain municipal undertakings had not paid. Electricity stations had been put down in exceedingly bad positions, where the cost of coal transport was great and there was no water for condensing purposes. He thought that they should be more ready to push their undertakings, so as to be in a position to supply any consumer. The policy of waiting for an assured margin of profit before

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making extensions was responsible for the present position. Alderman BUZZEY, of Poplar, also urged those present to increase their equipments so as to develop power load. In this way, by catering for all consumers, they should be able to keep out the power companies. He considered that the power company now under consideration before the House of Commons would prove, if passed, to be a monopoly which would afterwards have to be bought out at a very high price, as the water companies had been. He thought that even now the promoters would be prepared to sell their Bill.

Alderman BRUCE, of Sunderland, explained the position his undertaking occupied as to the supply of power in bulk. The area around was in the hands of a power company, but under the advice of their engineer, Mr. Snell, they had spent £75,000 on the extension of their plant. By means of this they were able to supply the shipyards and engineering works within their area, and to save them putting in their own generating plants. They had one contract for five years at the rate of 1⅛d. per unit. He questioned the lower prices which were given in the paper, and thought that they must be for the supply of high-tension current, which would have to be transformed. As a result of their power supply, they had been able to give a 10 per cent. reduction to their lighting consumers. Their power factor had gone up from 17 per cent. to 22 per cent., and they expected it would reach 26 per cent. when more power consumers were supplied.

Bailie MCPHERSON, of Edinburgh, did not think Alderman Ivey's suggestion of supply from overhead wires as at Finchley could be generally applied. It was the corporations lagging behind which led to the companies obtaining powers, and they must keep pace with the times to check the tendency in parliamentary circles, which at present was to encourage company trading.

Mr. H. FARADAY PROCTOR, of Bristol, said that his undertaking were now supplying one consumer at the rate of $\frac{13}{16}$d. per unit, and he thought that the contract was a profitable one. He deprecated any disinclination to trust engineers on financial matters, as to supply cheaply was the great aim of the engineer. He quoted the American saying that "an engineer was a man who could do for one dollar what any fool could do for two."

Mr. A. H. SHAW, of Ilford, said that the Tyneside Company were supplying motors and other accessories to their consumers as well as power. Unfortunately, many local authorities had not power to do this.

Mr. J. H. SNELL, of Sunderland, defended the price of 1⅛d. per unit, which one speaker had thought was too high. He had found that of two private installations in Sunderland the cost of production in one case was 1⅛d. per unit, and in the other 1·08d. He thought, therefore, that the Corporation were quite right in charging 1⅛d. per unit if consumers could be obtained on those terms. The Tyneside Company did supply motors, and the loan charges for them were heavy. He thought that frequently the electrical energy was sold at too low a rate, and the loss made up out of the high rates obtained for motors.

Councillor HODGSON, in a short reply, said that the holders of municipal orders practically have had a monopoly up to the present time. He thought that they should keep companies out by supplying cheaply. He could give no further details as to the supply for which ½d. to ¾d. per unit had been quoted. In his area they were just bringing into force a new tariff, under which motors could be supplied at 1⅛d. for the first 1,000 units for the first quarter, and 1d. per unit for all above this.

At the close of the meeting the members of the association were entertained at luncheon by the Corporation in the City Chambers. Lord Provost Sir John Ure Primrose presided, and there were about 350 seated at the tables.

The LORD PROVOST, proposing the toast of "The Incorporated Municipal Electrical Association," remarked that to-day no dwelling could be considered up-to-date, and even in the highest sense sanitary, unless electric lighting was the method of illumination, and a city could not be classed as in the first rank which had horse haulage on its tramway system. He ventured, however, to caution both officials and members of public corporations, in seeking to further these municipal undertakings, to bear in mind that they were founded and built up at great capital cost, in these progressive days, without any certain tenure of life, and that it was necessary, therefore, that sinking funds and reserve funds be built up, and profits not taken for the relief of the rates.

THURSDAY, JUNE 29.

Extensions to Outlying Areas.

BY A. B. MOUNTAIN, CHIEF ELECTRICAL ENGINEER, HUDDERSFIELD.

The Municipal Electrical Association, at its first annual convention, held in 1896, discussed an important paper read by Mr. A. H. Gibbings upon "Extensions to Outlying Districts," the consideration then being confined to the value of extending mains from the central portion of a town to its residential suburbs. The discussion upon this paper was most interesting, and will well repay members for reading again. To somewhat reduce the scope of this paper, it is proposed to confine the problem to extensions to the urban or rural districts, which in so many cases are found surrounding the incorporated areas, and into which the population of such towns has extended or is now spreading. In the author's opinion, the subject requires consideration from two distinct points of view: (1) the policy of extending the area of supply into districts governed by other authorities; (2) the engineering problems connected with such extensions.

Considering, first, the question of policy, it may be well to think of the probable development in matters of municipal government and the position of our electrical and other undertakings in the future. The work of the municipal authorities has during the last 30 years been enormously extended, not only in the direction of public improvements to streets, efficient drainage, public recreation grounds, and other work connected with and necessary for the better development of public health, but the control of such important undertakings as the supply of water, gas, electricity, and trams has involved the authorities in works in the nature of trading undertakings requiring special knowledge and most careful management. The control of education has still further increased their responsibilities. In the author's opinion, the duties of the authorities must be still further increased by the addition of many other matters, including the work now undertaken by the guardians of the poor, as it seems ridiculous to suppose that the authorities responsible for the good government of a city in all other matters should not be able to look after its poor, and the enlargement of the boundaries of the boroughs or cities to cover the areas now under the direction of the guardians must sooner or later follow.

The problem of housing the working classes is now receiving the earnest attention of the councils of many of our large cities, and electric traction has simplified the solution to a large extent, by enabling the working classes to live a considerable distance from their work. Obviously, the fact of spreading the population over a greater area must be of advantage from the sanitary or public health point of view, and the rents of houses constructed in the outer districts should be considerably lower, but the central authority, by adopting this course, would possibly reduce the rateable value of its own area, while increasing that of the outer districts, and deprive its trading department of revenue, unless these commodities were extended to such areas. The fact that large works are now being built in these outer districts, owing to the lower cost of land, and in many cases lower rates, is a serious matter for the central area financially, although no doubt very desirable, as it enables the workman to live in a healthy district yet close to his work. The extension of tramways has largely assisted this movement, and if cheap electricity can be provided for motive power and lighting a still further drifting of the population should ensue. Many corporations are supplying water and gas, and a few are supplying electricity to the adjacent areas, and in practically every case are charging from 10 to 25 per cent. more outside the boundary of their own area.

It is difficult, at the present time, to understand how and why the existing boundaries were formed, and it would certainly seem extremely desirable to have a readjustment. We find in some cases two towns actually side by side, managed separately with duplicate undertakings, which could by combination even now effect very considerable economies; or, in other cases, we find the central or principal area surrounded by districts in which the actual workers of the town reside, whose interests are identical with both areas, and yet, in many cases, the question of amalgamation has not been seriously considered. By deferring amalgamation enormous sums of money have been practically wasted upon the duplication of sewerage, water, gas, tramways, electrical, and many other works or departments, which could be more economically and successfully managed by one central authority controlling a large area. The argument of the outer

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areas is nearly always based upon the fact that rates are lower in their area than in the central one, but this is only because their responsibilities are less, and the advantage in the rates is often more than counterbalanced by the increased charge for water, gas, and electricity. It is exceedingly difficult to define the limit of expansion for the boundaries of a town; it must depend, to some extent, upon the density of its population and the geographical surroundings; but assuming the question of housing the working classes to be a controlling point, the limit of residence from the centre of the town would be the time which it would be reasonable to allow for travelling night and morning, and assuming this to be half an hour, it would mean, taking 10 miles per hour as the speed of travelling, that the limit of residence would be within a radius of about five miles, and this would represent an area of 50,265 acres.

It was not suggested that it is advisable for one town to attempt to undertake the supply of other distant towns or villages, even although this is quite possible, and might, in some cases, prove financially successful; but it would seem to the author to be the actual duty of all the large central authorities to extend the electric supply mains into those districts immediately surrounding the central area, if it is considered probable that future extensions of their boundaries will bring these districts under the control of the central authority. If this will not be the case, the matter becomes a question of municipal trading, and it must be considered upon purely business lines. In many cases it will, no doubt, be profitable, but the revenue obtainable from the outer districts is usually small in proportion to the capital expended, and although the price may be increased to the statutory limit, this will tend to reduce the demand, and be of little advantage. The price to be charged for the energy supplied to the districts outside the control of the central authority involves several complicated points: the districts bear no risk of contributing to any losses upon the undertaking, nor do they receive any profit, but they contribute towards the repayment of capital or purchase of the works, which eventually belong to the central authority, so that the charge might be uniform throughout the whole area, if it were not for the fact that the cost of supplying such outer districts, owing to the increased capital outlay per consumer, is more than for the central position of the area. In most cases an additional charge of 10 per cent. would be ample protection, and, as will be shown later on, the cost of supplying electricity in the case of a small village installation is so low that it is doubtful if more than this could be obtained. If it be considered desirable to supply the outlying areas, a commencement should be made as soon as possible, because the neighbouring power company will certainly endeavour to supply these areas, and should they succeed and the area afterwards become amalgamated, it will no doubt be a costly operation to buy out the company.

Engineering Consideration.

Assuming that there are outlying districts within five miles of the centre of the town, and that such districts have a scattered residential population, with the houses on the sides of the main roads or in the form of small villages, it is obvious that the cost of mains per consumer will be very much heavier than in the central portion of the area, and it is also a fact that the revenue or units sold per lamp is less; consequently, it would not be profitable to undertake the supply upon the same lines adopted in the town unless such supply was a high-pressure one. But as most towns, owing to the development of traction and motive power, are now generating high-pressure alternating currents, the cost of mains may be, by the use of such high pressure, considerably reduced, and it is comparatively easy and economical to deal with extensions within the limits suggested. It is, of course, quite impossible to apply general rules to individual cases; the conditions will probably not be identical in any two areas, but if the outer districts to be supplied are of a residential character, the most suitable and economical arrangement would be to carry the high-pressure alternating current either one, two, or three phase by underground mains to the approximate centre of each village, reducing the pressure by static transformers and distributing by overhead wires.

The methods adopted for transformation and distribution will, to a considerable extent, depend upon the magnitude of the demand; if large, rotary converters can be employed with direct-current distribution, but in most cases it will be found more economical to employ static transformers, and the fact that the latter require practically no attention will help considerably to reduce the cost of supply. One of the advantages of alternating current for distribution is that the drop of pressure does not matter for isolated consumers. It will, no doubt, often happen that an extension of perhaps half a mile is desired to reach some important detached residence; this would probably mean a drop of 20 volts or more upon the main, with which variation it would be impossible to supply satisfactorily, but by fixing a regulating transformer at the consumer's house the pressure may be kept constant and a considerable saving in capital effected. The cost of connecting consumers who will only contribute a small amount of revenue is, however, considerable if the distribution is by means of underground mains and service. The author has found from actual experience that the average cost of connecting consumers by underground low-pressure service is about £7. By adopting overhead wiring for distribution, the average cost of the service is reduced to about £4, in both cases meters and fuses being included.

The cost of overhead mains in a system where conductors of small sectional area are to be used may be put at about half the cost of underground mains, the heavier the main the less being the advantage of placing the same overhead. There are other advantages with an overhead distributing system which make it particularly suitable for outlying areas. Extension may readily be undertaken to detached houses, at little cost, and with practically no risk of capital, because the poles and wires may be taken down if desired, and used elsewhere. The area of the main can at any time be increased by simply putting up a larger wire in place of the smaller, which is then available for use in other places, so that very considerable extensions may be undertaken with a very small expenditure of capital at the commencement. The connection of consumer's premises does not necessitate the cost and annoyance of disturbing the surface of the roadway or footpath. The cost of maintenance compares favourably with underground mains, and repairs are of the most simple kind and do not involve skilled supervision. At present, however, the feeling against overhead mains seems so strong that it is only possible to obtain consent for their erection in the more enlightened areas.

In some cases the district council may prefer to purchase in bulk and distribute themselves. From the consumer's point of view there is little to be said in favour of this arrangement; it must increase the charge, due to the extra engineering and clerical supervision; it will cost the central authority very little more to keep in order 50 extra meters, take readings from the same, and render and collect the accounts, whereas the district council would require to engage someone to do this work and generally supervise the distributing system, which would cost from 10s. to £1 per consumer. This useless addition to the cost will make it very difficult in small places to obtain consumers. The pressure at which the supply is to be given should have careful consideration; it is essential that the small houses and cottages should adopt electricity, and in such cases the cost of lighting is the important factor, which is materially affected by the efficiency of the lamps, and, since a lamp of 5 c.p. and 8 c.p. will predominate, the lower the voltage can be kept the better. But the low cost of supply, although most important, will not be sufficient to induce the small consumers to adopt electricity. Prepayment meters, with or without free wiring, are essential, as the working classes, as a rule, are unable or unwilling to pay bills rendered quarterly or half-yearly.

There are several advantages in supplying the surrounding areas. The load factor is improved, due to the following facts: The market day in the town is usually the village half-holiday. Fogs, thunderstorms, and dark clouds seldom cover the whole area at the same time. The demand being mainly for residence lighting, the load upon the works will be prolonged until late in the evening. The street-lighting which may be obtained is of considerable assistance to the revenue and the load factor, and if overhead wiring is adopted the lamps may be fixed most economically upon the poles and a switch wire run back to a central position, so that all street lamps may be switched on or off from one point without the expense of lamplighters. The enlargement of the demand reduces the proportion of the standing charges per unit sold throughout the whole area.

To give some idea of the comparative cost of supplying from a small village installation and by means of mains extended from a central area, and to emphasise the importance of keeping down the capital expenditure, particulars are given of an existing installation just completed by the author, and the estimated cost of supplying from a central source by underground and overhead distributors. The population within the area is approximately 4,000, the estimated number of lamps which will be connected at the end of the second year, 2,800 of 8 c.p. The revenue, based upon the present consumption, will be as follows:

16,760 units sold to private consumers at 4½d. per unit ...	£330	1	8
3,240 units per 40 street lamps ...	40	0	0
Meter rents ...	20	0	0
	£390	1	8

Capital Expenditure, District Council's Installation.

Cost of generating works having a capacity of 68 kw.—gas-engines, dynamos, and switchboard ...	£1,400	0	0
Overhead wiring 6½ miles, services and meters for 80 consumers, 40 street lamps ...	1,600	0	0
	£3,000	0	

Central Supply with Overhead Distributors.

Proportion of cost of generating works, 68 kw. at £20 ...	£1,360	0	0
Four miles of 2,000-volt feeder cables with a capacity of 100 kw. ...	1,230	0	0

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Sub-station and transformers	110	0	0
5½ miles of overhead wiring, 80 services and meters, 40 street lamps	1,600	0	0
	£4,300	0	0

Central Supply with Underground Distributors.

Proportion of cost of generating works	£1,360	0	0
Four miles of feeder cables	1,230	0	0
Sub-station and transformers	110	0	0
5½ miles distributing cable	1,950	0	0
80 services and 40 street lamps	700	0	0
	£5,350	0	0

The Cost of Supply, District Council's Installation.

	Pence per unit.
Total cost for 20,000 units, excluding capital charges	2·25
Interest and sinking fund charges, 6 per cent. upon £3,000	2 16
=£367s. 10d.	04 41

Supply from Central Area with Overhead Distributors.

Total cost for 20,000 units sold in the outer area, excluding capital charges	1·00
Interest and sinking fund charges, 6 per cent. upon £4,300	3 09
=£340. 16s. 8d.	4·09

Supply from Central Area with Underground Distributors.

Total cost for 20,000 units sold in the outer area, excluding capital charges	1·00
Interest and sinking fund charges, 6 per cent. upon £5,350	3 85
=£404. 3s. 4d.	4·85

From the above statements it will be seen that by adopting overhead wiring a difference of ¾d. per unit could be made in the charge, which, as already pointed out, is of the greatest importance when dealing with small consumers. The comparisons are, of course, only true during the first few years. As the feeders become loaded the capital charges per unit are reduced; the proportion of the capital allowed for the generating works is also reduced, due to the improvement in the load factor. In conclusion, the author trusts that this paper and the discussion which may follow will be the means of stimulating local authorities to develop their electrical undertakings and carry light into many of the dark surrounding areas.

Mr. S. L. PEARCE, of Manchester, said that the subject of the paper was a most important one, but that the extensions to supply outlying areas were often inadvisable from an engineering point of view. In Manchester they had found that the high cost of supplying certain areas taken into the boundaries, had prevented them from using the powers which they had to do so. He thought it inadvisable to charge a higher rate to these outlying areas. He had not found that any improvement of load factor resulted from the supply to the districts which had been connected up. A high-tension transmission must, of course, be used for such work, and he asked for further information as to the successful employment of three-phase distribution. He advocated that the number of sub stations employed should be kept down, so that large and economical units could be employed in the same. He had not found the Board of Trade unreasonable in giving their consent to overhead feeders, but the consent of small local authorities was exceedingly difficult to obtain, even for the supply of tramways in rural districts. He warned those present against being led away by outside considerations to increase their unremunerative expenses on mains.

Mr. R. A. CHATTOCK, of Birmingham, considered that the supply of outside areas by a corporation was a considerable assistance to the absorption of those areas at a later date. He saw no reason for a five-mile limit, and proposed rather to supply all districts which housed the working classes of the central area. Up to the present Parliament were not inclined to assist the efforts of the corporations in this direction, and Birmingham had power to supply in bulk in certain areas, but not to distribute. He thought this was a mistake, as it involved a double profit. The Board of Trade were not unreasonable as regards overhead wires. He advocated supply being given for a radius of 1½ to 2 miles from the sub-stations. The proposed 10 per cent. extra charge was not feasible, in his opinion, and it was against the clause in the provisional order as to uniform rates of charging.

Councillor MCGAUL, of Birkenhead, did not see why ratepayers in the central area should supply outside the area at a loss. In Birkenhead they charged such areas at 1d. extra per unit, and the Board of Trade had not objected.

Mr. J. G. GRIFFIN, of Swindon, described how boosters should be used to supply outlying areas. With these connected between the main 'bus bars and the spare 'bus bars to which the long feeders were connected, considerable saving in copper could be effected. The system could be used up to a distance of three miles.

Mr. J. K. BRYDGES, of Eastbourne, believed in charging higher rates to outlying districts, and had arranged to do so in one case, before the application was considered by the Board of Trade. His committee in this case had secured a three years' guarantee from large householders in the district, which ensured the Corporation against loss. He employed boosting transformers in the feeders and charged ½d. per unit more.

Alderman HEY, of Halifax, said that the local ambition of small authorities frequently led them to lay down plant where it was quite impossible to make it pay. Two small areas outside Halifax had done this, and were now keen to supply current to his Corporation. In one case a refuse destructor had been put down, from which the authority wished to supply the trams. Hardly enough refuse, however, could be obtained to light a few arc lamps in the streets.

Mr. A. E. HADLEY, of the Electrical Company, Limited, lamented the fact that we were behind other countries in the supply of small communities, because overhead wires were not used. He knew of one district on the borders of Russia where 20 small villages, with from 200 to 300 inhabitants each, were supplied on the high-voltage three-phase system by overhead wires. Three-phase distribution was used, and the undertaking showed 7½ per cent. profit. In this country 40 miles of 20,000-volt overhead line had now been arranged in the county of Durham. This would enable collieries to be supplied which could not otherwise be reached. He thought it would do good if the municipalities made it clear to Parliament that progress was seriously impeded by difficulties in obtaining rights to put lines overhead.

Alderman PEARSON, of Bristol, gave particulars to show that Parliament did not favour a local authority going outside their area. In Bristol they wished to supply a detached portion of the borough at Avonmouth some six miles away, and had been refused by Parliament wayleaves through adjoining districts. The power companies which now surround most of our large towns were, of course, the strongest objectors to such wayleaves, and to the extension of municipal supply to outlying areas. He gave some amusing incidents of the extreme difficulty of extending municipal boundaries which could only be done by a long parliamentary fight.

Councillor CHATTERTON, of Huddersfield, held that personal questions rather than business or engineering reasons decided the matter before them. The members of small local authorities had a very high opinion of their own importance, and opposed anything which tended to detract from the same. After chaffing Mr. Mountain because he had supervised the laying down of one independent plant in an area outside Huddersfield, he advocated a cheap supply to keep power companies out of their areas. They must also see that their capital account was not inflated by items which ought to be met out of revenue.

In reply, Mr. MOUNTAIN said that the districts round Huddersfield were smaller than those round Manchester and more dependent on the central area. He thought that this accounted for the fact that his load factor had been improved. They had an increased output from the supply of these outside districts, but the maximum load was not increased. He used three-phase current for transmission, but distributed as three single-phase currents. He had actually carried out overhead wiring with the approval both of the Board of Trade and the council of the outside district. He was pleased to find that, as a rule, the chairmen who had spoken agreed with an extra charge being made, as it was not right that the supply should be given at the cost of the ratepayers. This extra charge would afterwards be an argument in favour of incorporating the area in question.

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Electricity Supply by Free Wiring and Prepayment Meters.

BY ALFRED R. SILLAR, CHIEF ELECTRICAL ENGINEER, COLCHESTER.

The object in bringing this paper before the association is to give a few hints to those station engineers who have never seriously considered the introduction of free wiring and the supply of current by means of prepayment meters into their towns. The reason that prompted the author to write this paper was the receipt of a circular letter which was kindly supplied to each chief electrical engineer by Mr. J. B. Mitchell, of Woolwich, this being a summary of replies received by him with regard to free wiring. In this summary the author was very much surprised to see that several electrical engineers of large towns had definitely stated that they did not encourage this system of supply, as it caused a considerable amount of trouble, and there was nothing to be made out of it. His reply to the gentlemen who made these statements is this: "Your undertaking has to compete with the local gas company or department in the supply of lighting and power, and if you cannot compete with them in the smaller branches of the business the competition is not real, and your undertaking must be the loser by it."

The supply of electricity by free wiring and slot meters is one which affects the residences of the lower, middle, and working classes almost entirely, together with a large number of small shops, the tenants of which live from hand to mouth, and cannot afford to spend money on an installation. These small consumers can be brought to be a very useful source of supply, and at the same time they will be found to be a first-class method of advertising the light, and the author is prepared to prove that since the introduction of free wiring he has received a number of applications for current on the ordinary system, which he would not have had had it not been that the consumer was recommended by a working-man who had already got a supply in his cottage. If distributing mains have to be laid in streets before a supply can be given on these lines, great care should be exercised as to the value of the class of property therein before determining a move. The author finds that a road filled with houses built some 30 or 40 years ago, and tenanted at about 5s. 6d. a week clear, will not give a single application when canvassed, whereas a road with fairly new property of from five to ten years' standing, renting at about 7s. a week clear, will bring an application from nearly every other house. The usual type of house which makes the best consumer is the one with about six rooms, with or without an entrance hall. The man who wants electricity in his house is the better-class artisan and shop assistant who is accustomed to have it at his work and knows the benefit of it, and at the same time the author finds that a large number of labourers, warehousemen, etc., earning not more than £1 a week avail themselves of a supply.

With regard to canvassing, the author's method of procedure has always been as follows: While the cable is being laid in the road two circular letters are forwarded to each house. The first one explains that a supply will be available immediately, and sets forth at length the advantages of electric lighting over other methods of illumination. The second circular is given verbatim, as it may be useful to engineers who have not yet adopted this system: "I am directed by the Electric Light and Power Committee to inform you that they have established a system of electricity supply in the borough by means of free installation in conjunction with penny or shilling in the slot meters at the option of the consumer. In the case of business premises the Corporation will supply any number of 16-c.p. or 8-c.p. lights fitted to pendants or brackets, together with the necessary wiring, switches, etc., providing that the consumer can show that these lights will be in use a reasonable number of hours during the year. In the case of residential premises four lights would be installed as above in the following positions:

Hall	one 8-c.p.	pendant	or bracket,	one switch.
Front room	one 16-c.p.	,,	,,	,,
Back room	one 16-c.p.	,,	,,	,,
Kitchen	one 8 c.p.	,,	,,	,,

Any reasonable alteration to the positions of the above lights will be considered by the borough electrical engineer, and any further lights will be supplied and fixed by the Corporation upon the payment of 8s. each. The cost of current supplied to the consumer under this system would be as follows: for a 16-c.p. lamp, about three hours 1d.; for an 8-c.p. lamp, about 5½ hours 1d. In order to keep consumers' lamps in as good a condition as possible, a new lamp will be given upon application at these offices after the consumption of each 40 units registered on the meter. In all cases premises will be connected to the Corporation's mains free of charge. My representative will call upon you in a few days' time and will give you any further information you may require." These two circulars are enclosed in an envelope and addressed "Important" with slip stating that a representative will call upon a certain day, and they are followed up with an evening visit by one of the members of the staff, usually the chief clerk, who is in a position to explain any details which the would-be consumer might not understand. The representative also takes with him some copies of the agreement, and anyone deciding to take a supply fills up this form and has it witnessed. This agreement has been purposely kept as simple as possible, so as not to frighten intending consumers, and is made between the town clerk as acting for the Corporation, the consumer, and the landlord. The use of the agreement is to keep the installation in the hands of the Council, to insure access to the installation at all reasonable times, and to prevent the consumer or landlord from interfering with it. The consumer or the landlord may purchase the installation any time on payment of the full value, and the Corporation reserves to itself the right of removing it at any time when it might be considered necessary. The author has, up to the present, no scheme whereby the consumer can be compelled to use the current for a given time and not return to gas, as he is given to understand that the legal difficulties in connection with a clause like this would be very great. A word of advice with regard to canvassing may now be given. The best man for the work is one who is thoroughly acquainted with the townspeople, and when the population does not exceed 100,000 some member of the office staff is sure to be found with this qualification. At the commencement the author employed a regular canvasser, but he quickly found that this was wrong, and at present all the canvassing is done in the evening by a clerk, as this has been found to be the best time of day to interview the class of consumer in question.

The author now passes on to the installation and the method of fitting up premises. The Corporation do not undertake any work in connection with free wiring, but a specification is issued for 50 installations at a time and given out to a local contractor. In the cottage or dwelling four lights are supplied, the one in the hall being merely an encouragement for obtaining consumers, as the revenue from it is practically nil, and the other three—those in the front room, back room, and kitchen—always pay their way. Consumers are also given the option of having the hall light fixed in a bedroom as a further inducement, the gas company only allowing three lights and making an extra charge for anything further. The present cost of these installations, taking 50 at a time, is 35s. per house exclusive of the lamps, which are supplied direct from the department, and the total cost of a house wired as far as the meter is, therefore, about 39s. In laying the service main where the applications are sufficiently numerous, the cable is looped from one cottage into the next, in some cases three or four being connected in this manner. The average length of twin $^{3}/_{20}$ vulcanised cable per house is 12 yards, and this, with the cost of the joint-box, house terminal box, meter board, meter, and the men's time laying and fixing, averages over the whole of the installations £4. 19s. 3d. The greatest item of cost attached to free wiring is that of the prepayment meter, and although there are a number of meters on the market at a fairly cheap price, the author has found by experience that it pays in the long run to get a meter which will be as nearly reliable as possible, even if the cost of it is considerably higher than the average. At the present time he is using three different types of meters, two of the mercury motor and one of the shunt motor type. Of these meters he considers that the mercury is the better, as the great trouble of the motor stopping through a dirty commutator is avoided.

A large number of defects are continually showing themselves in the present designs of slot meters, and the author believes it will be some years before the manufacturers will properly perfect them. In one type of meter in use at Colchester, discs are used to actuate the working in order to avoid stoppages through inequalities of the coins. The discs, however, are not a success, as they frequently get hung up in the mechanism of the meter and stop it while keeping the current on. With regard to the meters which are directly actuated by the coins, those with a long distance to travel should be avoided, as the shorter the way that a coin has to go the less chance it has of sticking. Some meter makers like to guard their penny meters against the possibility of a halfpenny working them, and also to try to prevent a disc or token being used of slightly larger or smaller diameter than a penny, but the result of this is, that when a bent or oval coin is used the meter hangs up, and the consumer gets his light for nothing. In a prepayment meter the motor and dial must be kept absolutely separate from the receptacle for the coins, and most meters have two different sealing doors fitted. The author has tried a good many different types of lamps on the slot system, and, amongst others, some very high efficiency ones, which gave nearly 25 per cent. more light for the money, but owing to the complaints of blackening he has gone back to a first-class four-watt lamp, and finds that it cannot be improved upon this type of supply. With regard to the most popular type of meter. In the initial stages of free wiring, on the canvass form the question was asked as to whether penny, sixpenny, or shilling meters were desired,

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and practically the whole of the replies were in favour of the shilling meter. Since, however, the system has been started the author has found that a certain number of applications from the poorer parts of the town have been received for penny meters. At the present time there is one penny meter in the town to every three shilling meters, and he has never yet had an application for a sixpenny slot meter.

The price for current charged up to the present has been 6d. per Board of Trade unit, as compared with 5d. less 5 per cent. for cash received from ordinary consumers, and the difference allows a sum of 1d. per unit for the repayment of the installations. Since April 1, however, the price to ordinary consumers has been reduced to 4½d., and the slot meters are being changed by means of replacing the change wheel to supply current at 5½d. per unit. As the slot consumer pays cash for his supply, the author always considered him entitled to the 5 per cent. benefit given to the ordinary consumers, and he has lately introduced a plan whereby any slot consumer having used over 40 Board of Trade units can obtain a new lamp by calling at the offices, where the claim is verified by reference to the meter register. The supply of these lamps serves a double purpose, as not only does it assist the consumer to replace his lights without any cost to himself, but it also keeps up the consumption of electricity and the revenue from these installations.

The author will now deal with the method of reading and collecting. At the end of every three months during the summer half-year, and every month during the winter, all prepayment meters are visited by an assistant from the meter department, and also a clerk from the borough accountant's office. The assistant reads the meter and registers it on a card, checking the money taken from the meter by the clerk. The clerk deals with the cash, and makes a similar check of the reading, and should there be any coins over and above the amount of the reading, which would represent current paid for but not consumed, these are returned to the meter. The working parts and dial of the meter are kept sealed by the meter department, and the cash part is locked with a Tourtell patent lock, the seals of which are kept by the accountant's department.

We now come to the principal question to be dealt with in this paper—that is, as to whether an installation on the slot system is a paying concern or not. First of all, to do this, some figures are given in relation to these installations which have been taken from the books of the department. The number of consumers dealt with are those which have been running throughout a complete financial year.

TABLE A.

Number of consumers, 82.
Units supplied, 7·433.
Units sold per consumer per annum, 90·6.
Amount received per consumer per annum, £2. 5s. 4d.
Average cost of installation complete with lamps, £2. 8s. 1d.
Average cost of meter, terminal box, and service cable fixed, £4. 19s. 3d.
Average cost of meter, etc., per equivalent 8-c.p. lamp, 12s. 3d.
Average cost of meter, terminal box, service cable, etc., to the ordinary consumer per equivalent 8-c.p. lamp, 1s. 11d.
Number of lamps actually connected, 422.
Number of equivalent 8-c.p. lamps, 655.
Number of lamps connected per consumer, 5·14.
Number of equivalent 8-c.p. lamps connected per consumer, 8·11.

In the second table the author proposes to show the financial result per installation, and to do this he must first give the cost of production, etc., at Colchester. The total cost for generation and distribution during last year was 1·70d., and the cost of interest and redemption divided by the number of units generated was exactly 1d. In addition to these, it will be seen in the figures given above that the cost of meters, service mains, etc., for slot consumers is more than six times as great as the average cost of meters and service mains of ordinary consumers, being in the case of slot meters 12s. 3d. per equivalent 8-c.p. lamp connected as against 1s. 11d. to ordinary consumers. As the cost of the installation is to be written off in five yearly instalments of 20 per cent. each, this amount will, of course, very largely reduce the profits on this system of supply, although it must be borne in mind that when the cost of the installation is paid off an additional profit of about 10s. per consumer will be realised. The author understands that some towns have obtained a special grant from the Local Government Board allowing them to borrow money for the installation costs of free wiring, but he has managed to pay for his system by means of an overdraft at the bank.

TABLE B.

	£	s.	d.
Revenue.			
90·6 units at 6d. per unit	£2	5	4
Expenditure.			
Cost of generation and distribution, 90·6 units at 1·7d.	0	12	10
Standing charges on 90·6 units at 1d. per unit	0	7	6
Repayment of installation at the rate of 20 per cent. on £2. 8s. 1d.	0	9	7
Additional interest and sinking fund on slot meters and service mains at 6½ per cent. on £4. 4s. 6d.	0	5	6
Cost of lamp renewals at 4 per cent. of the revenue	0	1	9
Net profit per installation	0	8	2
Total	£2	5	4

After five years have elapsed, and the cost of the installation is paid off, the net profit, taking the above figures standing as they are at present, will rise to 17s. 9d. per installation.

In conclusion, the author would remark that with all their troubles, which are sure to include faulty meters, extra cost for inspection and collection, and the inevitable consumer who never will get his correct amount of light for his money, he can only repeat what was stated at the commencement of this paper—viz., that this type of consumer is well worth catering for, if only for the competition which it brings to the gas company or department, and the advertisement which is the undoubted result.

Mr. R. B. LEACH, of Farnworth, opened the discussion on the above paper, and disagreed with a number of the figures published. The average income of £2. 5s. 4d. per installation was in his opinion too high, as the kitchen light was the only one used regularly. He also queried the cost of installation, which averaged only 9s. 9d. per light wired. He had found the slot meters unreliable. He did not think that with electricity at 5½d. they could meet gas competition in many places unless much more economical lamps were obtainable.

Mr. A. H. SHAW, of Ilford, had had considerable experience with the supply of small consumers in the way described by the author. With 123 houses, each with six lights, the average revenue was £1. 5s. 10d., which was below the author's figure. In Ilford they had supplied no shops on this system, which might account for the difference. The cost of installation averaged £3. 13s. 6d. His cost of connecting each consumer to the mains worked out at £5. 2s. 10d. They had now discontinued the system, but had induced builders to wire new houses, which brought them in touch with small consumers. They then gave one service connection to a whole block of houses. They still used some 400 prepayment meters, and obtained about £1. 10s. per annum from the same. The consumers using these meters obtained their lamps free.

Mr. E. T. WILLIAMS, of Gibraltar, said that half the revenue on the Gibraltar system was obtained from installations the wiring of which was rented. He did not advocate an additional charge per unit, but made a rental charge per lamp of 1½d. per month. This involved the repayment of the wiring cost over a period of 14 years. In order to save the cost of meters he had recently introduced a flat rate of 1s. 6d. per 8-c.p. per month, which he thought would give satisfaction. It was limited to installations with 10 8-c.p. lamps or under. In Spain this form of charging was largely used, and most of the wiring was done by flexible cords supported on insulators.

Mr. J. G. GRIFFIN, of Swindon, described the controversy which had raged in his town over free wiring. The outcome had been a standard specification to which any contractor could work, and the consumer paid the cost of installation on the three-year hire-purchase system.

Mr. H. R. BURNETT, of Barrow, had from 900 to 1,000 workmen's dwellings wired on the prepayment system, and obtained an average consumption of 100 units per annum from each. He had avoided the difficulty of free wiring by having an agreement with the builders. Also the landlords supplied and maintained the meters, which relieved him of the cost of upkeep. He had recently tried a new type of meter which would indicate the amount due. This would be collected each week, and the hand put back to zero. He thought that flexible cord of good quality run on insulators would be quite satisfactory.

Mr. C. TURNBULL, of Tynemouth, pointed out that the actual revenue the author obtained for his current supplied through the meters was only 3·8d. per unit, but that this was giving undue preference to the small consumer, which might lead to trouble from larger consumers. The $^{3}/_{20}$ cables for service connections was too weak mechanically, and he thought that manufacturers might use other materials for such small conductors to get mechanical strength. It was a good idea to have their clerks interested in canvassing.

Mr. W. A. VIGNOLES, of Grimsby, also criticised the author's figures, which he thought were dependent for their success on the high price of gas in Colchester.

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Mr. H. L. P. BOOT, of Tunbridge Wells, had not yet obtained a good prepayment meter; most of those he had tried had not passed out of his test-room. He thought that 12s. per light was the lowest cost at which good wiring could be done. He estimated the repairs and depreciation would range from 12½ to 25 per cent. He advocated the discarding of meters to small consumers and making a flat-rate charge.

Mr. J. K. BRYDGES, of Eastbourne, gathered from information which had been supplied to him by Mr. Mitchell, of Woolwich, that there was not much to be gained either from slot meters or free wiring. In certain cases slot meters were so constructed that the coins could be pulled back if a thread was attached to them.

Mr. A. B CRAMB, of Croydon, said that where he had found trouble from slot meters he traced a good deal of it to the fact that inferior lamps were used, so that the meter did not run the length of time expected. Several of the lamps tested took from six to seven watts per candle. He now supplied a new lamp for every 35 units consumed, and complaints had ceased.

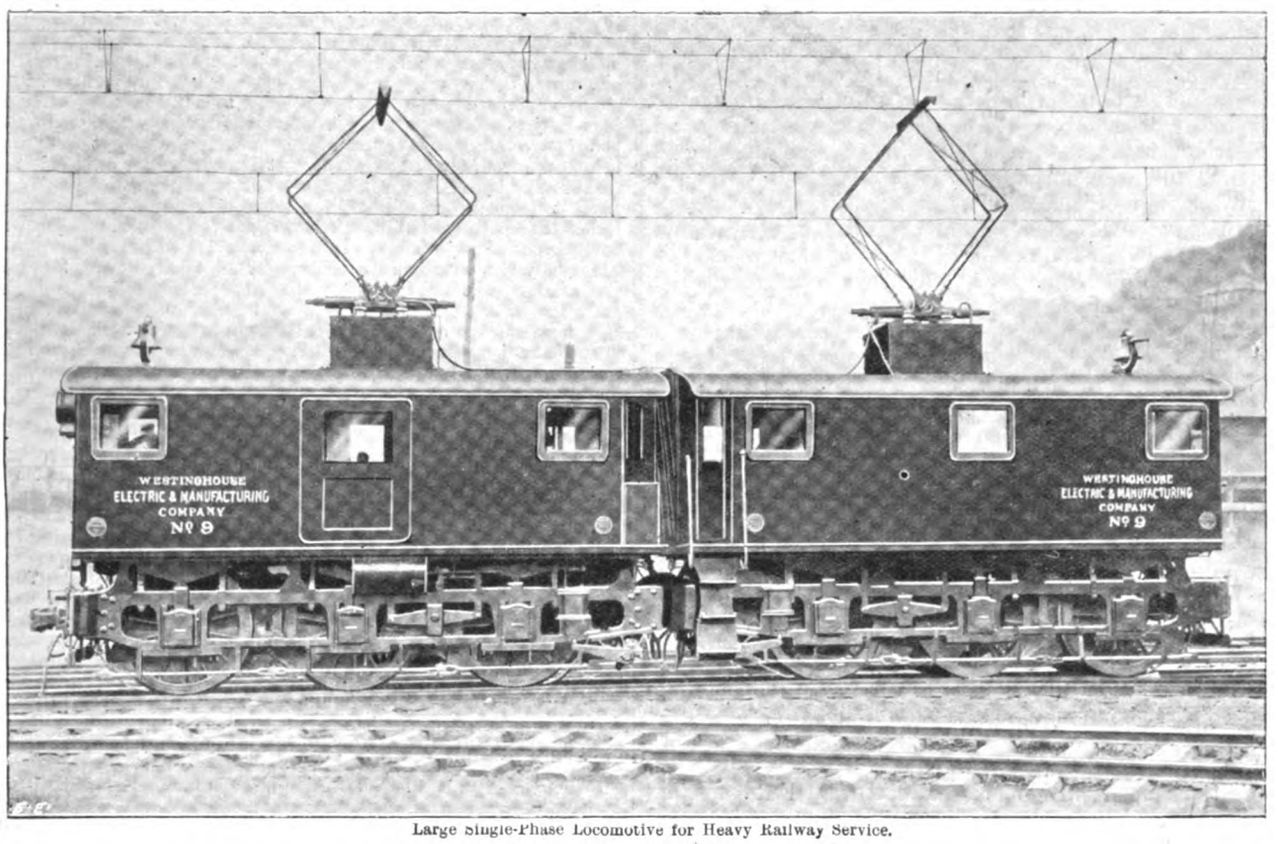
Mr. A. R. SILLAR said that he used a free wiring system with prepayment meters for small shops, and this doubtless accounted for the average revenue obtained. The wiring was done in casing, and the cost was low because of the keen competition amongst the contractors in his district. He was using the B.T.H. meter with success. The small cable used for service was lead covered and armoured, and there had been no faults due to mechanical weakness.

LARGE SINGLE-PHASE LOCOMOTIVE FOR HEAVY RAILWAY SERVICE.

Of the many interesting exhibits of railway appliances prepared for the inspection of the delegates to the International Railway Congress, probably the most novel, and certainly the most important in its bearing on the use of electricity as a motive power for heavy railroad service, was the Westinghouse-Baldwin single-phase alternating-current locomotive shown in operation on the Interworks Railway at East Pittsburg on May 16. This locomotive, built by the Westinghouse Electric and Manufacturing Company in order to convince the railway managers of the world of the possibilities and advantages of the use of single-phase current for heavy electric traction, was shown in operation first running light and then hauling a train of 50 new steel gondola cars weighing approximately 1,200 tons.

From the various details which are given herewith it will be seen that a number of new features are embodied in the construction of this locomotive, and that claims of priority may be made for it in a number of respects. It is, for instance, the largest alternating-current locomotive in the world, the largest to be operated by single-phase current, and it is equipped with six of the largest single-phase motors ever built. It is the first alternating-current locomotive for use in America, and is designed for the highest trolley voltage ever used in that country. This locomotive is also the largest ever operated by means of overhead trolleys, is the first on which forced ventilation is used in the motors, and is unique in many other similar ways.

The weight of the locomotive complete is 135 tons. It is built in two halves, each having one six-wheel truck with rigid wheel-base. These are coupled together, and are intended to operate normally as a single unit, but each half may be operated separately if desired. The locomotive is approximately 45ft. long over all, and 9ft. 8in. wide. The



Large Single-Phase Locomotive for Heavy Railway Service.

total height above the rail with trolleys lowered is 17ft. The wheels are 60in. in diameter, and are mounted on 8in. axles, with 6ft. 4in. between centres. The side frames of the truck are of cast steel, and are spring supported in the usual manner, the weight on the two inside axles of each truck being equalised. The cabs are built of sheet steel with angle-iron supports, and the entire cab as a whole is removable from the truck. Each axle carries a 225-h.p. single-phase series motor of the single-reduction type, making a total of six motors for the locomotive. One side of each motor is supported directly on the axle, and the other is suspended by spiral springs from the locomotive body. The motors are of the same general construction as the standard Westinghouse alternating-current railway motors of smaller size. They are so arranged that forced ventilation may be used, and increased output thus secured.

The locomotive is designed for a current of 25 cycles and a trolley voltage of 6,600, and one of the most striking points of the exhibition to those who have been accustomed to the enormous currents required in heavy direct-current traction work was the sight of so large a locomotive accelerating a 1,200-ton train over a third of a mile in length and receiving its entire power supply from

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a single No. 000 trolley wire. The 6,600-volt current is collected from the trolley wire by a pneumatically-operated pantagraph trolley on each half of the locomotive, and is carried through a suitable oil switch and circuit breaker to an auto-transformer in each cab. These transformers reduce the voltage to 325 for use at the motors. The trolleys may be raised or lowered from the cab by a suitable air-valve.

The three motors on each half of the locomotive are connected permanently in parallel, and are controlled by means of an induction regulator, which, under the direction of the operator, varies the voltage at the motors from about 140 to 325. The induction regulators are driven by small series motors of the same general type as the main motors. Both regulators are controlled by the multiple-unit system from a master switch at either end. They may be stopped at any desired point in their travel, and thus the locomotive may be run at any speed with the same facility and economy of a steam locomotive. Forced ventilation is used with the auto-transformers and induction regulators as well as with the motors, the necessary air being supplied by suitable motor-driven blowers. Motor-driven air compressors are also used.

The locomotive is designed for slow-speed freight service, this type having been chosen because the design of series alternating-current motors for very slow-speed service presents many more problems and is much more difficult than the design of equal capacities for the ordinary conditions. This problem having been solved, the production of similar locomotives for passenger service becomes a relatively simple matter. With the motors working at nominal full-load output the locomotive will develop a draw-bar pull of 50,000lb. at a speed of approximately 10 miles per hour. On several occasions, however, when hauling the 50-car train referred to above, steady draw-bar pulls of from 60,000lb. to 65,000lb. have been recorded on the dynamometer car, and momentary efforts as high as 100,000lb. have been obtained with no sign of slipping of the wheels. With lighter loads the locomotive may be run at higher speeds up to a maximum of about 30 miles per hour.

The successful completion of so large and powerful an alternating-current locomotive without the usual series of developments through gradually increasing sizes, which is ordinarily required when so great a problem is undertaken, marks a distinct advance in the production of electrical apparatus for heavy traction work, and now that the first important step has been taken should certainly prove the forerunner of the use of electric traction on main-line railways which has so long been looked for.

THE ACADEMIC SIDE OF TECHNICAL TRAINING.

Prof. Alexander B. W. Kennedy, LL.D., F.R.S., whose name is included in the birthday list of new knights, on the 29th ult. delivered the foundation oration on "The Academic Side of Technical Training" before the University College Union Society, the president of the union, Mr. Scott, M.R.C.S., being in the chair. After giving details of the movement from its inception, Prof. Kennedy dealt with the progress made since his appointment as professor of engineering at the college in 1874, and said:

In 1874 the professor of engineering at University College—and this practically applies to similar chairs elsewhere—had to do not only with the work which is at present done here by Prof. Harcourt, Prof. Fleming, and Prof. Cormack, but practically the entire work of all the assistants of all these professors, for I doubt if an assistant to a professor of engineering had ever been heard of before that date. (My first classes had, I think, from three to six members.) Now, of course, engineering teaching generally is systematised and subdivided to an extent only comparable with the similar arrangements existing in connection with medical studies. If anybody is in the least interested in seeing what an unfortunate professor of engineering was expected to know in 1874, I recommend the study of the calendar of University College for that year. I look back upon the engineering prospectus which I drew up myself, following very much the lines previously laid down by Prof. Fuller, with wonder and amazement that I should have ever ventured to talk about so many different subjects, and with much admiration at the way in which I must have stood the after-lecture cross-examination by my students, who, after all, were not so very much younger in those days than myself. It was the sort of thing that could only have been done by a young man whose enthusiasm was not tempered by discretion, and it is no wonder that at that time candidates for such engineering chairs were not plentiful.

Now, all the great engineering societies have recognised formally that no engineering training is complete without its academic side, and a very important committee, consisting of delegates from the five great engineering societies, with Sir William White as president, has been at work for some time formulating their ideas as to the nature of the qualifying training, and going so far as to formulate also ideas as to the preliminary education of young engineers before they commenced their academic training. I do not wish—or rather I do wish very much, but it is not my subject to-day—to enter upon the very thorny questions involved in what that preliminary education ought to be according to the notions of a grown-up engineer. I will say, however (for it is no secret), that communications received from many headmasters of our great schools, while not going so far as some of us would like, are yet quite astonishingly radical in their ideas as compared not only with 30 but even with 15 years ago.

As to the general trend of our academic training, I think we engineers are entitled to say that it should be so arranged as best to train the best engineers. I put it in this way because I mean it to be understood that while on the one hand the *best* engineer is certainly not the man who knows his own business only and narrowly, on the other hand, I think we are entitled to demand that the engineer should not be looked upon as the mere by-product of the training, but as the chief result to which other things are to be subordinated. I think that University College is not likely to fall into this mistake, but the point has really to be kept in mind in cases where, as here, the engineering education is only one branch of the wide range of education covered by the whole work of a university college.

In saying this, however, I particularly do *not* mean that the academic training of engineers should be laid out exactly on superficially utilitarian lines. The idea of giving a young man just as much mathematics, just as much physics, or just as much chemistry as the minimum that he can professionally require is not only pernicious, but absolutely fallacious. There is no doubt that the only way of knowing a subject up to a certain point in such a fashion that, up to that point, it can be thoroughly utilised, is to study the subject up to some point very much further advanced. It is not at all a valid objection to the teaching of any particular point in mathematics or physics that it is more complicated or more advanced than anything which the engineer will be likely to require in practice. That, in itself, is not an objection at all, because, as I have said, it is impossible really to master a scientific subject up to a certain, often very elementary, point without having at least a superficial knowledge of a much greater extent of the subject. But it is desirable, indeed necessary from our point of view, that the advanced work in purely scientific subjects should be specially chosen so as best to deepen and make certain the knowledge of the earlier work. This may be, and almost certainly is, a very different thing from choosing it so as to form the best basis for still further study of the particular science in question. In this connection I must point out, at least as my opinion, that it is a mistake to consider that there is only one mathematics or one physics, and that either the preparatory work or the whole teaching must necessarily be the same for everybody—for the man who is to devote himself to engineering, or for the man who intends to spend his life in physical work. For instance, I think an engineering student may be allowed to take for granted that A times B is equal to B times A (he is always quite prepared to believe it), and that it is perfectly reasonable to make to him dogmatic and probably quite erroneous statements as to atoms (let us say), or as to the ether, without any of the qualifications which would be necessary supposing the atoms and the ether were to form the basis of the man's future studies.

It is, no doubt, a noble conscientiousness which sometimes prevents a man who is in the front rank among scientists from making to his students, as quite general, statements which he knows to be true only with qualifications or limitations. But the case is one in which often the general statement, given with authority, will really give the student a truer conception of the facts than a more accurate statement which is guarded by reasoning and explanation which he—that is, the student—cannot understand and will almost certainly misunderstand. As a writer in *Nature* put it a few days ago, referring to the theory of quaternions, "the truth is that very few students are able to appreciate to the full an absolutely logical argument until they have a certain amount of practical knowledge imparted to them more or less *by authority*."

I can illustrate this easily at my own expense. Years ago I read Sir Archibald Geikie's "Scenery of the Highlands" for the first time with great delight. Meeting Prof. Bonney in the common room soon after, and knowing of the existence of certain geological controversies, I asked him (perhaps more or less maliciously) if I might take Geikie's geology as all right. He hesitated a moment, and then said emphatically, "It is quite right enough for *you*, anyhow."

I have no doubt that Prof. Bonney's way of putting the matter was the perfectly legitimate one; it is exactly the point which I wish to emphasise, and I quote my old friend (although at my own expense) as indicating exactly the position which a scientific man is entitled to take up, and will wisely take up, in dealing with students to whom his subject is in effect only a secondary one.

There is one matter in connection with the teaching both of mathematics and physics to engineering students which I think might well be emphasised more than is generally the case. Whether it is desirable that it should be emphasised in dealing with the general student, I do not venture to say. I mean the point that the answer to any question can only be as accurate as the data of that question. For the ordinary examination question in mathematical physics it is necessary and unavoidable to presuppose certain data, which in real life are absurd and impossible. In the ordinary everyday questions of engineering there is nothing more misleading than to take for granted the data of the examination paper; and a very great deal of the disrepute into which mathematical work had fallen at one time

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among engineers was due to the fact that although the average student was able to use his methods rightly, he was unable to perceive whether they led him to a right result. I think it must be possible, even if it is not exactly easy, to point out to the student the extent to which the accuracy of his answers is influenced by the assumptions which he makes. It is, I am afraid, too often presumed that the method of working out the answer is the chief thing; perhaps it may be from some particular point of view. But for our purposes, foolish as it may sound the method of working out the answer is only secondary; the answer itself is the chief thing, and we really *must* have that answer right when it finds itself translated into steel or stone. We would much sooner have a right answer got by an imperfect method than a wrong answer got by the best method in the world. And an answer may be wrong in two ways; it may be wrong because the data are in themselves wrong—that is to say, inapplicable to the particular case—or it may be wrong by being stated in a form much more accurate than the real data will allow of as when we find the indicated horse-power of engines given to six significant figures, when we know perfectly well that the fourth must always be doubtful. It would be most useful if our scientific professors would discuss these points with their students, and show them specially the extent to which the methods and theorems of the mathematician and the physicist may be properly applied when the only data available for the problems are such as actually are found in practice. It is hardly fair to leave the engineering professor to tell his pupils — or to leave the engineer to tell his assistants—that the methods they are using are quite inapplicable, and the results which they are getting obviously inaccurate. This is in every way inadvisable, and may lead the otherwise guileless student to discount all his teachers instead of only one! Every scientific experimenter knows that it it is often the most difficult part of his work to say how alterations in data or want of knowledge of accuracy in data may affect the result, and I should like much to see this matter systematically dealt with by the teachers who have actually to do with the scientific or theoretical treatment of the questions concerned. If they have any doubt as to what is the general nature of the complex engineering questions which have to be solved, a letter addressed to any engineer in Westminster would bring them the fullest information. But happily most of the university colleges now have engineers on their senates, so that the information can be had without going outside their own walls.*

I do not intend to say anything here as to the preliminary part of the academic teaching of specially engineering subjects, including laboratory work. This may be subdivided in many ways according to the individuality of the teachers, the arrangement of the staff, and the aims of the particular college, and it cannot be said that any one way is necessarily better than any other.

But as to the more advanced part of engineering teaching in colleges, I want to put forward an idea that I have more than once had occasion to express. I should much like to see the development of some such connection between old and distinguished students of a college—who become later on older and more distinguished engineers—and the college at which they have studied or some other college, as exists in the similar case of the medical profession. I do not mean simply, or indeed at all, that, for example, University College should ask senior engineers in the country or in Westminster to give occasional lectures to their students on special subjects. I do not say that such an arrangement may not be useful as an accidental or occasional thing, but I mean much more than this. The senior engineer (I am afraid I come into this category myself now) may have a very large experience and have carried out a great deal of work, but he is probably not in touch with the college or with academic work of any sort, nor in touch with students at all; and, therefore, while he knows his subject, he may be a very unsatisfactory teacher. There are two difficulties in an older man going straight from business to lecture. One is that, being out of touch with students, he does not understand the difficulties which present themselves to young men and which have so long ceased to be difficulties to himself that he has even forgotten their existence. Then, secondly, having been for many years accustomed to look at his professional work entirely from the non-academic side, he really knows too much to be able to lecture about anything. He would be too apt to overload his lectures with masses of, no doubt, very important statements, which would not be appreciated by men in the student stage, and which by themselves would also probably involve difficulties of apprehension, which would make their mere statement to the student useless—a condition of affairs exactly comparable with that which I have already deprecated upon on the scientific side of the work. My suggestion is that to get the full benefit from its best pupils, a college should, if possible, keep in touch with them after they have left it. A few years after they have left college, and when they have fairly got into the swim of professional work—but before they have so much lost touch with the difficulties of their college days that they no longer appreciate the student's point of view—they might be made to help in teaching by giving lectures on the special branches of engineering with which they were specially and actively familiar. They should do it before they have forgotten what they formerly learnt, or have had it driven out of their heads by the pressure of other ideas, and while college methods and points of view are still familiar. They would be men still making their way in their profession, still, let us hope, full of enthusiasm for their work, and certainly they would be daily finding out the differences between actual and academic problems. Teaching of this kind could in no way replace the general preliminary teaching of engineering subjects in the college, which must continue to be given, as it is given now, by a professor, or professors, the bulk of whose time is spent at the college and who are thoroughly in touch with all the students. I confess, however, that I hope a time will come when in any case professors of engineering will not remain permanently in academic harness, but will come out and take their place—a most important one — as colleagues among the active and leading engineers of the country, and will look upon such a position as that which they ought to reach rather than a solely academic position, however eminent. But, in addition to the work of the permanent professor or professors, I believe that old students coming back in the fashion I have indicated, not in one only but in several branches of engineering, and giving short courses of special lectures to third-year students, would very much help both the students and the rest of the teaching staff. The arrangement would also have the very great advantage of bringing about a closer and warmer connection between the men who are at work in their profession and the colleges where they were trained. It would also help to keep the colleges themselves in that actual and continual touch with engineering things and ideas which is so absolutely essential for their continued usefulness. The growth and development of engineering, as of all things technical and industrial, is so rapid, so varied, and so continually ahead of all text-books, that without personal contact of professors and teachers with actual work the teaching of a college may, indeed must inevitably, soon fall behind and become out of date. For this reason I have strongly advocated, in certain recent cases where I have been asked the question, that not only should a professor of engineering be allowed to carry on the real practice of his profession (I do not mean the giving of expert evidence) conjointly with his academic work, but that he should be encouraged and pressed to do so. This may result in the teacher giving up professorial for professional work altogether sooner than he would otherwise do. But if so, the students who have passed through his hands are certainly not the losers, however much the college may regret the loss. And no doubt the more it is found that the academic position forms a step in the professional, the more and the better candidates will be found for each academic vacancy which occurs.

It will be noticed that the scheme I have outlined is closely analogous to the system already general in connection with medical training, where the lecturing and professorial staff on the technical side consists almost entirely of old students (occasionally from other colleges) who are beginning to make their way professionally, or who, by the time they have become professors, have actually made their way to the highest ranks of their profession.

In conclusion, I will only add that I can hope for nothing better than that during the next 30 years—at the end of which I fear I cannot expect to be again asked to lecture here—the advance in the academic side of technical training may be as great and as real as it has been during the last 30 years, and that then, as now, and as in 1875, University College may in this matter hold the advanced position which it has always tried to maintain and deserve.

Lord RAYLEIGH, in seconding a vote of thanks to the lecturer proposed by the CHAIRMAN, spoke in highly eulogistic terms of the practical value of the address. As an illustration to show how much the efforts of the engineering departments in English university colleges were appreciated, he quoted the fact that the Indian Government had ceased to take their engineers from Cooper's Hill, but had taken them in what he called the open market, and with better results.

Subsequently, Prof. Vernon Harcourt, for 23 years engineering professor at University College, was presented by the students on his retirement with a magnificent silver bowl suitably inscribed.

* I should like to add here my great appreciation of such work as has lately been done by Prof. Karl Pearson in the publication of his "Research Memoirs." There is no scientific worker, as I had much occasion to know personally, who is more thoroughly alive to the points which I have just raised than my old and most distinguished colleague, the value of whose recent investigations has received such cordial recognition from the most practical of engineers.

PERSONAL.

Mr. Albert E. Armstrong, of Willington-road, West Hartlepool, who was apprenticed to Messrs. Richardson, Westgarth, and Co., of the Hartlepool Engine Works, and Messrs. Brown, Boveri, and Co., of Baden, Switzerland, has been appointed chief electrical engineer to the Wahai Grand Junction Gold Co., New Zealand, and his first duty on arrival will be to supervise the erection and working of three sets of turbine electrical machinery, just completed at the Hartlepool Engine Works.

The successful candidate for the post of chief assistant electrical engineer at Battersea is Mr. P. MacAlister, who formerly held the position of mains superintendent there.

We regret to learn that Mr. Alexander, electrical wire inspector under the Swansea Corporation, met with a serious accident whilst repairing a wire on a raised trolley. One of the wires was carried away and struck him on the forehead, precipitating him a distance of about 20ft. to the ground.

Mr. Hamilton Kilgour has resigned the position as borough electrical engineer of Cheltenham.

We understand that the Southampton Corporation have increased the salary of the electrical engineer, Mr. H. F. Street, by £100.

Mr. Ernest T. Williams, chief electrical engineer, Gibraltar, and formerly of Belfast and Salford, was married on July 5 to Miss M. C. Catleigh, only daughter of R. Catleigh, Esq., of King's Lynn.

The Leeds Council have increased the salary of Mr. G. E. Watmough, tramway car works superintendent, to £250 per annum.

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SYSTEMS OF CHARGING.

Municipal engineers have had during the past fortnight several opportunities of discussing the charges made for the supply of electrical energy. At the meeting of the Incorporated Municipal Electrical Association in Scotland five out of the six papers read dealt more or less closely with this subject. Then came Mr. J. H. Rider's paper before the annual conference of the Municipal Tramways Association of Great Britain on Tuesday last on "Charges for Supply from Combined Lighting and Traction Stations." This final contribution to a well-worn subject is remarkable for the clear way in which the cost of producing electrical energy for various purposes is analysed so as to give a true basis for differential charges. The need for such a paper is proved by the discussion which followed. Mr. Rider's text was: "Can a combined station sell electrical energy to a tramway as cheaply as the tramway can produce its own?" The tramway managers who spoke treated the matter as though the word "can" was replaced by "do." They then answered this query in the negative, and strongly advocated separate generating stations for tramways. We were pleased to see that many of the chairmen of tramway committees who were present looked at the subject in quite a different light, and recognised the advantages of having a common generating plant to supply all the electrical energy needed within a given area. The essential difficulties in the matter are two. The first is that of fixing the charges on the maximum demand system in each town. The limit of eightpence per unit fixed by Parliament is the most that can be demanded, and there is no doubt that this charge made for a short period of average daily use is the correct way of ensuring that each consumer bears his share of standing charges. If this is adopted, and a very low rate equal to the real running expenses is made for the additional consumption, an equitable system is secured, which will encourage an extensive use of electrical energy for all purposes. The first difficulty being then solved, the second has to be met—that is, failure of consumers to recognise the equity of the above system. This was apparent from the discussions at the Edinburgh convention. Speaker after speaker said that the maximum demand system would have to be abolished because the users of electricity could not understand it. They also said that a flat rate must be adopted, but in nearly every case it was clear that a series of flat rates was contemplated. These were to be fixed on the basis of the average cost of supplying each class of consumer with due regard to their average load factor. We are not surprised that the maximum demand system does not meet universal approval amongst small lighting consumers, but looked for more appreciation of the same from tramway managers. These gentlemen are daily confronted with problems on parallel lines. Thus their costs of being ready to carry passengers are heavy, outweighing the actual cost of doing so. The cars, to meet the morning and evening rushes, have to make one journey with practically no passengers on board. If passengers for these journeys could be found, the cost per car mile would scarcely be altered, but the revenue per car mile would be nearly doubled. This would enable fares to be reduced, just as the maximum demand system enables long-hour consumers to get electricity at a very low rate. We trust that tramway managers will read Mr. Rider's paper carefully, and that the result may be less bickering over the charges they are called upon to pay from combined stations. The engineers of these stations need to verify their allocations of costs, and if this is done each year, there cannot but be advantages from the single supply to all concerned. Example in these matters is better than

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any theoretical discussion, and the case of the North-Eastern Railway Company should convince the doubting tramway managers. If a power company which looks to make a profit out of the supply of power can, by reason of its diversity of loads, sell energy to a large railway company more cheaply than they can produce, there should be little opening for separate tramway stations.

MUNICIPAL TRAMWAYS ASSOCIATION.

FOURTH ANNUAL CONFERENCE.

Presidential Address.

BY ALFRED BAKER, GENERAL MANAGER, BIRMINGHAM CORPORATION TRAMWAYS.

Gentlemen,—I have, in the first place, to congratulate the members of our association on its continued usefulness and prosperity. During the past 12 months many matters affecting tramways and light railways have had consideration, and on more than one occasion we have been able to express our views and to make representations which have been attended with happy results. In numbers we have not had such a large accession to our ranks as Mr. Bellamy, our late president, was able to report during his year of office. This, of course, was accounted for by the fact that our association already comprises nearly all the corporate bodies and individuals entitled to join under its existing constitution. Our present membership numbers 55 corporations and 82 managers and principal assistants. We represent in capital expenditure upwards of 21 millions of money; our cars run 113 million miles per annum; and we carry more than 1,100 million passengers every year. The managers' section of our association, following the usual custom, has during the year held meetings for the discussion of useful and interesting papers on matters pertaining to the operation of tramways. The meetings this year were, through the kindness of the Lord Mayor, held at the Council House, Birmingham, and the members were very graciously welcomed to the city by Mr. Alderman Beale, J.P., chairman of the Tramways Committee of the City Council. I am convinced that the managers and their assistants appreciate the opportunity afforded by these sectional meetings of comparing notes on technical matters and points of general interest.

Municipalisation in America.—Perhaps the most striking feature of the year, certainly one that has caused most widespread interest in the tramway world, is the announcement that the great city of Chicago has declared, by a majority of upwards of 25,000 of its citizens, in favour of the municipalisation of its street railways. It has been a very common thing for the opponents of municipalisation of tramways to point to America in their endeavour to show that better results can be obtained from private than from public enterprise. They have always asserted that the American citizens were far too "cute" to undertake municipal ownership. Now, no one denies the "cuteness" of the American, but it must be remembered that civic life in America is comparatively young, and it seems to me to be a sign of national good sense that, as opportunity arises, America is not above taking a lesson from this country. Chicago is a city with an enormous mileage of privately-owned lines. It has been estimated that the cost of purchase cannot be less than eight million pounds. The City Council is, therefore, face to face with the gigantic task of co-ordinating the various systems with a view to giving the city one complete scheme of tramways under proper civic control. It is characteristic of our cousins that, having once decided on a course of action, they have begun in no half-hearted manner in tackling what is, perhaps, the biggest thing in tramways in the world. In was little thought eight or ten years ago that the United States was likely to find an object lesson in tramway management in this country. Yet such has proved to be the case. The striking success of municipal ownership and operation in the great cities of the United Kingdom—London, Glasgow, Liverpool, and Manchester—with their cheap fares, efficient services, and large profits, has long been the astonishment and envy of the civic authorities across the water. Now that Chicago has set the example to her sister cities, we shall doubtless be hearing of widespread municipalisation throughout America. Indeed, San Francisco has already won two elections in favour of municipalisation of its public utilities. In the early history of electric traction we had to go to America for all our knowledge. It speaks much for the engineering talent of this country that there is now no need to copy the United States any longer. It is generally acknowledged that, so far as the construction and equipment of tramways are concerned, we are not now so far behind—indeed, many people are of opinion that we can give points. However, whether this be so or not, we are grateful for what America has taught us in the past, and if our municipal experience is of any value to Chicago or any other American city, we shall be glad to place it at their disposal in the fullest and freest possible manner. Before passing from this subject, I think we may heartily compliment Glasgow on being invited to teach Chicago something of the art of successful municipal ownership and operation of tramways.

Carriage of General Merchandise.—Those of you who had the good fortune to be present at our annual conference held in Liverpool last year, and of listening to our late president's most excellent address, will readily recall some of the large number of points he touched upon and dealt with in such a skilful and interesting manner. Mr. Bellamy's remarks covered such a wide field that I find it somewhat difficult to deal with the subject of tramways and light railways without going over again some of the ground he traversed. It will be remembered that amongst the most striking features of that address was the allusion to the possibility of linking up urban districts with rural districts by means of tramways and light railways for the purpose of general merchandise traffic, and the suggestion that our association might effectively demonstrate its general usefulness by preparing a memorandum of a scheme for facilitating the provision of such means of conveyance in conference with the representatives of municipalities and county councils, for consideration by the Minister of Agriculture. This important matter has, I am glad to say, been under the consideration of your executive committee, who, however, are not in a position to lay any proposals before you at the present time. The subject is of such vast importance that every detail of a scheme of this character must be carefully thought out, so that no ill-considered proposal may be propounded. I sincerely hope during the coming year some such scheme as outlined by Mr. Bellamy may be formulated and action taken likely to bring it to fruition. Our association can, of course, only "outline" a scheme and place at the disposal of the authorities such technical and practical knowledge and experience as we possess.

Carriage of Parcels on Tramways.—A step in the direction indicated, although it is one limited to towns and suburban districts, has been taken by the inauguration in two or three of our large cities of parcel carriage services. These have been undertaken for the first time in the history of tramways on anything like a large scale, and with proper organisation for the carrying on of the business. It has, of course, been recognised for many years that tramways could be used for this kind of traffic with very considerable advantage and profit to the community. Nothing, however, has hitherto been attempted on quite the same scale as the system inaugurated with such marked success by the Manchester Corporation in April of this year. The use of electricity as a motive power has, of course, rendered a quick service of parcels carriage much easier of accomplishment than would have been possible under the old methods of traction, and we shall doubtless see in the near future very considerable development in this class of business. Primarily, tramways are authorised and intended for the carriage of passengers, and it is the first duty of tramway undertakers to give quick, efficient, and cheap services for this purpose. When this has been accomplished to the satisfaction of the community, it seems to me that if another branch can be conducted without interference with the business for which the tramways were originally intended (and this should be the first considera-

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tion), the community have a right to demand that their lines shall be used to their fullest capacity in the public interest. That Parliament contemplated the use of tramways for goods as well as passenger traffic is shown by the fact that since the General Tramways Act of 1870 was framed nearly all the local Acts contained a schedule of charges for goods, parcels, and live animals—even to the donkey. The result of the working in Manchester and Bradford will be watched with the greatest interest by all who are concerned in the operation of tramways, and doubtless many of us will profit by the experience of these go-a-head cities.

Tramway Speeds.—I now come to a subject which has exercised the minds of those engaged in the operation of tramways for a considerable period. I refer to the speed at which cars are allowed to be driven upon tramways. In the early stages of electric traction it was difficult to get the Board of Trade to authorise a greater speed than eight miles an hour. This was the maximum speed at which the cars were allowed to travel. The average speed, inclusive of stops, was not much beyond that obtainable on horse tramways some 25 years ago. That the Board of Trade was right in exercising great caution in safeguarding the public when the new system of traction came into vogue no one will deny. As time went on, however, the equipments adopted for properly controlling the cars, both mechanical and electrical, together with the introduction of improved devices for saving the lives of persons falling in front of, or being knocked down by the cars, were of such marked improvement on those at first in use that it was felt the Board of Trade might safely grant increased speed over that originally allowed. Representations were made by the parties interested, and in some cases the Board of Trade were induced to grant a slightly increased rate of travelling. It is satisfactory to find that these concessions did not increase the number of accidents occurring in the places where the higher speeds had been obtained. In 1903 Liverpool, with its enormous traffic, was able to demonstrate, after a period of marked immunity from accident, that a higher speed than that allowed under the Board of Trade regulations could be safely granted, even in heavy city traffic, and it is satisfactory to know that the Board, after careful enquiry, felt able to give an increase of 25 per cent. over the rate of travelling originally permitted. In his report to the Board of Trade recommending these changes, Lieut.-Colonel P. G. von Donop stated: "Electric cars have now been running in Liverpool for nearly five years. The drivers are now very efficiently trained, and there has been of late a great freedom from serious accidents. Under these circumstances, I consider that an increase of speed might now be allowed." The general manager of the Liverpool tramways in his annual report states that the broad effect of the change is that while under the old regulations the average speed, including stops, was limited to 5·8 miles per hour, under the new regulations the average speed is increased to about 7½ miles per hour, and that, notwithstanding these changes, street accidents of all classes have considerably declined during the year. There are many members of our association who think that much greater facilities might still be granted in this direction, and I confess I am one of their number. When it is remembered that in one year the tramway cars in the United Kingdom ran upwards of 190 million miles, and that they carried 1,800,000,000 passengers, the number of fatal accidents reported is so small, that this, in itself, would seem a very strong argument in favour of a higher rate of speed. It seems somewhat anomalous that motor-cars and motor 'buses—vehicles that can wander all over the carriageway, and frequently do—are allowed a speed of 20 miles per hour, while tramcars, running on fixed lines from which they cannot deviate, are limited to a considerably less rate of travel. No one, of course, wants to get an authorised speed which it is impossible to make use of in crowded thoroughfares. Here the speed of the cars must to some extent be regulated by the density of the traffic, but in less populous suburban districts it is of the greatest importance that passengers should be transported at a quicker rate than is now permitted. Time is, of course, the greatest factor in the solution of the problem of urban and suburban communication. It is of no use projecting schemes for the housing of the working classes in the outskirts of our large towns and cities unless adequate means of communication are provided. The workman not only wants to be carried to and from his work, but he wants to be carried quickly, and without spending too much time on the road. The same thing applies to the clerk and to the business man, and I think our efforts ought to be directed in the first place, if we have not already done so, towards getting the most perfect equipments upon our cars to enable them to be kept under absolute control, and afterwards to use every endeavour to get our speeds increased to such an extent that we may give the public not only a cheap but a rapid method of transit. In concluding my remarks on this subject, I think I cannot do better than quote the head constable of Liverpool. In speaking at the Southport meeting of the British Association he said: "He considered that the faster the street traffic the safer it was. There had been a considerable decrease in accidents in Liverpool since the introduction of electric trams. The trams had educated all classes of the public in regard to taking greater care in the highways." This is striking evidence, and there is no doubt that the experience of Liverpool in this respect is common to other towns.

Motor Omnibuses.—The past year has witnessed what I may call a motor omnibus boom. Opponents of electric tramways, and especially opponents of municipal tramways, have seen in the coming of the motor omnibus the doom of electrically-driven tramcars. They have seen tramways in our great cities lying derelict, electric tramcars sold for base uses, such as bathing machines and hen roosts, and the millions of money spent in this country on tramway undertakings utterly wasted. A terrible picture surely, but fortunately the advent of the motor omnibus is not likely to leave such ruin in its train, whatever else it may leave behind. Tramway men have, of course, paid the most careful attention to the motor 'bus to find out whether it was likely to prove a useful adjunct to tramways in dealing with the great mass of traffic requiring to be handled in our great cities, but it did not take long to find out that, however useful the motor 'bus may be in some respects, and whatever advantages over a horse omnibus it may have, it cannot now and never will be able to compete successfully with an up-to-date electric tramcar. To quote the Hon. Arthur Stanley, M P, an ardent automobilist, and president of the Tramways and Light Railways Association. In addressing that association, Mr. Stanley said: "When anyone finds a cheaper mode of traction than a metal wheel on a metal rail, then tramways will be run off the road, but not till then." There, gentlemen, lies the crux of the whole question—viz, the cost of operation. Everyone interested in electric traction knows what it costs to operate tramways on a fairly large scale in this country. The figures are published year by year, and are well known even to "the man in the street," but the "boomers" of the motor 'bus are peculiarly reticent as to the working costs of the petrol-driven vehicle. The only figures yet published, so far as I am aware, are those in the weekly edition of the *Tramway and Railway World* for Feb. 7. These relate to the operation of the Hastings omnibuses, and are set out as follows: general repairs and tyres, 3 50d; wages of conductor and driver, washing 'bus, etc, 2 50d.; oil, petrol, grease, etc, 2 00d; all other expenses, including depreciation at 20 per cent., 3 50d.—total, 11·5d. per mile run. I understand that these figures are stated by the makers, and are not likely, therefore, to err through excess of caution. It has since been reported in the daily Press that the result of a year's working shows a very considerable loss. Now let us see how these cost compare with electric tramways. Taking six of the largest undertakings in the United Kingdom, I find that the total operating costs average 6·12d. per car mile. This figure includes power costs, traffic costs, maintenance and renewals, and general expenses. "Ah! but you must remember," say some, "that motor omnibuses have no permanent way to provide, whilst tramways are costly to maintain." Quite true; but taking the same six undertakings, I find that the interest and repayment of loans on the permanent way and overhead equipment amount only to another 1·036d. per mile run, so that, taking

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even this serious item into consideration, there is still a difference in cost of 4·354d. per mile run in favour of electric tramways. It must never be forgotten—and tramway men are not likely to forget—that the cost of operating tramways includes very heavy amounts for rates on the tramway portion of the public road, while omnibuses pay nothing whatever, although they do considerably more damage. Of course, the principal item of expenditure in connection with motor 'buses is for indiarubber tyres. I am informed on good authority that these cost from 2 l. to 2½d. per mile run. Now, assuming a motor omnibus to be capable of running 90 miles a day, the same as an electric tramcar, you have for 365 days a total of 32,850 miles. This means in money for tyres, at 2½d. per mile, £342. 3s. 9d. Now, a set of four tramcar wheel tyres can be bought for £8. These will have on an average a life of 50,000 miles, which works out at a minute fraction of a penny per mile—to be accurate ·0384d.—so that what costs the motor omnibus £342. 3s. 9d. per annum, costs the electric car about £5. 5s. 1d. per annum. If one takes, therefore, a fairly large city, where, say, 100 vehicles are required in daily service to deal with the traffic, you have a difference in this one item alone of upwards of £33,600 per annum in favour of electric trams. I do not want to labour this matter, and I say nothing about the increased carrying capacity of tramcars as compared with motor 'buses. I think I have said enough to show that motor omnibuses are not going to supersede tramways, and that municipalities and ratepayers need be under no apprehension that the large amount of capital invested in their tramway undertakings is likely to be sacrificed.

Amalgamation.—Another matter which has been freely discussed of late, and one to which your executive committee has given a great deal of attention, is with regard to the advisability of amalgamating the three tramway associations—viz., our own association, the Tramways and Light Railways Association, and the Association of Tramway and Light Railway Officials—so as to form one single powerful organisation, which it is claimed would more adequately represent the views of all those engaged in the tramway industry. You will remember that originally we were formed as a municipal tramway managers' association. After a short time it was felt to be desirable to alter the constitution so as to embrace chairmen of tramway committees, and a proposal will be before you at a later stage of these proceedings to still further widen the basis of our association so as to admit vice-chairmen of committees as well as chairmen. With regard to amalgamating the three associations, there is much to be said in favour of having only one powerful body to watch over tramway interests, and if satisfactory arrangements can be made I see no objection to it. Municipal interests, however, must not be subordinated, and I, for one, would never be a party to any alteration in our constitution which would tend in the slightest degree in that direction. The matter, however, is under the consideration of your executive committee, who are giving the most earnest attention to the whole subject. Informal conferences have already been held with members of the other associations, but nothing will be done without the full sanction of the members of our association in general meeting. Now, with regard to our programme, last year it was found that we had more papers than we could properly digest. This year it has been felt desirable to limit the number so that we may give each paper full consideration, and also allow our members every opportunity of inspecting the exhibits of the manufacturers at the Tramways and Light Railways Exhibition in the adjoining hall. There the members will doubtless find much to interest them—many things that are up-to-date and novel.

Standardisation.—It is true that a great deal of the material now used in the construction and equipment of tramways has been standardardised by the British Standardising Committee, and in this respect something like order has been evolved out of chaos. There is, however, I think, a word of warning due here, lest, following the easy path of standardisation, we should, perhaps unconsciously stifle initiative and invention. Standardisation up to a certain point is good. It enables manufacturers to stock certain articles which long experience has proved to be in greatest demand. It also enables buyers to purchase, without themselves having to get out special designs, or to pay manufacturers for so doing, and this, of course, is a very considerable convenience. The point I wish to make is this: we must not accept as finality anything that happens to be standard, otherwise our engineers and inventors will become disheartened, and we shall become "sticks in the mud." I know inventors are sometimes somewhat of a nuisance, and trying to one's nerves and temper, but we may some day "entertain an angel unawares." It behoves us, therefore, to be on the look-out for the "angel" who can show us something even better than the standardised article, especially if it tend towards increasing our revenues or adding to the efficiency of the business in which we are all engaged.

I shall not detain you longer except to express the hope that this year's conference may be as interesting and instructive as those which have preceded it.

ELECTRIC TRAMWAY AND RAILWAY EXHIBITION.

The third International Electric Tramway and Railway Exhibition was formally opened by the Earl of Derby at the Agricultural Hall, Islington, N., on Monday last. A luncheon followed, at which Mr. James W. Courtenay, the chairman of the Exhibition Committee, presided. In proposing the toast of "The Industry of Transport," Lord Derby quoted some interesting statistics showing the enormous growth of the tramway industry during the past few years. The total number of passengers carried in 1878 was 146 millions, in 1898 the number had risen to 858½ millions, while in 1903-4 the tramways had carried nearly 1,800 million passengers.

Messrs. Babcock and Wilcox, Limited, whose stand is No. 13, have an excellent exhibit of models of their water-tube boilers, chain-grate stokers, water-softening apparatus, etc. They have also at the back of their stand one of their silent gravity bucket conveyors erected to show the details of construction. These conveyors, while specially designed for boiler-house work, carrying coal to the bunkers and ashes from the boilers, are also adapted for conveying other materials. The actual conveyor exhibited is capable of handling 20 tons of small coal per hour. The driving device is a very important feature of this conveyor, and may be actuated by any motive power obtainable. It consists of a spur-geared engine operating two sets of pawls, which successively thrust the chain in the direction of its travel, engaging with both sides simultaneously. By this device any wear in the chain links is compensated, and a chain works as freely and easily after years of constant use as when newly started. Another special feature of this conveyor is the application of free or revolving wheels where the direction of the conveyor is changed, either from the horizontal to the vertical in the same plane, or at any angle to the first plane of motion. In descending from an upper run to any depth the maximum stress is at the point of turning to descend, and here the wheels carrying the chain and buckets cease to rotate as soon as they touch the revolving free wheels, and when movement ceases friction also ceases, and, consequently, wear on the chain, wheels, and axles ceases also. The conveyor is practically automatic in its cycle of action, no handling being necessary from the point at which the material is delivered into the receiver hopper, until it is "discharged," further than moving the levers of the dumpers to fill up the sections on which it is desired to operate. The turbine tube cleaner is also shown on the stand, and there are some interesting specimens of special steam-pipe work.

Messrs. Bruce Peebles and Co., Limited, of Edinburgh, show on their stand No. 48 a considerable amount of novel apparatus for electric traction purposes. Their exhibit, in fact, gives some practical examples of the steps which the firm are taking to develop alternate-current traction on the latest lines. They have on view a standard tramway motor and controller for direct-current working as well, but visitors will be mostly interested in the newer type of plant for three-phase and single-phase working. Amongst these we specially noticed the continuous-current three-

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phase traction equipment which has been built for the Canadian South-Western Traction Company, of London, Ontario. The exhibit consists of a truck fitted with two 135-h.p. motors. This company operates an interurban line some 30 miles in length, which is being equipped by Bruce Peebles and Co., Limited, on the three-phase system at 1,100 volts. In order, however, that the cars may be able to run into the city of London, which has an existing 500-volt service, it was necessary that the motors should be able to run on continuous current, and they have been designed accordingly. The motors have a distributed winding similar to that of an ordinary three-phase induction motor, and an armature with both commutator and slip-rings wound similarly to a series-wound

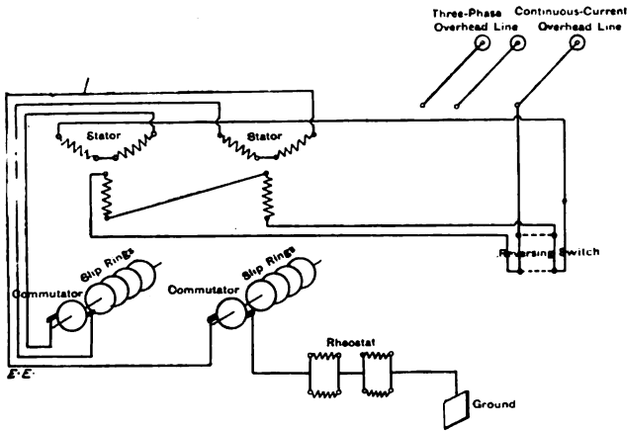

FIG. 1.

continuous-current armature on the two-circuit principle. When running on continuous current, the motors are controlled in the same way as a pair of standard 500-volt traction motors. When running on three-phase current, however, the brushes are lifted off the commutator from the driver's stand, and the motors are started in cascade, and afterwards cut into parallel, giving the same character of acceleration as with two continuous-current motors in series-parallel. Through the courtesy of the firm, we are able to give the accompanying illustrations to show how the motors are connected for the various methods of operation. Thus, Fig. 1 shows the connections when the motors are worked on the continuous-current supply and connected in series. Fig. 2 shows the connections on the

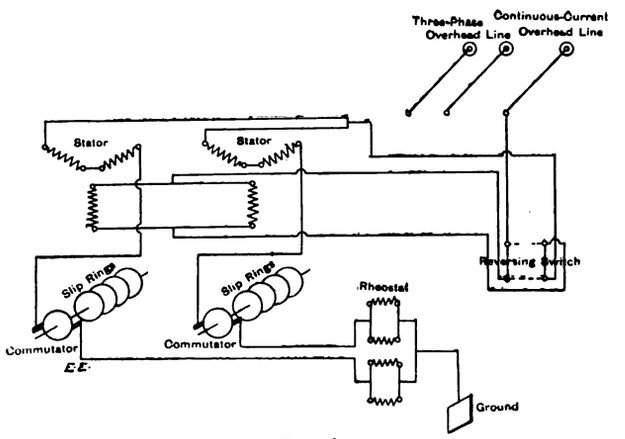

FIG. 2.

same supply with the motors in parallel. When the truck is running on the interurban line with three-phase currents, the cascade connections are as shown in Fig. 3. It will be seen that in this case the two rotors are connected in cascade, and that the regulating resistance is inserted in the stator circuits of the second motor. Fig. 4 shows the connections with the two three-phase motors in parallel. In this instance the regulating resistances are placed in the rotor circuits, which are wound on the two-phase system. The reason for this is that the resistances required for direct-current working can be more conveniently utilised with a two-phase winding. The design is such that one controller works the motors on whichever system they are run. The brushes are lifted off the commutator when the motors are running on the three-phase line, but the brushes on the slip-rings are never lifted. When this equipment is at work in Canada, some interesting figures will be obtainable as to the economy of the system. The three-phase motors allow of a considerable amount of energy being returned to the line on down grades when braking.

On the same stand there is to be seen a three-phase locomotive which has been built for the Portmadoc, Beddgelert, and South Snowdon Railway. Nine other locomotives of similar design are in hand. The motor has a vertical shaft, owing to the difficulty of fitting so large a motor on to the narrow gauge of 2ft. The locomotive as shown is capable of hauling loads of 50 tons up gradients

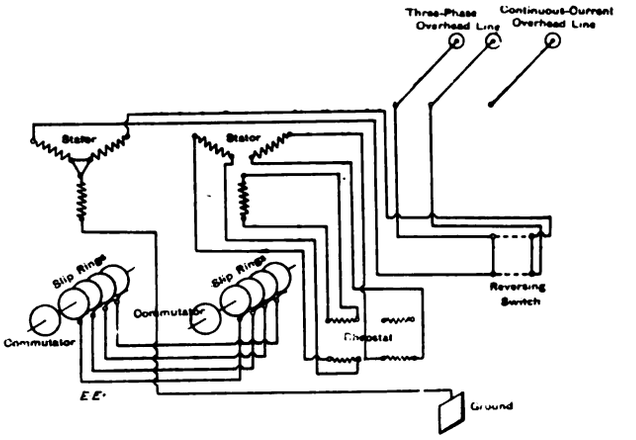

FIG. 3.

1 in 40, and it can also attain a speed on level of 25 miles an hour. The normal horse-power of this locomotive is 100, but the motor can be worked up to 250 h.p. for short periods. One feature of the design is that the weight is kept low, and the power developed is high for such a small-gauge locomotive. The single-phase traction motor on this stand has been constructed under the Peebles-Arnold-LaCour patents, and is of the compensated repulsion type. It is claimed that the efficiency, power factor, freedom from sparking, and economy of current consumption achieved by this motor constitute a record in this type of machine. It differs from the Latour motor in that three brushes only, instead of four, are required with the bipolar arrangement.

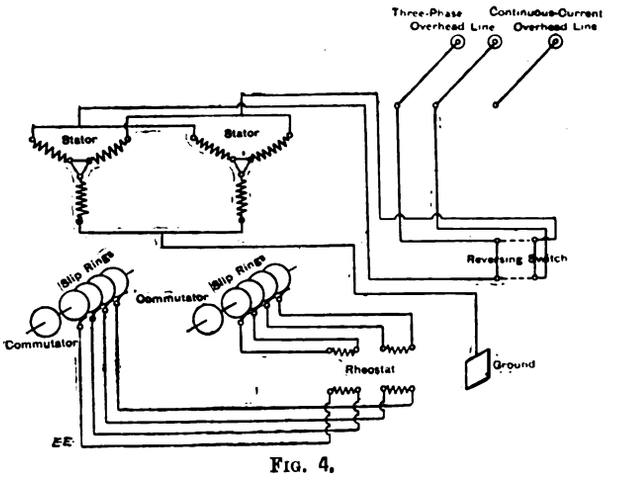

FIG. 4.

The motor exhibited is capable of, approximately, 80 h.p., and has six poles, five brushes only being used. The firm also exhibit a 400-kw. motor converter for converting 6,600-volt three-phase current into 550-volt continuous current. This converter, which is built on the Peebles-Bragstad-LaCour patents, combines the advantages of both a rotary converter and a motor-generator, and, at the same time, it avoids the disadvantages of both these machines. The firm have a large number of orders going through for these converters.

Messrs. Dorman and Smith exhibit a long range of their grip-contact circuit breakers, and they are showing a new design of time-limit tripping gear for use in connection therewith. This device seems to fill every requirement of

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central-station practice. It is a relay arrangement to close an auxiliary circuit to automatically open the circuit breaker on any overload that would cause injury through rise of temperature in the circuit controlled. The period of time introduced by the time-limit device is inversely as the amount of the overload, ranging from over five minutes for very moderate overloads to about seven seconds for excessive overloads. The circuit breaker when used with the time-limit device is wound so that it will instantaneously

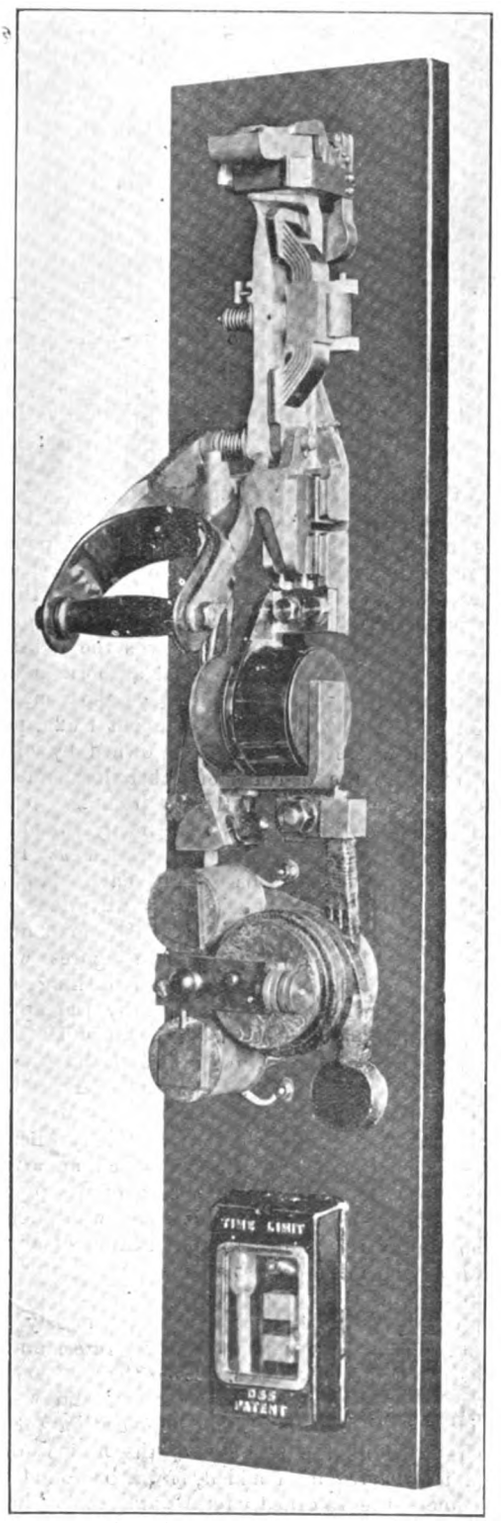

FIG. 5.—Dorman and Smith's "Grip Contact" Circuit Breaker, combined Overload and Reverse Current form, with D. & S. Time Limit Device.

open the circuit if subjected to any overload that would cause mechanical injury: thus the time-limit device can be set to operate from 50 to 300 per cent. overload, and the circuit breaker itself will operate instantly when the current exceeds 300 per cent. of the normal rating. The values can be varied if desired for special purposes. The illustrations (Figs. 5 and 6) which we give of the time-limit apparatus are easily understood without a long description. It will be seen that a certain portion of the main current is used to heat one bulb of a U-tube containing mercury. This causes the mercury to rise in the other leg of the tube and to close the subsidiary circuit which actuates the tripping device of the circuit breaker. Visitors interested in circuit breakers would do well to look closely into the grip contact employed by this firm. It will be found that when the switch is closed, the contact faces are gripped together firmly. On releasing the trigger the lever grip is released and the switch is opened by the powerful spring plunger, the pressure of which was previously exerted to keep the contact faces gripped together. The advantages of this method of construction are: (*a*) the contact faces are kept clean by friction, when opening and closing the switch; (*b*) the gripping device ensures cool working, when the switch is closed; (*c*) the releasing of the "grip," when the trigger is operated, ensures the switch opening with certainty under all circumstances. This series of circuit breakers are also arranged with a secondary switch, which is closed after the primary switch; the latter is then independent of the operator's hand and is free to open immediately. The firm exhibit one of their circuit breakers for three-phase working, in which two of the tripping devices operate on overload in two of the phases. The third switch is controlled by a no-load device. All three switches are simultaneously opened if either of the three devices acts. At the back of the stand a handsome

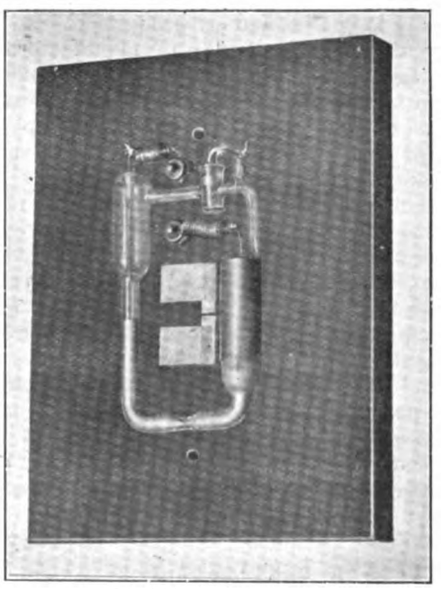

FIG. 6.—Dorman and Smith's Time Limit Relay (cover removed).

traction switchboard belonging to the Swansea Corporation is on view.

The Brockie-Pell Arc Lamp, Limited, exhibit on Stand 146 their latest form of enclosed type of arc lamp, which has been recently introduced. They have also on the stand a number of the Newcastle type of lamp, which have been largely used in connection with the street-lighting from the tramway poles in that city. These lamps are of the double-carbon open type, and burn for 36 hours with one trimming. They are shown in the central carriers as used in the above-mentioned city, and also at Brighton. We understand that the company have a flame arc lamp which will be on the market at a very early date.

The British Electric Equipment Company show a variety of fittings for the overhead trolley system which should meet every possible contingency. In the whole series the insulation used is of the "Dirigo" type, which is remarkable for its stability, and for the fact that it is absolutely non-absorbent of moisture. The Nicholson patent frogs and crossings are exhibited, and these will be found specially suitable where swivelling trolleys are employed. Visitors to the exhibition would do well to get a special bulletin issued by the company describing their new type of bond, which they have christened the "soldered bond." Their latest apparatus for sanding tracks worked by pneumatic pressure is also worthy of careful inspection.

The Electrical Power Storage Company on Stand 113 have some very large secondary batteries on view. Amongst these is their O L 74 type, which has a capacity

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of 5,000 ampere-hours when discharging in one hour, or 10,000 ampere-hours when discharging over four hours. To get this large capacity, two sets of plates are placed in the one containing vessel. The mechanical details of the cell are worthy of special inspection, and the arrangements are such that the cost of upkeep should be reduced to a minimum. They have also an O K type of cell with 53 plates on the stand with a capacity of 5,200 ampere-hours on a four hours' discharge. Either of these cells are suitable for heavy traction work The smaller batteries used for electric vehicles are also well represented. For instance, one box contains 44 cells of the A B 15 type, which have a discharge rate of 30 amperes over five hours. The weight is as low as 30lb. per cell complete with acid and ebonite containing vessel. The plates in these cells are divided by perforated ebonite separators with rubber ribs, which tend to prevent any damage being done by vibration. The other sets of automobile batteries exhibited have a smaller capacity. Accumulators for ignition purposes are also well represented.

The Electric Tramway Equipment Company, which have their headquarters at 86, Glover-street, Birmingham, have a general exhibit, comprising overhead line material, switchboards, and gear and pinion wheels of a number of standard types. The gear wheels in question are machine-cut from individual hammered forgings of Siemens-Martins open-hearth steel. The pinions produced in this way have an exceptionally long life, and by production with automatic machinery the labour charges in manufacture are kept down to a minimum. We understand that one of these pinions can be machined complete in a little over an hour. In the overhead line material the "Verus" type of insulation is used throughout, and some interesting special types of insulators made of this material are on view. Amongst these is a half-globe insulator, which is exceedingly useful where the space is so limited that the ordinary globe strain insulator cannot be employed. An exceedingly large range of ears is shown, there being 70 different types manufactured by the firm, varying in length from 7in. to 42in. Amongst the switchgear we noticed a number of section feeder panels, amongst which was one of the type now largely used by the British Electric Traction Company. In the construction of these, double insulation between the iron of the section pillar and the live metal of the switchgear is everywhere provided. Specialities for use in connection with surface-contact systems are also exhibited by this firm

The Berliner Telephone Company naturally introduce into their exhibit a large variety of telephone equipments for use in connection with tramway undertakings. Amongst these there are complete equipments for feeder pillars and a series of portable telephones which can be used in connection with plugs in such pillars. Amongst these is a portable breakdown telephone set, which will appeal to tramway engineers. A water-tight bell which will be of considerable service for exposed positions is also interesting. In this the mechanical motion is transmitted from the electromagnet to the gong through a thin metallic diaphragm, which effectually seals the mechanism of the bell against moisture or dust.

The Aron Electricity Company, Limited, on Stand 138 have a historic collection of meters, ranging from the earliest Aron type up to the latest production of this firm. Amongst the newest instruments we noticed a continuous-current meter, with which was combined a maximum demand indicator. This indicator was in the form of a dial at the top of the meter, and gives a reading directly in watts. In the instrument we inspected the maximum consumption in any period of 10 minutes was indicated by this pointer. This was done in the following way: The pointer was connected by means of a gear wheel to one wheel in the counter-train. This gear wheel was drawn out of gear at 10 minutes' intervals, and working against a spring returned to the zero position. The pointer being loose on the shaft is not returned to zero by the spring, and thus registers the maximum amount recorded in any interval of 10 minutes. The demand indicator being direct reading is exceedingly convenient, and it is also well to have a meter and demand indicator combined. An alternate-current motor meter for the two-rate system is also on view. A large number of meters suitable for tramway work were to be seen on the stand.

CHARGES FOR SUPPLY FROM COMBINED LIGHTING AND TRACTION STATIONS.*

BY JOHN HALL RIDER, M.I.C.E., ELECTRICAL ENGINEER, L C C. TRAMWAYS.

In 1896 the author read a paper before the Municipal Electrical Association advocating combined lighting and traction stations. The principle was laid down that where the lighting and tramway undertakings were in the hands of the same authority, the supply should be given to both from the same generating station. There are now about 114 such stations at work, some being originally lighting stations with tramway plant added, and others, like Plymouth, which was the first, designed especially for the combined supply. All kinds of objections were formerly raised against combined stations. Engineers who ran lighting plants were supposed to be unfit to be trusted with the supply to a tramway. Tramway work was said to impose such strains upon the machinery that not only was no lighting plant capable of standing them, but also that American-built engines were absolutely essential. In the light of experience these and other myths have disappeared, until practically the only question now left is the most important of all: "Can a combined station sell electrical energy to a tramway as cheaply as the tramway can produce its own?"

In an appendix to this paper are given several tables in which are set out the prices charged for lighting, power, and tramway supply by the various owners of a number of combined stations. It has been difficult to get at the exact figures in many cases, but it is believed that those given are substantially correct. In some 60 towns the lighting and tramways are owned by the same local authorities, and the prices charged for energy to the tramways departments vary from 2·75d. to 1d, with an average of about 1·62d. per unit. In three cases where the tramways owned by one local authority run into the districts of other local authorities, energy is purchased from the latter at from 2d. to 1d. per unit, and in one case energy is temporarily taken by one local authority from an outside corporation at 1½d. per unit. Twenty-five corporations supply energy to various tramway companies within their areas at prices varying from 2¼d. to 1d. per unit, with an average of about 1·67d. per unit. On comparing any of these figures with the published returns of local authorities owning separate traction stations, one is at once struck by the apparently low cost at which the latter can work. Out of 10 towns the highest cost is given as ·86d. per unit and the lowest ·34d. per unit, with an average of ·515d. per unit. There does not appear to be much room for combined stations after that!

Comparisons, however, are odious, especially when unlike things are compared. The price at which an article can be sold depends upon the entire cost of its production. While the author is bound to acquit those who publish and those who supply the figures for publication of any desire to mislead, yet he must protest against such figures as those just quoted being used to express the "total power costs." They do nothing of the kind. They are merely "works costs," and do not include either rents, rates, and taxes, insurance, or any office expenses. Even the addition of these items would not give "total power costs," and we have to include interest, sinking fund, and depreciation (or reserve fund) charges before the real cost of the unit is obtained. When all these have been added, it will be found that in many instances the so-called "total power costs" have been doubled, and the actual cost of production will have been brought to figures not very different from those at which energy is sold to tramways from a combined station.

To show the absurdity of the whole thing, we only have to ask any of the tramway undertakings generating their own electrical energy, and whose returns are published in the *Electrical Times*, whether they would be prepared to sell energy at the "total power costs" there given, even with the addition of 10 per cent. as a substantial profit. We have an answer to hand from Glasgow, where, although the

* Paper read before the Municipal Tramways Association.

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so-called "total power costs" are only ·41d. per unit, 1,243,632 units were sold last year to the electricity department at an average price of 1·47d. per unit. There is no doubt that in some cases the price charged for tramway energy is too high, but in others it would appear almost as though it were being sold under the real cost. The extremes are reached at Dover (2·75d.) and Bradford (1d.) It is not fair that the tramways should be called upon to pay a high price merely to balance a loss on the lighting undertaking. Neither is it fair to sell under cost to the tramways because a profit happens to be made on the lighting. Each class of consumer should be treated in the same way, and if a profit be made by the electricity works, each class should contribute to it at an equal rate. It should not be a difficult matter to arrive at a fair basis of charging. Generating electricity for tramways is exactly the same process as generating it for lighting or any other service, and the only difference between the two is that the tramway demand lasts for perhaps 16 hours per day, while the lighting only lasts for an average of about three hours.

Generating costs are of two kinds: (*a*) those which depend only upon the maximum amount of energy demanded; and (*b*) those which depend only upon the number of units generated. The former decide the amount of plant which has to be provided, and therefore, while fixed in actual value for a station of any given size, are lessened per unit in almost direct proportion to the number of units generated. The latter are, practically, a constant value per unit. The one may be called "fixed costs," and the other "running costs." In "fixed costs" we may include interest, sinking fund, and depreciation on land, buildings, and plant; rents, rates, taxes, and insurances; salaries and wages at generating station of the stand-by staff required, whether the output be large or small; coal, water, etc., required for keeping certain boilers under steam in readiness for "peak" load. In "running costs" we may include coal, water, oil, etc., used in running plant under load; salaries and wages of staff other than above; repairs to plant.

To allocate properly to the lighting and tramway departments their correct shares of the above costs, we have to estimate: (1) the maximum demand in kilowatts of each service (from this we know how much plant to provide for each, including spares, and therefore the "fixed costs" for each service); (2) the approximate output in units per annum taken by each (from this we know how to arrive at the "running costs" for each service). This is equivalent to saying that the correct charges for supply from combined lighting and traction stations may be obtained by the use of the "maximum demand" system, but it must be properly applied. In the author's opinion, there should be one electricity supply department for the town, and it should provide all energy required, and for whatever purpose. It should feed into the overhead wires of the tramway department just as into the wiring of any building, and, as a result of this, it should provide all underground feeder and distributing cables. By adopting the "maximum demand" system of charging, all energy would be fairly supplied on the same terms, whether to tramways, to public lighting, or to private users. But the initial price should be kept high and for as short a period as possible, while the second price should be kept as low as it was possible to make it. All classes of consumers would then be charged at rates in accordance with their use of the supply, and the "long-hour" demand of the tramways would result in a very low actual price per unit.

To simplify the book-keeping, the tramway demand and output could be calculated at the beginning of each year, and the average price per unit arrived at. Thus, if 8d. per unit prove to be the correct charge for the first hour's supply per day and ¾d. per unit afterwards, an average 16-hour tramway load would come out something like—

$$\frac{8\text{d.} + (15 \times \tfrac{3}{4}\text{d.})}{16} = \frac{8 + 11{\cdot}25\text{d.}}{16} = \frac{19{\cdot}25\text{d.}}{16} = 1{\cdot}2\text{d. per unit.}$$

It is difficult to give any opinion as to what the figure really ought to be in each case without knowing all the circumstances. Manifestly, where the tramway demand lasts only 10 hours per day, the cost per unit must be higher than where it lasts 16 hours, as the "fixed costs" would be unaltered. And where coal costs only 6s. per ton the unit must cost less to generate than where coal costs 20s.

It is therefore unreasonable and beside the mark for the tramway department of one town to grumble if it be asked to pay 2d. per unit because another town only charges 1·5d, unless all the circumstances are alike. In the author's opinion, however, the price per unit for a 10-hour tramway load per day should not be more than about one-half and for a 16-hour tramway load not more than one-third of the average price per unit for a three-hour lighting supply. If rates higher than these be charged, it will be found, in all probability, that the tramway department is being asked to bear costs which should belong to the lighting department.

TABLE I.—Lighting and Tramways owned by same Local Authority.

	Price per unit for		
	Lighting.	Power.	Tramways.
Aberdeen	6½.—2d.	3d.—1d.	1·51d.
Ashton	3·75½.	1·5½.—1d.	1·5½.—1d.
Ayr	5½.	2d.	1·5d.—1d.
Barking	4·5d.	3·25d.—1·5½.	1·5d.
Bexley	6d.	6d.—2d.	*
Blackburn	6d.—3d.	1·5d.—1d.	1·5d.
Blackpool	7½.—2d.	2 5½.	2½.—1·75d.
Bolton	4d.—1d.	2½.—1d.	1·25d.
Bournemouth	3·5½.—2d.	—	1·683d.
Bradford	4d.	2½.—1·125d.	1d.
Brighton	7d.—1d.	7d.—1d.	1·5½.
Burnley	4d.	3½.—1d.	1·56d.
Burton	6d.—3d.	3d.—1d.	2d.—1·25d.
Bury	5d.—4½.	2·75d.—1d.	1·4½.
Cardiff	7d.—2d.	4½.—1d.	*
Chester	4·5d.	2d.—1·25d.	1·75d.
Chesterfield	6d. 3½.	1·5d.—1·25d.	1·71d.
Colchester	5½.	—	2d.
Darlington	4·5d.—3·75½.	2½.—1·5½.	1·75½.
Darwen	4·5½.	3½.—2d.	1·71d.
Derby	6½.—3d.	3d.—1d.	1·5d.
Doncaster	5½.—4·5½.	2d.	1·5d.
Dover	7d.—3d.	6d.—3d.	2·75½.
Dundee	4½.—3d.	2d.	1·49
East Ham	6½.—2½.	2·5½.	1·75d.
Exeter	5d.	2·5½.	1·78½.—1·75½.
Farnworth	6·5d.—2·5d.	2·5d.—1d.	1d.
Gloucester	6½.—2½.	4·5½.—1·5d.	1·25½.
Halifax	4½.—3d.	2d.—1d.	1·62d.
Ilford	6d.—2d.	7d.—1d.	1·5d.
Ilkeston	—	—	1·5d.
Ipswich	6d.	2d.	2d.
Keighley	7d.—3d.	2·5½.—1·5d.	2d.
Kirkcaldy	4·5d.—3½.	2·25d.—1d.	1·75d.
Lancaster	5d.	2·5d.	2d.
Liverpool	3·75.—3½.	2d.—1·5d.	1·14d.
Lowestoft	7d.—3d.	2·25d.	2·25½.
Maidstone	7d.—2d.	2½.—1d.	2½.—1·5½.
Manchester	5·5d.	1·8d.—1d.	1·49½.
Nelson	4·5d.—3d.	2·5½.—2d.	2d.
Newport	5·5d.—2d.	2d.—1d.	1·5d.
Nottingham	—	—	1·25d.
Oldham	4d.—1·5½.	2d.—1·5d.	1·5d.
Plymouth	4½.	2·5½.	2d.
Rochdale	6½.—d.	1·5½.—1d.	1·5d.—1d.
Rotherham	4·5d.—4½.	1·5d.—1d.	1·5d.
Salford	3·5d.	2d.—1·5d.	1·89d.
Southampton	4·5d.	3d.	2·25d.
Southend	6d.—4d.	2d.	1·875d.
Southport	6½.—2d.	2d.—1·5d.	1·5d.
Stockport	5d.—2·5d.	3d.—1·5d.	1·5d.
Sunderland	5d.—2·5d.	2 5d.—1·125½.	1·875d.
Swindon	5d.	2·5d —1d.	2·125d.
Wallsey	5d.—3d.	3d.	1·63d.
Walsall	6d.—2d.	2d.—1·25½.	1·76d.
Warrington	6d.—3d.	2½.—1d.	2d.—1·5d.
West Ham	7d.—2d.	5½.—1d.	1·6d.
Wigan	5d.—3d.	1d.	1·5d.
Wolverhampton	5d.—2d.	2d.—·75d.	1·66d.
Yarmouth	6d.—4d.	3·5d.	2·5d.

* Power run by Tramways Department.

TABLE II.—Lighting and Tramways owned by different Local Authorities.

Town.		Price per unit for		
Lighting.	Tramways.	Lighting.	Power.	Tramways.
Aston Manor	Birmingham	6d.—1·5d.	2d.	1·5d.
Boole	Liverpool	6d.—2d.	2d.—1d.	1·5d.—1d.
Nelson	Burnley	4·5d.—3½.	2·5d.—2d.	2½.
Shipley	Bradford	4·5d.—2d.	2d.—1d.	1·75d.

TABLE III.—Lighting and Tramways owned by same or different Companies.

	Price per unit for		
	Lighting.	Power.	Tramways.
Camborne	7d.—4d.	4d.—1d.	1·49d.
Glossop	4·5d.	4d.—1d.	1·5d.
Merthyr	7d.—2·5½.	4·5d.—1·5½.	1·5d.
Scarborough	7d.—3d.	2d.	1·4d.
Musselburgh	—	—	2d.
Stalybridge	4d.	2d.	1·5d.

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TABLE IV.—Tramways owned by Company; Lighting owned by Local Authority.

	Price per unit for		
	Lighting.	Power.	Tramways.
Aberdeen	6d.—2d.	3d.—1d.	2·25d.
Ashton	3·75d.	1·5d.—1d.	1·5d.—1d.
Barnsley	7d.—2d.	1·5d.	1·48d.
Barrow	6d.—3d.	3d.—1·5d.	2d.—1·25d.
Batley	6d.—2d.	3d.—1d.	1·5d.
Bickdale	7d.—2d.	2d.	2d.
Carlisle	5d.—4d.	2d.—1·5d.	1·75d.—1·5d.
Cheltenham	6d.—3·25d.	6d.—1·5d.	1·9d.
Cleckheaton	5d.	2d.	1·5d.
Colne	6d.—2d.	3d.—1d.	2d.
Croydon	7d.—1·5d.	2·5d.	2d.
Devonport	4·5d.—4d.	—	1·32d.
Dewsbury	5·5d.—3·5d.	3d.—1d.	1·5d.
Gravesend	7d.—2d.	—	2d.—1·5d.
Greenock	6d.—2d.	2·5d.—1·5d.	1·2d.
Hebburn	4d.	2d.	1·9d.
Middleton	4d.	2·5d.—1·5d.	1·5d.—1d.
Paisley	4d.	2·5d.	2·5d.—1·25d.
Peterborough	4·5d.—4d.	—	2·15d.
St. Annes	7d.—2d.	2·5d.	2d.—1·75d.
St. Helens*	4·5d.	2d.—1d.	1d.
Taunton	6d.—2d.	2d.	2d.
Tynemouth	5d.—2d.	2·5d.—1·25d.	1·5d.
Worcester	6·5d.—3d.	2·5d.—1d.	2d.—1·75d.
Wrexham	4·5d.	2d.	2d.

* Plus 10 per cent. per annum on capital expended on plant, feeders and overhead.

DISCUSSION.

Mr. W. N. TITTENSOR, of Preston, made a long contribution to the discussion, the gist of which was that the tramway undertaking ought never to be charged more than 1d. per unit in a town where coal was obtainable at 15s. per ton. He defended his charge of 1½d. per unit at Dundee on the grounds that the plant was not an up-to-date one. At Preston the electric light company had offered to supply the tramways for 1⅛d. per unit, but he had advised his committee that they could generate their own current for 0·96d. The balance-sheet for the first year's working had yet to be audited, but it showed a works cost of 0·58d., and a total cost, including capital charges, of less than 0·9d.

Bailie ALEXANDER, of Glasgow, said that the question largely depended on the point of view from which it was approached. Each man was apt to look at the matter from a personal point of view, and not as to what was best for the whole community. He thought that if the town was large enough to warrant the highest class of supervision for each undertaking, there was much to be gained from having two generating stations, between which a certain amount of rivalry and emulation would exist. Where there was one station, he thought there should be one committee and three sub-committees, dealing respectively with the generation of electricity, the supply of light and power, and the running of the tramways. The first committee would then generate and sell electricity to the other two. The figures which were given by the author as to the Glasgow tramway station did not make it clear that the power supplied to the electric lighting department was used on peak load. He thought that this justified the charge of 1½d. per unit, and he considered that the Lighting Committee sold electricity on the peak load at 6d. per unit. The Tramway Committee had recently agreed to supply more electricity to the Lighting Committee at the rate of 1d. per unit.

Treasurer LYON, of Aberdeen, agreed with the last speaker, and considered that in his city they gained from having one first-class plant controlled by a single first-class engineer. Under the arrangement in Aberdeen the tramway department paid for its power exactly what it cost to produce. This last year was certified by the city accountant to be 1·51d., which agreed very closely with Mr. McElroy's figure of 1·49d. for Manchester.

Mr. H. E. BLAIN, of West Ham, chaffed electrical engineers because they covered up their figures of costs under technicalities which were difficult to disprove. His conclusion was that these engineers were making a handsome profit out of the tramway undertakings. He wished Mr. Rider's paper had gone farther and that he had analysed the figures of the cost of supply to tramways from separate stations. He (the speaker) had gone into this, and found that these costs, including capital charges, were as follows: at Glasgow, 0·92d. per unit; at Birkenhead, 1·01d.; at Reading, 1·02d.; at Sheffield, 0·645d.; and at Leicester, 0·498d. Of this latter figure 0·306d. was the works' cost per unit, and the capital charge of 5½ per cent. for interest and sinking fund averaged 0·192d. After some remarks as to errors in metering and to private consumers being charged less for power than tramways, Mr. Blain gave his estimate as to what it would cost to supply the tramways at West Ham from a separate station. This would vary from ·98d. to 1·19d., according to the units used.

Alderman HEY, of Halifax, considered that even if a separate tramway station would give a cheaper supply, the general community might benefit considerably from having the two undertakings on one supply station. In Halifax this had been found to be the case. The starting of the tramways had enabled the lighting department to pay even with a reduction in the charge of energy for lighting from 6d. to 4d. per unit.

Mr. C. J. SPENCER, of Bradford, considered that the price charged to tramway departments from combined stations had been rather a matter of bargaining than of policy. He was surprised that the charge at Manchester was as high as 1·49d., and wondered as to how much of the plant in the station was charged against the tramway department when calculating the depreciation. He queried the position at which metering could be done. If the meters were placed in the station, the tramway department had to pay for all losses in transmission and distribution. He thought the meters should be placed out on the system as they were in the case of lighting consumers.

Mr. P. FISHER, of Dundee, thought that many of the speakers had mistaken Mr. Rider's point, which was—can the supply be given to tramways from combined stations as cheaply as from separate works? Most of the speakers had considered rather the question—is the supply given as cheaply? He thought that the Aberdeen figures of cost were wrong, but believed in combined stations.

The TRAMWAY ENGINEER of BOLTON also questioned the accuracy of electricity meters. Combined stations might be good for the ratepayers, but tramways could be supplied more cheaply from their own works.

Mr. J. H. RIDER, in reply, said he was pleased that such a long and useful discussion had followed a paper which he had prepared at very short notice. He believed not in having a lighting department to supply the tramways, but in having an electricity department which would sell current to all requiring it. The argument that there were two departments at Leeds, and that one was supplying cheaper than the other, could be answered by him to the effect that if the right system of charging were adopted it would be cheaper to have one station. It was true that the London County Council were putting down a traction station, but then they were not the supply authority. If they became so in the future, he would advocate one station for traction, lighting, and power. He was glad to get Mr. McElroy's support, as it was at Manchester that the correct system of charging for electricity supply was first adopted under the advice of the late Dr. John Hopkinson. He formulated the idea of dividing the charges into capital and running expenses, and if only the right division was made, an equitable system was assured. A high first charge for a short period was required, and this, unfortunately, was limited by the maximum in the provisional orders. The first charge should be made as high as possible and for a very short period, after which the bare running expenses should be charged on the rest of the consumption. This second charge should be fixed at the lowest possible value. Care should also be taken that the depreciation charges met by both lighting and traction consumers were fairly distributed.

A hearty vote of thanks was passed to Mr. Rider for his paper.

LANCASTER ACCOUNTS.

The following abstract of the revenue account is taken from the accounts of the Lancaster Corporation electricity department for the year ended March 25, 1905.

Dr. *Expenditure.*	£	s.	d.
Generation of electricity	2,824	13	7
Distribution of electricity	675	6	9
Fitting consumers' premises and lamps sold	198	8	9
Attending and repairs to public lamps	263	18	8
Rents, rates, and taxes	374	0	0
Management expenses, salaries, etc.	763	8	6
Special charges, insurances, etc.	27	9	5
Allowances and bad debts	64	8	5
Balance carried to net revenue account	3,854	14	7
	£9,046	8	8

Cr. *Income.*	£	s.	d.
Sale of current, less discounts	8,161	5	10
Public lighting	681	8	7
Sale of lamps and other apparatus	203	4	9
Cost of summonses—repaid	0	9	6
	£9,046	8	8

APPOINTMENTS VACANT.

Shift-Engineer Foreman. Applications to Box S 92, *Electrical Engineer* Office. See advertisement in previous issue.

Various.—Head of electrical engineering department; salary, £200 per annum. Head of civil and mechanical engineering department; salary, £200 per annum. Assistant for building construction, etc.; salary, £130 per annum. Halifax Education Committee. Applications by July 11. See advertisement in last issue.

Borough Electrical Engineer, Cheltenham. Salary, £400 per annum. Applications by 18th inst. See advertisement.

Lecturer on Electrical Engineering, Hull municipal technical school. Salary, £200 per annum. Applications, on forms, to J. T. Riley, D.Sc., director of studies, by 15th inst. See advertisement.

Electrical Engineer as manager to lighting and power contractors. See advertisement.

Draughtsman for switchgear work, Ferranti Limited, Hollinwood, Lancs. See advertisement.

FORTHCOMING EVENTS.

University of Liverpool.—Opening of new electrotechnics laboratory by Sir J. Swan, July 8.

Permanent-Way Institution. — Summer convention begins on July 21, continuing till July 27, in the course of which a visit will be paid to Holland.

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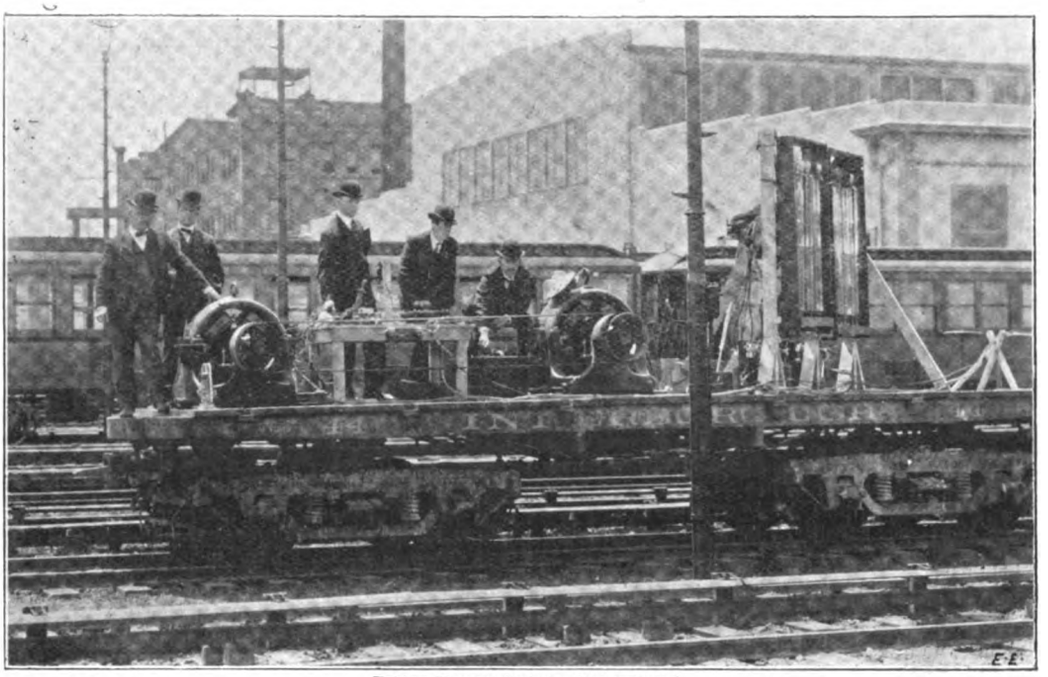
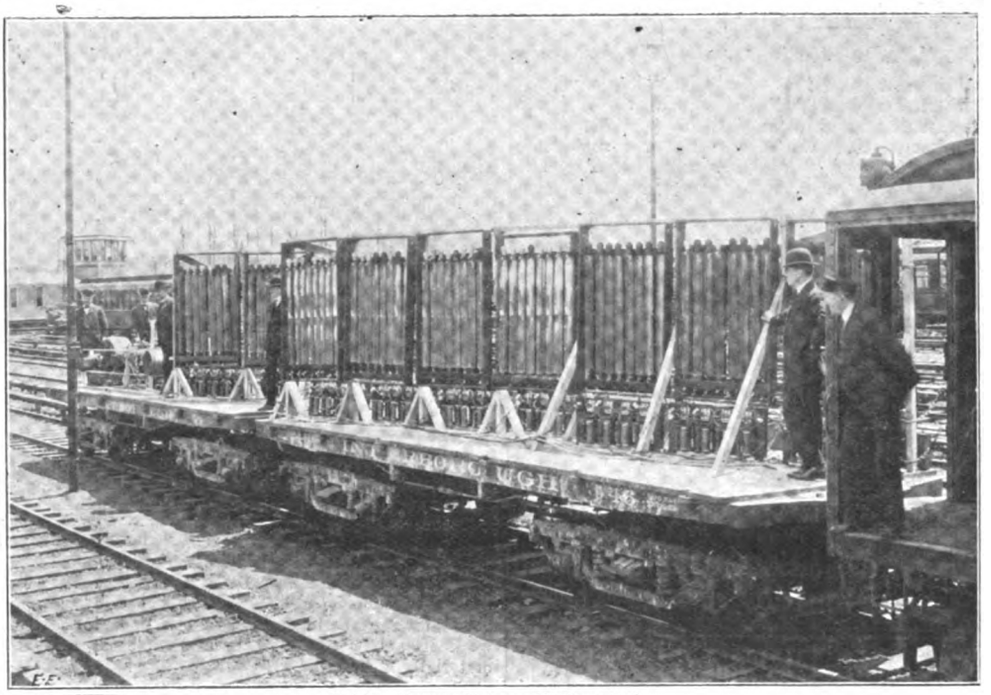
TAKING MOVING PICTURES UNDERGROUND.

A series of interesting moving pictures were taken a short time ago by the American Mutoscope and Biograph Company in a section of the subway of the Interborough Rapid Transit Railroad of New York. A number of scenes were included of the stations when the passengers were leaving or boarding local trains, and the results were in every way successful. The light by which these photographs were taken was provided by a number of the Cooper-Hewitt lamps fixed on two flat cars in nine banks of eight lamps each. The lamp known as the "K" type, which is 45in. long, was used, and the total candle-power of light amounted to 52,500 c.p. The banks of lamps were mounted diagonally across the foremost car, so that the light was thrown immediately in front of the camera, which was mounted on the next car. Each lamp was backed by a polished metal reflector, and the kicking coils by means of which the lamps are started were arranged underneath the frame.



Taking Moving Pictures Underground.

The manner of generating the current is worthy of note. A Westinghouse 40-h.p. 600-volt motor taking its current direct from the third rail was mounted on a truck and connected by belt to a 22½-kw. Westinghouse 110-volt generator. The various auxiliary apparatus, such as voltmeters, rheostats, switches, etc, were conveniently mounted between the two machines. The work was entirely successful, and during the entire trip only one lamp went out. The details of the subway construction were brought out with extraordinary clearness, due to the exceedingly high actinic power of the Cooper-Hewitt lamp The accompanying illustrations show the arrangement of the lamps and the generating outfit on the cars.



Taking Moving Pictures Underground.

ROBERTSON ELECTRIC LAMPS LIMITED—ANNUAL OUTING.

The outing to which the directors of the Robertson Electric Lamp Works at Brook Green annually treat their staff and employés, and incidentally some favoured visitors, has always been, as far as we can assert from personal knowledge, a howling success. This year it took the form of a trip to Margate, leaving Victoria last Saturday at 8 a.m., and no wonder when the hundreds of girls trooped into the station wringing wet the genial manager, Mr. C. Wilson, feared the

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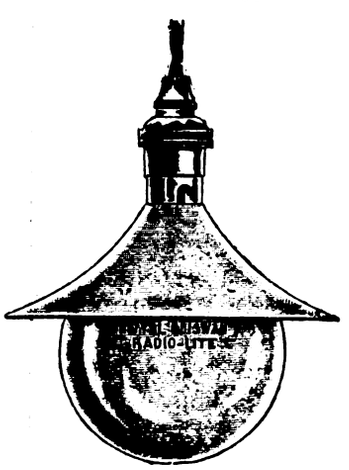
day which was beginning. However, all got aboard safely bar those who were unfortunate enough to come by the Underground, which was flooded by that time. They missed their train. Some of them came on by a later train; the others missed a treat. Soon after Sittingbourne the sun came out, and when Margate was reached the beach and town blazed forth in a golden July sun under the bluest of skies. A most enjoyable dip in the ocean at Cliftonville commenced the proceedings, and an excellent dinner followed at 12.30 so as to leave a long afternoon before the party. We may say here that by the party we understand the staff of the works (about 30) and their guests. The firm on these occasions go upon the sensible plan of providing a train, etc., for all their employés, and the husbands and wives of those who are thus blessed, and to leave them to roam at their free will upon arrival at the port selected. The young people, being away from the all-seeing eye of the foreman and staff, enjoy themselves all the better for being left to their own devices. And that is where part of the howling success comes in. Some call it singing, but no matter. There was not much speechmaking at the dinner, but the toasts of the company, the managing director (Mr. C. Wilson), the staff, and the organising secretary (Mr. Saville, who deserves all the praise bestowed upon him, and so forth) were duly honoured. From what we heard, the company is still making rapid progress. This year the output increased by 40 per cent., reaching a total of 4,000,000 lamps. This necessitated a corresponding increase in the number of employés, and considerable extensions to the factory, which have been carried out and completed satisfactorily. We are glad to learn that there was not a single accident during the whole year. After dinner a brake and a landau, the latter of which nearly came to grief in a collision, took the party through the wheat and barley fields to Birchington, and a prolonged halt was made at the Minster Gardens for strawberries, tea, and frolic. We have been asked to specially notice the running form of some elderly gentlemen present; and while on the subject of sport we must mention the excellent shooting in the subsequent match, Messrs. Wilson, Saville, and Hogg coming out with 31 and 29 points respectively. After the return to Margate there was yet another tea, a lovely walk along the front, and a lively return to Victoria, which was reached at midnight without any mishap, and with the unanimous feeling of having been made to have a real good time.

TRADE NOTICES AND NOVELTIES

The "Radio-Lite" Lamp.

Accompanying is an illustration of the "Radio-Lite" lamp, which has been put on the market by the Edison and Swan United Electric Company, Limited, to meet the growing demand for a special form of spherical-shaped electric lamp. It is manufactured in two sizes—viz., Types II. and V.—and for any voltage from 100 to 250. In Type II. the diameter of the bulb is 4in., and in Type V. the diameter of the



bulb is 5in., giving a downward reflection of 40 c.p. to 50 c.p. and 80 c.p. to 90 c.p. respectively. It gives a beautiful soft bright light; on account of the special method of frosting adopted and the position of the filament the diffusion is particularly fine. This lamp will, the company believe, become indispensable for the special purpose it has been designed—viz., shop lighting, corridors, institutions, house lighting, etc.

LEGAL INTELLIGENCE.

LLOYD'S v. THE MARCONI INTERNATIONAL MARINE COMMUNICATION CO.

In the Chancery Division, on Wednesday, Mr. Justice Kekewich heard an adjourned summons in the action of Lloyd's v. Marconi International Marine Communication Co., by the company, against the plaintiffs, asking for further and better affidavit of documents. Mr. Ogden Lawrence, K.C., and Mr. Ashworth Jones (instructed by Messrs. Waltons, Johnson, Bubb, and Whatton) appeared for the plaintiffs, and Mr. Stewart-Smith, K.C., and Mr. Gover (instructed by Mr. Geoffrey Chubb) for the company.

Having heard counsel on both sides, his LORDSHIP said the difficulty was very much increased by what he had no doubt was a perfectly genuine attempt on the part of the plaintiffs to avoid any question of shirking discovery. Still he was afraid they had done themselves harm; but probably in a further affidavit which he was going to direct, the plaintiffs would think it right to recall as far as they could the action up to a point. His Lordship thought it would be proper to order a further affidavit of documents, but with regard to the point made as to the title of Lloyd's to certain signalling stations, it seemed to him that the defendant company was in the wrong. Costs would be costs in the action.

COMPANIES' MEETINGS AND REPORTS.

CHILI TELEPHONE.

The report for the year ended March 31 states that the aggregate number of subscribers at all centres at the end of the year was 6,874, as compared with 5,814 at the beginning, or a gain of 460 for the year. The gross revenue in Chili from all sources was 978,746dol., an increase of 62,204dol. The expenditure in Chili was 445,140dol., an increase of 22,731dol. The net income in Chili from all sources was 533,606dol., an increase of 39,473dol. The average rate of exchange for the year was 16 30d. as compared with 16·36d. in the previous year, giving a decrease for the year of 0·06d. Converted into sterling at these rates, the net income was £36,227, an increase of £2,540. The liquid assets and liabilities in Chili on March 31, 1905, were valued at 16¼d., the current rate of exchange on that day, as compared with 16⅝d., at which they were valued on the corresponding date of the previous year. The balance to credit of the revenue account, including £2,502 brought from the previous year, is £34,547, of which £15,360 has been carried to reserve for renewal of plant, etc. An interim dividend of 3s. per share was paid on Jan. 14 last, and the directors now recommend a final dividend of 5s. per share, leaving a balance of £2,467 to be carried forward. The total mileage on March 31, 1905, was 10,759 miles, an increase of 875 miles.

ELECTRICAL POWER STORAGE.

The report for the year to May 31 states that the profit, including the balance of £470. 17s. brought forward, amounts to £9,600. 14s. 8d. Out of this sum the directors have carried £1,000 to the contingent fund, and set aside £2,500 for depreciation of patents, goodwill, etc. They recommend again the payment of a dividend of 6 per cent. on the ordinary share capital, which will absorb a further £5,389. 13s. 7d. and leave £711. 1s 1d. to be carried forward. In addition to the £2,500 set aside as above, the directors have transferred £13,500 from the special reserve account, making £16,000 in all, which has been applied in reduction of patents, goodwill, etc. This leaves £10,000 at the credit of special reserve to provide for possible diminution in the value of the assets, for repayment of debentures, etc. The buildings, plants, tools, etc., have been maintained in thorough repair and condition at a cost of £3,540. 18s. 4d., which sum has been provided out of revenue. The directors are glad to record another satisfactory year, notwithstanding the continued industrial depression and increased keenness of competition.

BIRMINGHAM AND MIDLAND TRAMWAYS.

The report states that the total revenue for the year, including £695 brought forward from the previous account, amounts to £108,626, and after deducting expenses chargeable to revenue, including repairs and maintenance, there remains £35,948. Deducting interest on the debenture stock and the dividend on the 5½ per cent. preference shares, amounting together to £14,996, there is an available balance of £20,951, which the directors propose should be applied as follows: to payment of a dividend on the preferred ordinary shares at the rate of 5½ per cent. for the year ended Dec. 31, 1904, £19,250; to be carried forward to next account, £1,701. The traffic receipts have suffered during the past year by reason of the dislocation of traffic brought about by the reconstruction of the lines for electric traction. The work has, however, now been completed, and the receipts have materially increased.

ELECTRIC CONSTRUCTION.

The report for the year states that the net profit is £3,908. 14s. 3d., and adding £3,805. 3s. brought from last year, the amount available for distribution is £7,713. 17s. 3d. The directors recommend that this profit be appropriated as follows: dividend at the rate of 7 per cent. per annum on the preference shares (to be paid on July 31 next), £4,394. 12s.; balance carried forward to next account, £3,319. 5s. 3d. The buildings and plant have, as formerly, been thoroughly maintained out of revenue, and £5,000 has been credited to depreciation account. The depreciation account now amounts to £58,000 and the general reserve fund to £32,000. The competition referred to in last report has been intensified during the year and still continues, but there are signs of improved trade in the near future. Meanwhile, every effort is being made to meet by economy and improved administration the low prices now current.

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GREENWOOD AND BATLEY.

At the annual meeting of this Company last week, the CHAIRMAN stated that the net profits for the year amounted to £32,000, representing an increase over the previous year of £6,000. A number of large orders were completed during the latter half of the year. A sum of £5,000 has been added to reserve, bringing the amount up to £55,000. The Company's plant now includes a 800-h.p. de Laval turbine, which has been found to result in an economy of fully £1,500 per annum. In conclusion, the chairman stated that the prospects for the ensuing year were encouraging, and the motion adopting the report and declaring a dividend of 7 per cent. on the preference shares and 6 per cent. on the ordinary shares was carried unanimously.

UNITED RIVER PLATE TELEPHONE.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, Mr. J. I. Courtenay presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN, in moving the adoption of the report, stated that the progress of the Company during the year was shown by the increase in the number of subscribers in the Buenos Ayres section, which was considerably in excess of that of any previous year. The directors were able to recommend a final dividend of 5 per cent. on the ordinary share capital, making, with the interim dividend, a return of 8 per cent. for the year. They intended to make an immediate issue of £50,000 in ordinary shares, which will be offered to the ordinary shareholders at par, to provide for the various requirements in connection with the continued extension and growth of the Company's business. The directors were adopting the policy of making moderate issues so as to avoid as far as possible calling up capital not immediately required in the business.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leicester.—Tenders are required for telephone cables, etc., for the Water Committee. Tenders by July 17.

Bath.—The Corporation invite tenders for a storage battery. Tenders by July 17. See advertisement.

Turnu-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

Fulham.—The Council invite tenders for extension of cables, feeders, etc. Tenders by noon on July 12. See advertisement in last issue.

West Ham.—The Council invite tenders for the erection of tramway offices and car depot, Greengate-street, Plaistow. Tenders by July 25.

Ilford.—The Urban District Council invite tenders for the supply of ·4in. and ·25in. concentric cable. Tenders by 4 p.m. on July 11. See advertisement.

South Shields.—The Town Council invite tenders for the laying of the permanent way for the service line to the car-shed in Dean-road. Tenders by 22nd inst.

London.—The London County Council invite tenders for two low-tension feeder switchboards. Tenders by 10 a.m. on July 11. See advertisement in last issue.

Leeds.—Tenders are invited for the supply of lamp-pillars, irons, carriages and furniture, and glass for lamps for one year, for the Street-Lighting Committee. Tenders by July 18.

Paris.—The Postal and Telegraph Department, No. 103, Rue de Grenelle, require tenders for copper wire cased in indiarubber and cotton and dipped in paraffin. Tenders by 3 p.m. on July 12.

Burton-upon-Trent.—The Corporation invite tenders for the electrical equipment on the overhead system of about 1¾ miles of tramway (Contract No. 10). Tenders by noon on July 7. See advertisement in previous issue.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10 000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Loughborough.—Tenders are invited for the supply of materials and stores for the year ending July 31, 1906, for the electricity works. Tenders to the Borough Electrical Engineer by July 18. See advertisement in last issue.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Neath.—The Rural District Council invite tenders for the supply, etc., of electric light and power mains, sub-stations, switchboards, feeding pillars, switch pillars excavations, and other works in connection within their area. Tenders by July 17. See advertisement.

London, S.W.—The London County Council invite tenders for the roadwork and plate-laying required for the construction for electrical traction on the conduit system of the authorised tramways from Wandsworth to Tooting via Red Lion-street, South-street, Garratt-lane, and Defoe-road. Tenders by 11th inst.

Wishaw.—Tenders are required for (1) underground mains; (2) excavation, temporary and permanent reinstating; (3) street arc lamps. Particulars can be obtained from the engineer, Mr. E. F. Cox, 10, Russell-street, Wishaw, N.B., on payment of a deposit of £2. 2s. Tenders to Mr. J. Logan, town clerk, Main-street, Wishaw, N.B., by 12 noon on July 11.

Stourbridge.—Tenders are required for the wiring of the workhouse buildings for electric light, also for the installation of a plant for working the same; also for the installation of gas pipes and fittings, according to specification which can be seen at the Clerk's Office. Tenders to Mr. George Francis James, clerk to the Guardians, 12, Hagley-road, Stourbridge, by 12 noon on July 12.

London, S.W.—The London County Council invite tenders for the roadwork and plate-laying required for the reconstruction for electrical traction on the conduit system of the tramways (*a*) from the authorised tramways in Red Lion-street, via York road, Battersea Park-road, Nine Elms-lane, Albert-embankment and Lambeth Palace-road to Westminster; (*b*) along Lambeth-road; and (*c*) along Falcon-road; and for the execution of certain paving works in connection therewith. Tenders by 18th inst.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

RESULTS OF TENDERS.

Canterbury.—The tender of C. Breeze, Canterbury, at 13s. 6d. per ton, has been accepted for supply of coal to the electricity works, for the Town Council.

Gravesend.—The tender of S. Blandford, Gravesend, at £51, has been accepted for installation of electric light at Church-street School, for the Education Committee.

Aston.—The Public Works Committee have recommended for acceptance the tender of the Brush Electrical Engineering Co., at £4,505 15s. 7d., for the overhead electrical equipment of the tramways in High-street, Birchfield-road, Lozells-road, Witton-road, and Wheeler-street.

Cables, etc.—The Johnson and Phillips Electric Cable Works, Ol Charlton, report the following contracts: Ipswich, distributor mains Grimsby, distributor mains; Great Northern Railway Co., feeder and distributor mains; Handsworth, additional lighting and tramway feeder and distributor mains for the Witton district; Pembroke Dockyard, additional lighting and power feeders.

Norton.—The following tenders for the laying of the main from Wold-road to Whitewall have been received:

J. Taylor, Malton	£139 10 0
E. Leefe, Norton	148 18 0
R. Yates and Sons, Malton	118 10 0
J. Read, Malton	132 12 10

Marylebone.—Tenders were received from 46 firms for the supply of stores to the generating station. The following firms have been selected: G. Hatch Limited, white cotton waste, £1. 13s. 6d. per cwt., common 18s 6d.; W. H. Wilcox and Co., mutton cloths £1. 18s. per cwt., sponge cloths 10s., lubricant for grease lubricators 3d. per lb., asbestos packing 1s. 2d., rubber insertion 1s. 6d.; British Insulated and Helsby Cables, cables of various sizes and prices; Baxter and Counter, cable-jointing materials—viz., Para rubber strip, black adhesive tape, binding wire and fuse wires, indiarubber solution, shellac varnish; Veritys Limited, indiarubber gloves; St. Helens Cable Co., prepared tubing.

New Ferry (Cheshire).—The Lower Bebington Urban District Council have received the following tenders for the work of electric installation for fire brigade alarm in New Ferry:—

Barlow and Young	£65 10 0
Electrical Engineering and Maintenance Co.	49 0 0
Pulford Bros.	48 11 8
Price and Taylor	40 15 0
H. G. Ruddell	34 2 6
Cox-Walker and Co.	33 0 0
Frith and Son	27 0 0
National Telephone Co.	26 17 10
Lloyd and Co., King-street, Rock Ferry (accepted)	25 0 0

BUSINESS NOTES.

TRACTION.

Southampton.—The Town Council have decided to introduce single-deck cars.

Radcliffe.—The Dumer's-lane section of the Urban District Council's system has been opened.

Cape Electric Tramways.—An interim dividend of 2½ per cent. has been declared by the directors.

Southowram Light Railway.—An enquiry has been held into an application for extension of time to construct this line.

Keighley.—It has been decided to apply to the Board of Trade for an extension of time in which to complete the Stockbridge section.

Llandilo.—An enquiry is to be held on the 14th inst. by the Light Railway Commissioners as to the expediency of granting an order for a light railway.

Halifax.—The Corporation have replied to the Zoyland District Council that at present they are not prepared to extend the tramways to Ripponden.

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Portmadoc and South Snowdon.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order sanctioning this line.

Liverpool-Southport.—Through bookings have been instituted between the Liverpool Overhead Railway and the electrical section of the Lancs. and Yorks Railway.

Baker-street and Waterloo Railway.—A Select Committee of the House of Lords has passed the Bill authorising a subway at Charing Cross for foot passengers.

Brighton.—The Corporation "tourist car," inaugurated at the instance of Mr. Marsh, the acting engineer and manager, made a trip on Monday, and was well patronised.

Rowley Regis.—It is proposed to hold a conference between the Urban District Council and the Birmingham and Midland Tramway Co. in reference to the tramway to Blackheath.

Bishop Auckland.—The United Kingdom Tramway, Light Railway, and Electrical Syndicate have applied to the Board of Trade for an extension of time in which to construct the Bishop Auckland, Shildon, and Spennymoor tramways.

Lincolnshire Light Railways.—In regard to the two light railway schemes for this district, it is reported that the promoters of the Barton Railway have withdrawn their scheme, so that there will only be the Lindsey scheme for the Commissioners to enquire into.

Blagdon and Pensford Light Railway.—A committee has been appointed, by the Somerset County Council, with power to assent to the construction of this light railway, on being satisfied that all the reasonable requirements of the county surveyor were complied with.

Yarmouth.—The electrified line from Yarmouth to Gorleston was opened on Tuesday. This is expected to form an important and remunerative section of the Yarmouth system already in operation on the other side of the river, with which it is hoped shortly to be linked up. The inaugural ceremony was followed by a luncheon, at which several members of the Corporation, officials, and others were present. The cost of the new section was £50,000.

Barry.—The Urban District Council have under consideration a scheme to provide the town with a system of electric tramways. The service will supply not only the town, but will also extend to the island. During the past week or two a census has been taken on behalf of the Council of those using the brake service and the foot passengers between the town and island, and the results are such as to encourage the local authority to proceed with their scheme.

Fareham.—The Gosport and Fareham Tramway Co. sought permission from the South-Western Railway Co. to continue the laying of their lines as far as the railway station, thus passing over some 80 yards of the company's private road. In reply, the railway company state they will only allow the metals to be laid to within 100 yards of their property. It is suggested that a further communication be sent to the company requesting as a compromise that the distance be reduced to 50 yards.

St. Annes.—At the meeting of the Urban District Council a letter was read from the Blackpool, St. Annes, and Lytham Tramways Co. as to the greasiness of the tramlines caused by the laying of Westrumite on the roads. It was resolved that the surveyor be instructed to point out to the tramways company that, inasmuch as the greasiness arising from this cause lasts only a few hours after each application, and as the roads are treated with this solution on four or five occasions only during the year, the matter complained of will not seriously affect the running of the cars.

Balsall Heath.—The Balsall Heath section of the tramway between Birmingham and Mary-street was closed on Saturday morning. As a result of the excavations which have been going on for some time in Longmore-street, where the sewers are being relaid, coupled with the heavy rains, the roadway became undermined. As not only the old track but the temporary track was seen to be unsafe, this section was closed. The contractor had a gang of men hard at work laying a temporary track on a part of the roadway which was considered safe, and towards two o'clock the route was again reopened for traffic.

Bath.—At the meeting of the Rural District Council a report was presented with reference to the Weston-to-Lansdown Light Railway. The present width of High-street is not sufficient to permit of a tramway being laid along it to connect the present tramway system with the line up to Lansdown, but the committee saw no objection to the scheme if the promoters were willing to undertake the widening of the road. That would mean the securing of half a dozen cottage properties not very valuable. If that were done, it would be a great improvement. It was imperative, however, that High-street should be widened before trams went there. The report was adopted.

Barcelona.—The Barcelona Tramways Co. announce that a contract has been entered into for the sale of the undertaking at a price which, including accrued profits to June 30 last, will permit, after paying off the debentures, debenture stock, and preference shares with interest, of a return to the ordinary shareholders of approximately £14 per share. A first instalment of £5,000 has been paid to the company, and a banker's guarantee for securing payment of the remainder of the purchase money has been arranged to the satisfaction of the Board. An extraordinary general meeting of the company will be called in the course of a few days to submit the agreement for approval.

Dover.—The work on the tramway extension has been delayed by drainage and other difficulties arising from the congested traffic on Crabble Hill. The double line is now laid up to "The Gate," and part of the way the cementing and wood paving has been put down between the rails. From the railway arch on Crabble Hill down to Crabble Paper Mills nothing has been done except the erection of posts to carry the overhead wires. From the mill up to the further side of the athletic ground the rails are down ready for the cement and pitchers. This length has been rather tedious, owing to the elaborate curving of the rails. Beyond the athletic ground the sleepers are down and the rails upon them, but not yet completely laid.

Stretford.—It was reported at the meeting of the District Council that the Light Railway Commissioners had reconsidered the West Manchester light railways order as to a proposal from the promoters to abandon or transfer a part of the scheme. The Commissioners decided they could not report to the Board of Trade in favour of any alteration in the terms of the order. "If any alteration is desired," the Commissioners continued, "it must be made by agreement." As to this they only said that in fixing £1,500 to be paid by the company they had in mind the fact that the earnings on the line in Trafford Park would belong to the company. If the line was owned by the Council some reduction should be made, but the company could hardly expect to escape the payment of a considerable contribution having regard to the fact that they resisted the proposals of the Council.

Maidstone.—At the monthly meeting of the Urban District Council last week it was stated that the net profits on the first 8½ months' working amount to £1,531. 5s. 10d. If the Council succeed in getting an order for taking the line up Week-street and Stone-street, the working expenses will work out more favourably. The profit mentioned has been achieved in the face of a charge of 2d. per unit for power. The Chairman of the Tramways Committee, in concluding his remarks, expressed the belief that the undertaking would be a great success, and would always yield 5 per cent. clear profit, after all expenses had been paid, including repayment of principal and interest. He congratulated Mr. Headley, the electrical engineer, upon the result, and the committee's report was unanimously adopted. An enquiry into the application for sanction to the extension of routes has been opened.

Leith.—The work of laying the new tramway rails and the causeway at the foot of Leith-walk was completed last week, and the completion of the remaining street work in Leith-walk is now a matter of days. The work of fitting up the overhead equipment is not so far advanced, but there is now practically no doubt that the Town Council will be able to carry out their intention to open a section of the new electric system before the trades' holiday at the end of July. Some delay was feared in connection with the overhead equipment, but the Tramways Committee have had an interview with the contractors, and they learn that that equipment will be delivered almost immediately. Ten cars are ready for delivery, and these will, it is expected, be put on the route from the foot of Leith-walk to Newhaven, by way of Pilrig-street, towards the end of this month. It is expected, however, that the formal opening ceremony will not take place until September.

Waltham Abbey.—A committee of the House of Commons last week commenced an enquiry into the scheme for an electric railway from Gracechurch-street to Waltham Abbey. The cost of construction is estimated at £275,862 per mile. The Great Eastern Railway and the London County Council are opposing the Bill, the latter contending that a scale of fares for workmen should be allowed which the promoters say would render the scheme impracticable, though they are prepared to carry workmen at the rate of 3d. return between the City and Walthamstow up to 7 30 a.m. Sir Douglas Fox, chief engineer of the scheme, gave evidence as to its practicability. Sir A. Binnie gave evidence that the project better satisfied the public needs of the district than any other scheme that had been advanced. The commercial side was dealt with by several well-known financiers, who expressed favourable opinions. Mr. Stephen Sellon favoured "zone" fares, and estimated that 44 525,000 passengers a year would be carried between the City and Waltham Abbey.

Derby.—During the past 12 months the receipts from horse traction amounted to £16,297. 18s. 6d., and from electric traction £17,799. 15s. 7d. The sum of £507. 12s. 10d. was received from advertising, making a total of £18,307. 8s. 5d. from the electric cars, and the net revenue amounted to £7,620. 1s. 4d. The repayment of loans and interest absorbed £4,899. 7s. 1d., leaving a net profit for the year of £2 720. 14s. 3d. That spoke very well for the future of their cars. The number of miles run by the electric cars was 411,823½, and the cost of current per car mile was 1 55d. The receipts per car mile came to 10·31d., and the cost of working per car mile was 6 31d. The number of passengers carried on the electric cars was 4,001,009. The Tramway Committee look for much better figures during the ensuing year. The receipts for the last quarter had been £8 069, or nearly a half of the whole they had taken since the cars had been running. The cars have earned £8,000 in the last three months, and in view of the fact that the Kedleston-road route will be open in about three weeks, and that it will have a good portion of the summer traffic, a substantial profit is anticipated. The Corporation unanimously adopted the report.

London County Council.—At Tuesday's meeting the annual accounts were presented, of which we have already given some particulars. The receipts for the electrical section were £545,295, and on the horse section £133 799. The surplus on the working of the electrical section was £182,798 but as there was a small deficiency on the horse section the surplus on the whole is slightly reduced. The total receipts have been £145,856 more than in the previous year, despite the fact that the Streatham service was suspended during electrification. The passengers numbered 164 818,550 being an increase of 31,679,475, and the car miles aggregated 14,081,397, an increase of 2,544 853. The average fare per passenger was ·97d., against ·93d. in the previous year. During the year 81 top-covered cars were introduced, and the earnings were found to be considerably increased. The profits to the Council from the northern section amounted to £53,845. The Islington Borough Council have assented to the use of the overhead system for the Archway-road section. The Highways Committee recommended a vote of £12,500 for a site for a car-shed at

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Poplar. A recommendation was also submitted that £13,500 be voted for more top covers, and that £19,000 be voted for track work on the conduit principle for the Aldwych subway, the work to be carried out by the Council's staff.

Cardiff.—The receipts of the Corporation trams for last week created a local record, amounting to £2,905. 2s. Considerable inconvenience was caused on Saturday morning to workmen and others proceeding to their work in the early hours, owing to a breakdown in the tramway system. It was discovered about half-past five that a leakage had occurred somewhere in one of the small cables feeding the trolley wire, and it took rather a long time to discover where it was. Eventually a fray was found in one of the small feeder cables connecting one of the underground feeders with the trolley wire, and situate at a place where it could not be easily seen. No time was lost in putting things to rights, with the result that by half-past seven the trams were running, and the many workmen who had been inconvenienced and delayed, and who sheltered from the heavy rain under railway bridges and such like places, were able to proceed to their destinations. In the course of a short conversation, Mr. Arthur E. Ellis, borough electrical engineer and tramway manager, stated to a local reporter that, though the occurrence was annoying, everything had been done to guard against such defects. "When you have between 60 and 70 miles of trolley wire to superintend," he said, "you cannot be looking at every spot at the same moment. This is just the thing which would be caused by weather such as we experienced last night, and it was just the sort of night when our gangs could not work. It was impossible to work in such weather."

Ackworth.—The Light Railway Commissioners have held an enquiry into the proposal to construct a light railway from Ackworth to Shaftholme Junction, near Doncaster, which is really the Yorkshire survival of the Ackworth to Immingham light railway scheme, thrown out last year. The scheme in its present form is in two portions, one relating to the West Riding, and the other for a line in North Lincolnshire from Winteringham to Barton-on-Humber. The Commissioners on this occasion dealt only with the West Riding portion. This proposal is for a single line from a junction with the Knottingley and Swinton Railway at Ackworth. It proceeds in a south-easterly direction through Thorpe Audlin to Kirk Smeaton, where it crosses the Hull and Barnsley Railway, with which a junction is proposed to be given, and thence it proceeds in a south-easterly direction through Norton Campsall, Askern, Sutton, Owston, and Thorpe-in-Balne to Shaftholme Junction on the Great Central and Great Northern Joint West Riding Railway, and also with the Lancashire and Yorkshire. At the other end of the system junctions will be given with the Midland and North-Eastern Joint Knottingley and Swinton Railway. A large number of local authorities, railway companies, and private interests were represented. It is proposed to work the line electrically. The initial outlay is estimated at £12,000 per mile, and the promoters (Messrs. R. E. C. Shann, W. F. Tempest, and others) expect a revenue of about £7,000 per annum. The system will be chiefly used for coal and other goods traffic, but passengers will also be carried. After hearing counsel for the freeholders, the Commissioners intimated that they would communicate their decision in due course.

LIGHTING AND GENERAL.

Hessle.—The Hessle electric lighting provisional order has been confirmed.

Kettering.—The Urban District Council are borrowing £14,500 for electric lighting.

Wallsend.—The electric company have been asked to give a price for the efficient lighting of new streets.

Frome.—The Urban District Council have decided to borrow another £11,000 for the purposes of the electrical works.

Maidenhead.—The Electric Light Committee recommend the adoption of the maximum demand system from Michaelmas.

Beckenham.—Permission has been received from the Board of Trade to an overhead wire to supply electricity to Oak Lodge.

Manchester.—The price of current for electric lighting purposes is to be reduced from 5½d. to 4½d. per unit as and from Sept. 29 next.

Leek.—The question of new plant was discussed at the last meeting of the Electricity Committee and deferred for further consideration.

Trowbridge.—The cable-laying for the proposed electric lighting will be commenced very shortly and will be pushed forward without delay.

Chester.—The Town Council have decided to purchase an additional feed-water pump at a cost of about £100 for the electricity station.

Durham Districts Electric Lighting Provisional Order.—The Bill embodying this order has passed a Select Committee of the House of Lords.

Cardiff.—The Electrical and Lighting Committee of the Corporation last week inspected the Canton electric power station and the Docks sub-station.

Electrical Power Storage Co.—The directors recommend the payment of a dividend of 6 per cent. on the ordinary share capital for year ended May 31, 1905.

Dundee.—The Harbour Trustees have under consideration a proposal to light the Craig Pier by electricity, and have instructed the engineer to report on the subject.

Thetford.—The Urban District Council have assented to an application from the Postmaster-General for the placing of overhead telephonic lines in various parts of the town.

Tredegar.—Expert advice is to be called upon the steps required to be taken by the Council to carry out their obligations under their provisional electric lighting order of 1901.

Hebden Bridge.—The electricity department last year made a gross profit of £37. There is, however, after charges for interest and repayment of loan have been met, a deficit of £459.

Musselburgh.—The employés of the company seem to have scored in the matter of wages, time and a half for Sundays having been conceded them after the commencement of a strike.

Woolwich.—Application is to made for a further loan of £16,275, being the amount spent for mains, switchboard apparatus and instruments, and brick culvert and easement for same.

Dorking.—An enquiry has been held into the Urban District Council's application for sanction to borrow £12,000 for electric light works. A new feeder is to be laid at once at a cost of £680.

Redditch.—The Electric Supply Committee's last report contains the accounts for the 15 months to March last, and show a gross profit of £783, as compared with £460 for the previous 12 months.

Ripon.—A circular has been issued to the inhabitants of Ripon whose rateable value is over £15, asking them to return a signed paper stating whether they would be consumers of electricity if it was installed.

Tunbridge Wells.—On Wednesday a motion affirming that it is desirable in the interests of the general body of ratepayers to consider the advisability of selling the electric lighting undertaking was proposed, and adjourned for three months.

Bridgend.—The District Council are renewing an agreement with the South Wales Power Distribution Co., by which they take all their electric energy from the company, and the company pay the Council 2½ per cent. on the amount of current consumed for lighting.

Birstall.—The Council have decided to purchase current in bulk from the Yorkshire Electric Power Co. under an agreement for 15 years, and it is said at a very favourable price. Application is to be made for a loan of £2,000 for works in connection with distribution.

Alloa.—The Town Council have arranged with the British Electric Plant Co. for the town's electric supply, and have resolved to discontinue the arc lamps in the streets, and to revert to incandescent lamps. It is stated that a saving of £168 might thus be effected.

West Hartlepool.—Terms have been arranged for the supply of electrical current to the Seaton Carew Ironworks for power purposes. This will involve an outlay of nearly £4,000 for a new main, but the net annual return to the Corporation will be from £1,200 to £1,500.

Bishop Auckland.—An application of the Durham Electrical Power Distribution Co. to transfer the Bishop Auckland order to the Cleveland and Durham County Electrical Supply Co., who have a station at Fylands, has received the consent of the Urban District Council.

London County Council.—On Tuesday it was agreed to lend the Islington Borough Council £15,304 for electric light installation and meters and the Stoke Newington Borough Council £900 for site of electricity station. Sanction was also given to the borrowing by the Islington Borough Council of £4,885 for electric light installation.

New Company.—The Bombay Electric Supply and Tramways Co. Limited, has been registered with a capital of £1 200 000, the object being to adopt an agreement with the British Electric Traction Co. for the transfer to this company of the existing tramways in Bombay and of the freehold and leasehold property of the Bombay Tramways Co.

Kendal.—The report of the electricity department for last year shows a deficiency of £821. The whole receipts for electric light have been £905, and the expenditure £725, leaving a gross profit of £180, as against £13 in the previous year. After providing for interest and sinking fund, there was a debit balance of £821 to be carried to the district account.

Norton.—At the last Urban District Council meeting it was resolved that the attention of the Northern Counties Electricity Supply Co. be called to the agreement entered into with the Council, whereby the company undertook to establish works within a period of two years, and that the company be also asked to give the reason why the undertaking was not carried out.

Paris-Rome Telephones.—It is anticipated that direct telephonic communication between the French capital and Rome will be open to the public within three months. An experimental wire of exceptional thickness is now being laid between Rome and Modena, and negotiations are in progress for the carrying forward of the wire by the French Government from Modena to Lyons.

Halifax.—It is proposed that the Education Committee be empowered to appoint on the staff of the municipal technical school one head of the electrical engineering department at a salary of £200, one head of the civil and mechanical engineering department at a salary of £200, and an assistant in the civil and mechanical engineering department at a salary of £130 per annum.

South Metropolitan Electric Light and Power Co.—We are informed that allotment letters in respect of debenture stock, and also of the ordinary and preference shares, offered for subscription on the terms of a circular dated June 23, 1905, have been posted, and the ordinary and preference shares were very largely oversubscribed by the existing share and debenture stock holders.

Fenton.—With respect to a letter from the Board of Trade asking what steps the Council had taken towards carrying out the obligations under the Fenton Electric Lighting Order, 1899, it has been decided to reply that the Council, after due consideration of the matter, have come to the conclusion that the demand for electricity in the district did not warrant the expenditure of providing works and mains.

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Harrow.—On June 30 the King visited Harrow in connection with the annual speech day, and the considerable extension to the play fields of the school. The town of Harrow decided in consequence of this event to specially decorate the streets and to illuminate them. For this latter purpose the Union "Excello" flame arc lamps have been used, a form of illumination which has proved exceedingly satisfactory.

Swansea.—In accordance with the order of Justice Buckley, the National Telephone Co. are joining up the Morriston and Mumbles and Swansea exchanges. Plans and specifications from the company for joining their lines to the municipal for intercommunication purposes have been laid before the Council. Mr. Mackie is to superintend the work, the services of Mr. Bennett, consulting engineer, being dispensed with.

Parliament.—The following Bills have been read a third time (*a*) in the House of Lords: The Metropolitan Electric Supply Co. (Acton District), South Wales Electric Power Distribution Co., Central Electric Supply, County of London Electric Supply Co., London United Tramways (extension of time); (*b*) in the House of Commons: Dublin United Tramways Bill, Metropolitan Electric Tramways Bill.

Oxford.—The following electric lighting work is to be carried out during the long vacation at Oxford under the supervision of Mr. Morgan Williams, M.I.C.E., consulting engineer to the University: Indian Institute and the University Museum (contractors, Messrs. Hill, Upton, and Co.); the Bodleian Library, camera (contractors, Messrs. W. A. S. Benson and Co.); new examination schools, extensions (contractors, Messrs. Lucy and Co.).

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: British Electric Traction Co.'s further issue of £415,422 5 per cent. perpetual debenture stock and £160,178 4½ per cent. second debenture stock; Eastern Extension, Australia, and China Telegraph Co.'s further issue of £150,000 4 per cent. mortgage debenture stock (perpetual); Potteries Electric Traction Co.'s further issue of £25,000 4½ per cent. debenture stock.

Surbiton.—The Council have obtained a provisional order to extend the limits of supply for electricity for all public and private purposes to that part of the urban district of Surbiton not included in the area of supply as defined by the Surbiton Electric Lighting Order, 1891, with the insertion of the Northumberland clause. The main object for obtaining an extension of the order was to prevent any other company or firm supplying the added district with electricity.

Scotch Orders.—Sir James Woodhouse's Select Committee of the House of Commons have passed the Rutherglen electric lighting order by altering Clause 7 and substituting the Clyde Valley Electric Power Co. for the Corporation of Glasgow as the body to which the order could be transferred at all. The committee also confirmed provisional orders under the Electric Lighting Acts made by the Board of Trade relating to Denny and Dunipace, Grangemouth, Inverness, Pollokshaws, Renfrew, and Uphall.

Norwich.—The Town Council have agreed to put by the profits made by the electricity undertaking until a substantial reserve has been accumulated. We understand that there is about £6,000 in hand. The business has been increased without any extra expense. Though over a quarter of a million more units than the previous year were generated, the cost of coal has been less. The great increase has been in current supplied for motor power, amounting to 22 per cent., and the lighting has shown an increase of 10 per cent.

Aston.—The Electricity Committee's last report shows that the number of lamps (8-c.p. equivalent) applied for is now 23,857 (not including approximately 400 8 c.p. equivalent at Electric and Ordnance Co.); number of lamps (8 c.p. equivalent) connected, 22,321; horse-power of motors applied for, 576·5; horse-power of motors connected, 518; number of disconnections, 15. The total Board of Trade units metered on consumers' lighting meters during month of May was 15,332; ditto, power meters, 19,880; ditto, traction meters, 72,060; total Board of Trade units sold during month of May, 107,272.

Derby.—An enquiry has been held into an application of the Corporation for sanction to borrow £9,960 for electricity works and lighting purposes for the Duffield-road and Kedleston-road section of the electric tramways. The town clerk, Mr. G. T. Lee, said that £9,600 was required for the extension of the electricity works for the year ending March 31, 1906, and £360 for capital expenditure in connection with lighting. The tramway extension necessitated additional generating power. Part of the route was now lighted by incandescent electric lamps, and it was proposed to utilise the tramway poles for the hanging of arc lamps.

Partnership.—We are informed by Mr. Morgan Williams, M.I.C.E., M.A., that, in view of the extension of his consulting practice, he has taken into partnership Mr. Harold W. Couzens, M.I.E.E., and the business of the firm will henceforward be carried out under the title of Morgan Williams and Couzens at 39, Victoria-street, Westminster. Mr. Couzens, in addition to his extensive experience of electricity supply working, both with municipalities and companies, has for several years past been engaged in the design and supervision of electric power, traction, and lighting undertakings on behalf of Messrs. Kincaid, Waller, Manville, and Dawson.

Torquay.—A letter from the Local Government Board, referring to the application of the Town Council for sanction to borrow £42,000 for the proposed new electric light and power station, has been referred to the Electric Lighting Committee. The Board adheres to the view that the proposals of the Town Council would probably involve a serious loss to the borough. The Board state that they realised the difficulty in which the Council was placed in consequence of the agreement entered into with the Dolter Electric Traction Co., and they suggest that the Town Council should place itself in communication with the Dolter Co. with a view to some arrangement being made.

Pumping.—At the monthly meeting of the South Staffordshire Mines Drainage Commissioners on Wednesday, Mr. E. B. Marten, surface engineer, reported that the wind, steam, and electric surface pumps have worked satisfactorily, and one more wind pump and one electric pump are being arranged for at Portobello. Some useful canal tests have been carried out. Mr. E. Howl, general manager, reported that underground pumps in Tipton district have been raising 8,550,000 gallons in 24 hours, as compared with 7,659,000 last month, and 11,296,000 during the corresponding month of last year. The increase was due to the installation at Park-lane of a new engine driven by Mond gas.

Agencies.—The Northern Electrical and Ventilating Co., of 6A, Stanley-street, Liverpool, have been appointed agents for the Richmond-Carey patent system of push-button lifts (no attendant required), also for their hydraulic, electric, and steam lifts and cranes. Messrs. Johnson and Phillips, of Charlton, Kent, have appointed Messrs. Guthrie Bros. and Ogilvy, of Prudential-buildings, Newcastle-on-Tyne, their sole representatives for the counties of Northumberland, Durham, Cumberland, and Westmoreland, with a view to giving increased attention to their business in that district, and any enquiries for electrical plant of all descriptions sent to the latter gentlemen will receive immediate and careful attention.

St. Annes.—Mr. J. H. Clothier, the electrical engineer, in his last monthly statement, gives the following figures: units sold during May, 35,271; units sold to May 31, 75,996; equivalent to 8 c.p. lamps connected, 17,699; units sold per 8 c.p. lamp connected, 1·65; maximum load—lighting 153·9 kw., traction 132·5 kw.; total number of consumers, 339. They had in addition received since the end of the month five applications for the equivalent of 374 8-c.p. lamps. The increase in units sold for lighting and power was still maintained. The traction output was still less, but last year's returns included the Whit-week traffic. This year's Whit week output showed a slight increase over corresponding week last year.

Dudley.—The total income of the Corporation's electricity department for the year ending March last was £10,707, including £3,284 for current to private consumers, £312 motor supply, £5,603 tramway company, and £1,299 public lighting. The gross profit amounted to £5,170, of which £2,071 was absorbed in interest on mortgage loans, £2,067 repayment of loans, and £338 banker's charges, leaving a net profit for the year of £693. The loans sanctioned and borrowed for the purposes of the undertaking prior to March 31 last amounted to £63,500, and £6,762 have been repaid. The total expenditure up to the same period was £77,552. It is recommended that a further sum of £1,000, part of the amount now standing to the credit of the revenue account, be transferred to a reserve fund.

London Electric Supply Co.—The Board of Trade has granted the company sanction to an additional system of electrical supply under the following conditions: Extra high-pressure alternating-current supply to motor-generators placed in sub-stations erected above ground. From the motor-generators a continuous-current supply will be given (*a*) for ordinary lighting purposes to the consumers at low pressure, between the adjacent conductors of a three-wire system, the intermediate conductor being, with the approval of the Board of Trade, connected with earth at one point only—namely, at any sub-station supplying a distinct network; (*b*) for special purposes where the approval of the Board of Trade is given under Regulation A (1) of the Board of Trade regulations across the outer conductors of the three-wire system. The low-pressure mains will be separate or concentric cables drawn into suitable ducts, or armoured and laid direct in the ground.

Yarmouth.—An enquiry has been held into an application of the Town Council for sanction to a loan of £10,000 for electricity extensions. The Borough Surveyor said the works had commenced by supplying current for 4,523 lamps; last year the number was 34,300. The number of units had increased from 114,000 in the first year to 959,000 last year. A loss was shown up to 1898; in 1899 there was a profit of £448, followed by a loss of £751 in the next year; since then net profits had been earned ranging from £279 to £1,350 last year. The total loss was £2,701, but the total net profits in 10 years had been £6,137. In addition, £15,950 had been paid to sinking fund. The money was required for plant extensions, boilers, condensing plant, switchboard, pipes, and pumps. Mr. Gordon Bryant, the electrical engineer, said the charge to the public for current was 6d. for one hour per day and 4d. afterwards. For motors the rate was 3½d. per unit, and the rate decreased with the quantity of current taken. The committee intended now to introduce a flat rate reducing the charge to consumers.

London Power Bill.—The copy of a largely signed petition presented to the House of Lords has been sent to the President of the Board of Trade with the following letter: "Administrative County of London and District Electric Power Bill. My Lord,—The London manufacturers who petitioned the House of Lords in favour of the above Bill had briefed counsel with a view to supporting their claims before the committee, but being in favour of the Bill they were not, under the Standing Orders of the House, enabled to present their case separately. Now that the Bill is coming before the House of Commons, the signatories to that petition, who employ nearly 100,000 men, feel that the representation of their interests and the full importance of cheap power to the industries of London may be lost sight of in the discussion of other subsidiary issues, and they, therefore, pray that the Board of Trade, as the department representing the commercial interests of the country, will receive a deputation representing the manufacturing interests of London. We enclose a copy of the petition which was presented to the House of Lords." The signatories represent a total of over 250 firms employing 100,000 hands in all.

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Nottingham.—The electric light fund for the past year shows stock value £1,075 in hand at the commencement of the year. Generation of electricity cost £6,435, distribution £2,128, public lamps £918, and general expenses £2,604. The receipts (including stock in hand value £1,160 on March 31 last), amounted to £25,819. 11s. 11d., the largest source of income being £19,804 received in respect of the sale of current by meter. For public lighting the committee received £3,067, and for rental of meters and motors £1,212. After meeting expenses, £12,656. 3s. 3d. was available for carrying to the net revenue account. This account showed that £2,314. 15s. 11d. was brought forward from the previous year, and ended with £2,982 to be carried forward to the current year's account. Repayment of loans last year amounted to £6,717, and interest on loans to £5,323.

Durham Collieries.—The Lambton Collieries Company, of Newcastle-on-Tyne, who recently decided to employ electrical power on a very extensive scale for haulage, pumping, coal-cutting, and lighting at their Durham collieries, have divided the contracts for the necessary electrical plant between British and German firms, the work to be carried out at a cost of over £26,000 by Messrs. Bruce Peebles and Co., Edinburgh, and by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. The power is to be taken from the large power station which is being completed at Philadelphia, co. Durham, by a syndicate. The following collieries are to be equipped with electrical power: Burn Moor, Lady Ann, Lumley, Newbottle (Dorothea and Margaret), and New Herrington, in addition to the Philadelphia works. The Hetton Coal Co. are also proposing to instal electric haulage, coal-cutting, and pumping plant at their collieries in county Durham, and the Durham Electric Power Co., who are to provide the necessary power, have placed an order for a 9,000-h.p. generating station, to cost £92,000, with Messrs. Bruce Peebles and Co.

Caterham.—We are informed that, owing to increased demand for current, the Urban Electric Supply Co. have found it necessary to put down more plant at their generating station in the Croydon-road, Caterham Valley. The foundations for another boiler, engine, and dynamo were commenced some days ago, and the work is being carried out by Messrs. J. and J. Ward, of Warlingham, who were responsible for the original buildings and foundations. The new boiler will be of the water-tube type by the well-known makers, Messrs. Babcock and Wilcox, fitted with mechanical stokers, and having a heating surface of over 1,200 square feet. The dynamo, by the General Electric Co., will be capable of supplying current to 3,000 8-c.p. lamps, and is just twice the size of either of the original machines. The dynamo will be driven by engines of 120 h.p., supplied by Messrs. Bellis and Morcom, Birmingham. The mains are being extended along the Essendene, Whyteleafe, and Croydon roads, and the company will shortly lay another large feeder cable to High-street, Caterham. It is hoped by the end of the present month there will be over 7,000 lamps connected. The whole of these extensions are being carried out under the supervision of Mr. F. Bruton, resident engineer of the company.

New Marconi Stations.—The Press Association is informed that Marconi's Wireless Telegraphy Co. has received an intimation from the Marconi Wireless Telegraph Co. of Canada that the installation of the Marconi-equipped wireless telegraph stations at Sable Island and Halifax (Camperdown station), under contract with the Canadian Government, has just been completed, and that these two stations are now in full operation. Marconi wireless stations at Whittle Rocks and Cape Rich are in course of erection and equipment, and will, it is expected, be in working order by July 31, by which date it is hoped that the effective range of other Marconi stations at Cape Ray, Heath Point, and Fame Point will be increased to such an extent as to provide a complete inter-station service between the following stations on the Canadian and Newfoundland coasts: Fame Point, Heath Point, Cape Ray, Whittle Rocks, Cape Rich, Point Amour, Belle Isle, Cape Race, Halifax, and Sable Island. This service has been established by the Canadian Government primarily as an aid to navigation in Canadian waters, and with a view to establishing an efficient substitute for the land line service along the shores of the St. Lawrence, which is subject to frequent delays caused by bad weather and the breaking of cables by ice floes.

London Gazette.—At a meeting of the Tin Electro-Smelting (Lennox-yard) Co. a resolution was passed that the company be wound up voluntary, and that Mr. Alfred Leclerc be and is hereby appointed liquidator. Proofs of claims *re* the Bury, Rochdale, and Oldham Tramway Co. are to be sent in by Aug. 8, 1905, to John Coomber and Samuel Johnson, Castlemere House, Rochdale. Proofs of claims *re* the Electro-Sulphur and Light Syndicate are to be sent in by Aug. 12, 1905, to E. S. R. Wilde, liquidator, of 61½, Fore-street. The last day for receiving proofs of claims in the estate of William James Hunter, electrical engineer, etc., of 8, Norwood-street, Leeds, is July 17, 1905. A second and final dividend of 1s. 8d. in the £ has been declared in the estate of Benjamin Mountain, engineer, of Kirkstall House, Kirkstall, and at Globe-road, Leeds. Mr. W. Henry Platts, 22, Park-row, Leeds, is official receiver. At a meeting of the General Engineering Co. (Coventry) a resolution was passed that the company be wound up voluntarily, and that Thomas Mason Daffern, of Little Park-street, Coventry, be appointed liquidator. A first meeting will be held in the estate of Gerald Leslie (otherwise Gerald Algar, trading as Gerald Leslie), electrical engineer, etc., of 5, Denning-road, Hampstead, on July 14, 1905, at 11 a.m., at Bankruptcy-buildings, Carey-street, London.

Coventry.—The annual report of the Corporation electric light undertaking for the 12 months ended March 31, 1905, states that the capital expended during the year has been £15,032, bringing the total expenditure to date up to £134,503. The amount raised on loan is £149,874, while other receipts on capital account have amounted to £1,776. The total capital sanctioned is £150,033. The balance of £159 has not yet been raised. The amount of capital repaid is £29,000, and the sinking fund amounts to £12,032. During the year the number of consumers has increased from 526 to 637, and the equivalent of lamps connected from 53,746 (8 c.p.) to 71,727. Further connections are being made. The number of units sold has increased from 920,192 to 1,375 735, and the revenue from sale of current and meter rental from £10,844. 7s. 10d. to £13,247. 16s. 2d. The increase in units sold to private consumers has been from 857,242 to 1,314,267, and the revenue from this source is £11,660, against £9,581. The working expenses are £5,031, as against £4,598 in the previous year. The profit on working is therefore £8,216, as against £6 245 last year. Capital charges amount to £8,628, against £5,470 last year, and after crediting £183 for bank interest, the net result is a loss of £228, against a profit last year of £775, and a loss the year before of £189. There is a balance in the hands of the treasurer on net revenue account of £1,625, and the committee recommend that the £228 be paid out of that amount, and the balance of £1,396 carried forward to next year's account.

St. Marylebone.—The Works Committee last night submitted a report on reinstatement of trenches after laying of electric light mains, in which they stated that they had addressed a memorandum to the Electric Supply Committee stating that they were not satisfied with the manner in which the work of reinstating the trenches after electric light works had been carried out, pointing out the serious subsidence which takes place in the roads after such reinstatements, and notifying their intention to make a claim against the electricity department for any expenses the works department may be put to in properly reinstating such trenches. The committee have also decided to engage another qualified person to supervise the work of reinstating the trenches in roadways, etc., after electric light works, and to charge the cost in connection therewith to the electricity department. The Electric Supply Committee will report on the Metropolitan Electric Supply Co. (Various Powers) Bill, and will recommend that the Bill should be further opposed in the House of Commons. The committee say: "Although the Bill contains a proviso that the company cannot give a supply of electrical energy at any point in the borough of St. Marylebone except to the Council thereof, there are other provisions in the Bill which render it advisable, in the interests of the borough, for the Council to further oppose the same. As the Bill stands, it would give the company power to break up any streets in the borough which they may find it necessary to break up for the purpose of supplying the Council in bulk, or of supplying any authorised distributors in Hampstead, Hammersmith, Kensington, or Fulham. There is no restriction as to the number of trenches which may be made, as in the case of the Central Electric Bill, and the provisions in regard to the breaking-up of streets are not altogether satisfactory. The Bill would also empower the company to supply railways, tramways, etc., outside the borough, for haulage or traction, for use within the borough. This is really a power which the company have sold to the Council. As regards this power, the Bill contains a clause for the protection of the Willesden District Council, to the effect that nothing in the Act is to authorise the company to supply energy to any company, body, or person for use within the urban district of Willesden, and we think a similar protective clause should be inserted with regard to St. Marylebone." In order to safeguard the consumers' premises as regards fire risk, the fire insurance companies interested have been notified that the change of pressure will in due course be carried out, and have been requested to inspect the installations and have the policies endorsed in the usual way. As it is quite possible that at the last moment the fire insurance companies' inspectors may consider it necessary to carry out some further alterations, and there may be a few days' delay in endorsement of the policies, they have considered it advisable to make arrangements for a temporary floating loan with Lloyds, to cover any liability in connection with the matter, and have accordingly arranged for a temporary insurance to the extent of £100,000 for the purpose. With regard to change of pressure, they report that, in accordance with the regulations, they had applied to all persons occupying premises supplied before March, 1896, for their consent, and about 40 of these consumers had objected to the change. The committee had made formal application to the Board of Trade for sanction to the change without the consent of the consumers, and Mr. Honaratus Lloyd, K.C., would act on behalf of the Council for the purposes of the Board of Trade enquiry. The town clerk has been served with a statutory notice for the abatement of a nuisance caused by the emission of black smoke from one of the shafts at the generating station. The committee understand from the engineers that the black smoke was due to the fact the mechanical stokers had not been put into use, but as this had now been done the nuisance would no longer continue. Another cause which might have contributed to the nuisance was the fact that as the contractors supplying the coal for the generating station had not yet been able to deliver coal under their contract, which had only recently been entered into, a small quantity of house coal had to be used in the meantime. That cause had now also been removed, so there would probably be no further occurrence of the nuisance.

PROVISIONAL PATENTS, 1905.

JUNE 26.

13140. Improvements in and relating to electric arc lamps. Alfred William Hill and the Sir Hiram Maxim Electrical Company, Limited, The Maxim Works, Gillingham-street, Victoria, London.

13156. Improvements in automatic electric switches. Henry Birkbeck, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Phelps Company, United States.

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13158. **Improvements in or relating to electric lamps of the character known as vapour lamps—in part applicable to other electric vapour apparatus** Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Southampton-buildings Chancery-lane, London.

13163. **Improvements in electric machines.** William Arthel Johnson, 4, South-street, Finsbury, London. (Complete specification.)

13182. **Improvements in electric switching apparatus** Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

JUNE 27.

13227. **Improvements in and relating to electrical lighting or heating devices, other than crucibles.** Frederic William Vesey Fitzgerald and Hugh Stanley Revell, 97B, Regent street, London.

13228. **Improvements in telephone or like transmitters.** John Shepherd Sawrey, 40, Chancery-lane, London.

13235. **Improvements in and connected with electrically and otherwise propelled tramcars, omnibuses, and other road vehicles.** George Samuel Thompson and Marian Martha Thompson, 11, Hartham-road, Tottenham, London.

13252 **Improvements in magneto-electric machines for use in connection with ignition devices of internal-combustion engines.** Henri de la Valette, 4, South-street, Finsbury, London.

JUNE 28.

16038A/04. **Central exchange telephone system** Bertil Brander Deutsche Telephonwerke, Zeughofstrasse 7, Berlin, Germany. (Date applied for under Patents Rule 9, July 20, 1904.)

13298. **Improvements in electric automatic cut-outs with time lag element.** Edward Woodrowe Cowan and William Parnell Hamlyn, West Bank, Dishy, Cheshire.

13327. **Improvements in responders for wireless telegraphy.** William John Hancock, 111, Hatton-garden, London. (Complete specification.)

13332. **Improvements in swivelling trolley heads, current collectors, and the like.** Paul Traugott Julius Estor, 52, Chancery-lane, London.

13346. **A device for testing or detecting electrical sparking.** Frank Eugene Smith, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 29.

13378. **Improvements in thermal electric cut-outs.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

13379. **Improvements in dynamo-electric machines** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13380. **Improvements in systems of electric control and apparatus therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13381. **Improvements in electrodes for electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

13382. **Improvements in systems of motor control.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

13383. **Improvements in and relating to electric conductors** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company United States.) (Complete specification.)

13384. **Improvements in and relating to electric conductors** The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

13394. **Improvements in or connected with telephone apparatus.** Christopher John Montgomery, 15, Waterstreet, Liverpool.

13395. **Improvements in and connected with accumulators.** Alexandre Antoine Riasse, 4, Corporation-street, Manchester.

13427. **Improvements in secondary batteries.** Isidor Kitsee, 18, Fulham place, Paddington, London. (Complete specification.)

13430. **Improvements in coin-freed apparatus for the supply of gas, electricity, and the like.** John Mesney Tourtel, 146A Queen Victoria-street, London.

13464. **Improvements in and relating to wireless telegraphic apparatus.** Alessandro Artom, 7, Southampton-buildings, Chancery-lane, London.

13482. **Improvements in and relating to electric switches with enclosed fuse.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13483. **Improvements in electric arc lamps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JULY 1.

13496 **Hygienic telephone attachment.** Harry James Frederick Crosby, 45 Little Humber-street, Hull.

13509. **An improved electric lamp for advertising and other purposes.** Albert Martin Lehfeldt, Long's-court, St. Martin's-street, Leicester-square, London.

13531. **Improvements in electric drills.** John Taufner and Peter Oberweis, Examiner Building, San Francisco, California, United States.

13563. **A new or improved electric ignition device or sparking plug for internal-combustion motors.** Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Chancery-lane London.

13569. **An improved telephone attachment.** David Charles Davies, 55, Chancery-lane, London.

13577. **Improvements in or relating to electric hoists suitable for use on warships.** Clarke, Chapman, and Co., Limited, and Harry Walker, 46, Lincoln's-inn-fields, London.

13586. **Improved method of and means for supplying current to branch stations of telephone exchanges** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Akt.-Ges., Germany.) (Complete specification.)

13587. **An improved starting switch for three-phase electric motors having a resistance in series with the rotor.** Siemens Bros. and Co., Limited, Hereford Berry, and Claude Martineau Toplis, Birkbeck Bank-chambers Southampton-buildings, Chancery-lane, London. (Complete specification.)

13588. **Improvements in dynamo-electric machines.** Siemens Bros. and Co., Limited, and Hereford Berry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London (Complete specification.)

13589. **Improved method of and apparatus for cooling commutators of dynamo-electric machines.** Siemens Bros. and Co., Limited, and Hereford Berry, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13590. **An improvement in electric switches for coin-freed mechanisms, time switches, or the like** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13597. **Improvements in sterlizer mouthpieces for telephones and the like.** Orin Henry Savage, 31, Bedford-street, Strand, London. (Complete specification.)

13605. **Improvements relating to telegraphic systems.** Pierre Picard, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 27, 1904, being date of application in Belgium.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 20.

1904.

14239. **Electric traction systems.** Da Kando. (Rights under Patents, etc., Act, 1901, not granted.)

14728. **Electrical measuring instruments.** Still.

14847. **Electrical fire-alarms or thermo-indicators.** Cyon.

14918 **Automatic telegraphic apparatus.** Damaskinos.

15563 **Electromagnetic signalling devices for selectively operating two or more alternate signals or the like.** Willis.

15618. **Electric circuit breakers.** Crompton and Co., Limited, and Harris.

16116. **Electromagnetic mechanism particularly for use in railway signal apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

16422. **Manufacture of electrical resistances** Electric Equipment and Securities, Limited, and Ruzicka.

16423. **Manufacture of electrical resistances** Electric Equipment and Securities, Limited, and Ruzicka.

16425. **Manufacture of electric incandescence bodies** Electric Equipment and Securities, Limited, and Ruzicka.

17019. **Alternating-current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

17978 **Suspending or supporting electric motors or differential gear, or both, on motor road vehicles or tramway vehicles.** Elie. (Soc. A. Vedrime et Cie.)

18359. **Incandescent electric lamp sockets** British Thomson-Houston Company, Limited. (General Electric Company.)

18361. **Resistances for electrical apparatus.** British Thomson-Houston Company, Limited. (General Electric Company.)

18446. **Mercury and the like vapour electric apparatus.** Cardan. (General Electric Company.)

18496. **Switch for electric circuits.** Farquhar.

18520. **Coin-freed gas, electric, or other meters.** Beaumont.

18704. **Electrical circuit breakers and automatic switches.** Electric and Ordnance Accessories Company, Limited, and Hall.

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22908. Multiple connecting system for telegraphic or telephonic communication. Arendt. (Date applied for under International Convention, Oct. 24, 1903.)

23899. Manufacture of incandescent electric lamps. Just and Hanaman.

29354. Apparatus for transmitting electric signals or impulses. Grabosch.

29531. Electrical signalling apparatus. Holmes. (Date applied for under International Convention, March 25, 1904.)

1905.

689. Current controller for electric railways on a sectional conductor system. Duckworth, Duckworth, and Kerr.

760A. Apparatus for use in wireless telegraphy. Heinicke. (Date applied for under Patents Rule 9, Jan. 13, 1905.)

952. Electric motors. Latour. (Date applied for under International Convention, Jan. 18, 1904.)

3283. Electrical sound-producing apparatus. Legendre. (Date applied for under International Convention, Sept. 24, 1904.)

3594. Transmission of electrical energy through space for the purpose of wireless telegraphy and the like. Artom.

3885. Electric trolley heads. Hensley. (Date applied for under International Convention, May 5, 1904.)

5374. Trolley retrievers for electric railways. Albee.

5782. Electric motor controllers Electric and Ordnance Accessories Company, Limited, Hall, and Garner.

6176. Relays for telephones, telegraphones, and the like. Christensen.

7568. Telephone transmitters. Gail.

8907. Systems of electrical distribution. Lincoln. (Date applied for under International Convention, May 3, 1904.)

8975. Automatic telephone exchange systems. Kugelmann. (Date applied for under International Convention, April 29, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	15/32-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-104 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2 7/16 2 11/16
—— 4 per cent. Mortgage Debenture Stock	100 ..	89-91 xd
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	92-95
—— 4½ per cent. 2nd Debenture Stock	100 ..	77-78
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5⅜-5⅝
Crompton and Co.	3 ..	1⅞-2⅛
—— 5 per cent. Debentures	100 ..	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1¼-1½
—— "A" Shares, 01-017,139	5 ..	2-2½
—— 5 per cent. Dsbentures	100 ..	89 94
—— 4 per cent. Deb. Stock, Red.	100 ..	83 88 xd
Electric Construction, Nos. 1 to 112,100	2 ..	¾ 1
—— 7 per cent. Cumulative Pref.	2 ..	2¼ 2½
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	95 98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10 xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	11½-12½
—— 4½ per cent. Preference	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	109 111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	100 103
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	31-33
—— 5 per cent. Bonds	100 ..	101-103 xd
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	11⅜-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11¼-12¼
—— 4½ per cent. Debenture Stock, Red	100 ..	106 108 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9⅜-10¼
—— 7 per cent. Preference	5 ..	9¼-10⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9 9¼
—— Nos. 60,001-80,000	5 ..	8⅜ 9¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13⅛
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	7⅛-8
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	105 107
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅛-4⅜ xd
—— ditto (1903) 40,001-80,000	5 ..	4⅛-4⅜ xd
Chelsea Electricity Supply	5 ..	6⅛ 6⅜
—— 4½ per cent Debentures	100 ..	108-110 xd
City of London, Ordinary	10 ..	10⅞-11¼
—— 6 per cent. Cumulative Pref.	10 ..	13¾-14¼
—— 5 per cent. Debenture Stock	100 ..	122-126 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-105
County of London Electric Supply, Ordinary	10 ..	8⅛ 8⅜
—— 6 per cent. Cum. Pref.	10 ..	12⅛-12⅜
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	115-118
—— 4½ per cent 2nd Debentures Prov. Certs	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¼-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-109
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2½-3
—— 5 per cent. Debenture Stock, Red	100 ..	85-90 xd
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	101-104
Havana Electricity, 1-15,000	10 ..	9½-10¼
Hove Electric Lighting, Ord., 1-13,000	5 ..	7½-9¼
Isle of Wight Elec Lt. and Pwr., 4½ p c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	⅜-½
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11½-12½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	101-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-101
Metropolitan Ordinary, 100,001-300,000	5 ..	9⅜ 10
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-115 xd
—— 4½ per cent. Cum. Pref.	5 ..	6⅜ 6⅝ xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	99-101 p.c. xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	98-101
—— Preference	4 ..	100-102
Notting Hill Electric Lighting	10 ..	14½-15½ xd
—— 4 per cent. First Mort. Deb., Nos. 1-500 (Reg.)	100 ..	100-102
Oxford Electric, Ordinary, 1-96 and 49-14,310	5 ..	6¼-7
—— 4 per cent. Debenture Stock	100 ..	99½-101½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	2⅝-3⅛
—— 4 per cent. Debenture Stock	100 ..	79-83
South London, Ordinary	5 ..	3⅛-4⅛
South Metropolitan Electric Light and Power, Ord.	1 ..	⅜-½
—— 7 per cent. Cum. Pref.	1 ..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-108
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13½-14½
—— 7 per cent. Pref.	5 ..	8½-9
—— 3½ per cent. Deb.	100 ..	87 99 xd
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅜-4⅞
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5⅛-5⅜
Westminster, Ordinary	5 ..	12 -13
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5 ..	6¼-6⅜ xd
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 —	6-6¼ xd
—— Ord.	5 ..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	140-143
Auckland Elec. Trams., 5 p c. 1st Mor. Deb. Stk, Red.	100 ..	101-106 xd
Barcelona Tramways, Ord., 1-20,000	10 ..	13-14
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9-10¼ xd
—— 5 per cent. Deb., Red., 1-600	100 ..	99-102
—— 4½ per cent. Red Deb. Stock	100 ..	96-100
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16xd
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1¼-1⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3⅜-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	92-96 xd
British Columbia Electric Railway Co., Ord. Def.	100 ..	105-108
—— Ord. Pref.	100 ..	98-101
—— 5 per cent Cum. Perpetual Pref. Stock	100 ..	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9½-9⅝
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11½-11⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-124
—— 4½ per cent. 2nd Deb. Stock	100 ..	97-99
Buenos Ayres and Belgrano Trams.	5 ..	3 3⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	6¼-6⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	6¼-6⅝
—— 5 per cent. Deb. Stock, Red.	100 ..	106-107 xd
—— Prov. Cert., all paid	100 ..	101-104 xd
Buenos Ayres Electric Trams., 5 p c. Deb. Stk., Red.	100 ..	96 98 xd
Calcutta Tramways, 1-102,268	5 ..	8¼-8⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	106-108 xd
Cape Electric Tramways, Nos. 1-480,000	1 ..	1¼-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅞-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102-104
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13½-14½
—— 6 per cent. Cum Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4 per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5 ..	2⅜-3¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9½-10 xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	97-102xd
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	101-103
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	9/32-11/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	104-106 xd
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	108-110
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1 600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum Pref.	10 ..	9⅛-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb Sk.	100 ..	103-106 xd
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9⅛-9⅜
—— 4½ per cent Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,1-2 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 ..	91-92
—— 4 per cent. Pref.	100 ..	101-103
—— ,, ,, deferred	100 ..	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100 ..	39-41
—— 4 per cent. Debenture Stock	100 ..	107-110
—— 5 per cent. Pref. Stock '91	100 ..	120-123
—— " " " '95	100 ..	119-122
—— " " " '01	100 ..	115-118
Liverpool Overhead, 5 per cent Pref.	10 ..	10-10⅛
—— Ordinary, 1-50,000	10 ..	3⅜-4⅛
—— 4 per cent Mortgage Debentures, Red., 1-1,700	— ..	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	99-100
Waterloo and City, Ordinary	100 ..	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100 ..	111¼-112¼
—— Deferred Stock	100 ..	102-104
—— 6 per cent. Cum. First Pref.	10 ..	13-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5¼-5⅜
—— 3½ per cent. Deb Stock, Red.	100 ..	101-103
—— 4 per cent. Deb. Stock, Red.	100 ..	99-101 xd
—— 4 per cent. Prov. Cert.	— ..	101¼-103½ xd
Oriental Telephone and Electric Company	1 ..	1¼-1¼
—— 6 per cent. Cum. Pref.	1 ..	1 1/16-1 3/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 1	1,531	1,493	+ 37	− 81h	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	June 24	378	392	− 14	—	8	8	" 15	14,528	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	July 2	1,137	1,174	− 37	− 211	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338h	6·03
Birmingham Corporation	" 1	333	347	− 8	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	June 28	1,100	990	+ 110	+ 648	24	24	" 25	43,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	" 29	1,321	966	+ 355	+ 1,243	17⅓	17½	" 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	July 1	860	793	+ 67	− 180	16½	16½	Dec. 31	31 846	2,325 677	579,264	3 28	13·19	—	7·27
Bolton Corporation	" 2	1,942	1,928	+ 14	+ 930	40	38	March 31	90,765	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	June 28	1,423	1,044	+ 378	+ 1,011	16 82	16 82	" 31	55,276	10,088,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	July 1	4,491	4,694	− 203	− 1,716	77	77	" 31	—	—	—	—	—	—	—
Brighton Corporation	" 2	1,092	1,189	− 97	− 863h	9	9	" 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	June 30	6,044	5,386	+ 660	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	July 1	1,149	1,113	+ 36	—	10 60	10·60	March 3	—	—	—	—	—	—	—
Burton Corporation	" 2	331	—	—	—	8¼	8¼	" 31	17,950	3,878 269	454,082	1·07	9 21	2,058	6·76
Cardiff Corporation	June 24	2,193	2,095	+ 98	—	26†	—	" 31	112,209	24,134,363	2,770,049	1 12	9·72	3,732	9·44
Carlisle Tramways Company	July 1	2·8	318	− 90	− 443	8·5	8·5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	" 1	6,530	6,476	+ 54	+ 1,676h	6	6	" 31	347,533	44,875,547	1,231,214	1 86	65·10	57,931	35·80
City and South London Railway.	" 2	2,406	2,511	− 105	— h	6¼	6¼	" 31	—	—	—	—	—	—	—
Colchester Corporation	June 26	223	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork B. T and L Company	" 29	613	550	+ 63	—	15½	15½	" 31	24,695	5,814,376	832,256	1·01	6·64	—	4·69
Darwen Corporation	July 1	260	229	+ 31	+ 159	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	" 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	June 30	178	186	—	— h	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	" 30	5,733	5,622	+ 311	} —	47	46	" 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	" 23	1,146	1,134	+ 12											
Dundee City Tramways	" 28	877	834	+ 43	—	22	21	May 15	—	—	—	—	—	—	—
East Ham Corporation	July 1	884	756	+ 128	+ 764	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	" 1	16,744	15,351	+1,393	— h	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	June 7	302	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	" 28	1,832	1,748	+ 84	+ 1,085	35½	33	March 31	74,019	17,349,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	July 1	1,357	1,311	+ 46	+ 904	35	35	" 31	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	" 1	2,194	2,240	− 46	+ 10	27	26	" 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	" 31	—	—	—	—	—	—	—
Ilkeston Corporation	June 28	135	153	—	—	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	" 28	224	221	—	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	July 1	6,451	6,273	+ 177	—	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	June 24	10,838	10,674	+ 214	+ 9,086	103	103	" 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	" 25	1,602	1,721	− 119	− 1,767h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	" 24	14,942	13,400	+1,542	+36,531	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	" 29	129	—	—	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	July 1	13,534	12,918	+ 616	+ 6,183	149	131½	March 31	631,866	126,930,875	14,123,124	1·19	10 73	4,293	6·99
Nelson Corporation	" 1	146	124	+ 22	+ 187	—	2¾	" 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	" 1	5,895	3,423	+2,460	—	50	45	" 31	197,849	43,069,934	4,326,152	1·07	10 98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	June 25	1 728	1 137	+ 591	—	—	34	" 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	July 1	2,508	2,221	+ 287	− 278	—	29	" 31	95,702	19,625,323	197,499	1·17	11·63	—	—
Reading Corporation	June 29	670	647	+ 23	—	—	33½	" 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	" 31	14,881	2 837,110	336,547	1·24	9·24	1,102	7·92
Rotherham Corporation	" 29	445	474	− 29	—	9½	7½	" 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	July 3	4,486	4,196	+ 290	+ 3,344	—	119	" 31	—	—	—	—	—	—	—
Scarborough Tramways Co.	" 1	170	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	" 2	4,900	4,788	+ 112	+ 1,956	—	52½	" 31	—	—	—	—	—	—	—
Southampton Corporation	June 28	1,067	1,014	+ 52	+ 305	—	18	" 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	" 28	439	427	+ 12	+ 362	—	9	" 31	—	—	—	—	—	—	—
Stockport Corporation	" 30	702	611	+ 91	+ 285	—	10½	" 31	—	—	—	—	—	—	—
Sunderland Corporation	July 3	1,419	1,334	+ 85	+ 284	—	20	" 31	—	—	—	—	—	—	—
Swindon Corporation	June 28	208	—	—	—	—	4½	" 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Wallasey U.D C.	July 1	870	843	+ 27	+ 543	11·85	10 5	" 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	June 24	336	316	+ 20	+ 166	7½	—	" 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	" 29	1,733	1,107	+ 626	+ 3,245	46	8 62	" 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	" 14	1,321	607	+ 713	—	—	7½	" 31	—	—	—	—	—	—	—

† And 98 miles of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures.

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NOTES.

Obituary.—We regret to announce the death of Mr. William Bruce Dick, one of the original founders of the electrical engineering firm of Messrs. Dick, Kerr, and Co., who died suddenly at Carrick Grange, Sevenoaks, in his seventy-sixth year.

Society of Arts.—The council of the Society of Arts attended at Marlborough House last week, when the Prince of Wales, president of the society, presented the society's Albert Medal for 1905 to Lord Rayleigh, O.M., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

The Institution.—The *Journal* of the Institution dated June contains the following papers: "Units and Standards," with discussion; "The Alternating-Current Series Motor," by F. Creedy, with discussion; "Earthing," by Mr. W. W. Lackie (at Glasgow), with discussion; "Some Effects in Three-Phase Working," by W. M. Thornton (Newcastle), with discussion; "Mechanical Construction of Steam-Turbines and Turbo-Generators," by W. J. A. London (Manchester), with discussion; "Shunt Resistances and Temperature Compensation for Ammeters," by A. Campbell; and "The Dissymmetry of a Three-Phase System," by A. B. Field.

"Wireless."—In the House of Commons last week, Lord Stanley, referring to the Wireless Telegraphy Act, expressed a hope that on the expiry of the measure in August of next year, it would be renewed for another 12 months to see where improvements could be made in regard to the working of systems and the granting of licenses. The question of granting licenses had been found a very complicated business, and as the question of national defence was so much involved, no license had been given or refused without the full consent and approval of the Admiralty. Lord Stanley intimated that a return would be made to the House of the licenses which had been issued.

Rapid Electro-Deposition of Copper.—Mr. Sherard Cowper-Coles described before the Faraday Society on the 3rd inst. his system of depositing copper of a rapidly revolving electrode. In the first part of his paper he gave a history of other attempts to increase the rate of deposition of copper, and at the same time to secure regularity in the deposit. He then gave a number of figures to show what had been done towards obtaining a strong tube of copper by deposition on a revolving mandrel. Certain critical speeds are necessary to get the best results, and these have been determined by revolving cones and comparing the deposit at varying diameters. The success of the process is due to the fact that impurities are thrown off by centrifugal force.

Iceland.—It is reported that an agent of Messrs. Siemens and Halske has laid before the Althing (the Icelandic Parliament) a proposal for the establishment of wireless telegraphic communication between Iceland and the Continent and between four commercial towns of the island, the company agreeing to provide the installation in return for a single payment of about £36,666. The company offers to deposit a guarantee for the efficient working of the system. The yearly cost of maintenance is estimated at about £2,777. An agent of the Marconi Company has also arrived, and will submit to the Althing proposals for the installation of wireless telegraphy between Iceland and the Continent and between the four commercial towns of the island. The Marconi Company has made experiments with some success from Cornwall to Iceland.

Top-Covered Cars.—The popularity of the top cover has induced the London County Council to embark upon the fitting up with this device of a further 150 cars, for which a vote of £13,500 was approved at Tuesday's meeting of the Council. When these covers were instituted doubts were expressed as to whether they would meet with favour at all weathers, and, doubtless, their value varies somewhat with the atmospheric conditions. In inclement weather their utility can scarcely be over-rated, and, judging by accounts generally, the average receipts rule higher than in the case of the uncovered vehicle. For instance, during the period from Feb. 26 to May 27 the 100 cars of the County Council already so fitted yielded 11·83d. per car mile, as against 11·11d. for the other cars. Another 60 cars are under construction, and the 150 sanctioned on Tuesday will for the most part be distributed over the lines in the Tooting and Wandsworth districts. The work of fitting the 150 covers will, as with some of the earlier ones, be carried out by the Council's staff, the cost per car being about £90.

Radioactivity of Thorium.—An abstract of an article on this subject by Mr. Otto Sackur appears in the *Journal* of the Chemical Society. The author measured the rate of decay of the emanation of the product obtained by Hahn by the fractionation of radium barium bromide, and from the values obtained concludes that thorium emanation was evolved from a new radioactive element present in Hahn's product. The possibility of thorium itself being inactive, whilst its radioactivity is due to the presence of some other substance, is discussed. The oxalate obtained from thorianite was converted into oxide and then into chloride, which, when submitted to fractional sublimation, did not indicate any separation of the radioactive component. Barium hydroxide solution was gradually added to a solution of the sulphate obtained from the oxalate and the precipitated barium sulphate was found to be strongly radioactive, a result due to the presence of thorium X. Attempts were also made to prove the presence of a new element by electrolytic methods, which did not lead to the separation of an element of constant radioactivity, but indicated that solutions of thorium from thorianite and other minerals behave on electrolysis like dilute solutions of a new element which is strongly radioactive.

Balanced Electrodes.—Prof. W. W. Haldane Gee read before the Faraday Society last week a paper on the use of balanced electrodes in voltameters. He described a number of such instruments, especially as used in the Manchester School of Technology with considerable success. We notice that while the electrode to be weighed is supported from the balance, the connection through which the current is conveyed to the same is always moved before any weighing operation takes place. Thus the author has made no attempt to carry the current which is to be measured through the supports of the balance. With such balanced electrodes it is not enough to know the apparent weight when determining increases; readings must also be taken of the density of the solution at the beginning and end of each period of observation. From the figures given of a number of trials exceedingly accurate results have been obtained with copper, zinc, and silver solutions. Some interesting experiments with mercury electrodes are also described in the paper. We agree with the author that this type of suspended electrode is worthy of a place in the laboratory and test-room. It has the same advantage over an ammeter that an ordinary voltameter has,

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and, further, it can be more quickly operated, as the plates need not be removed from the solution during the course of the experiments.

Alloys.—A demonstration was recently given by Mr. Sherard Cowper-Coles at Grosvenor-mansions, Victoria-street, of his low-temperature process for making alloys without fusing any of the metals. If a copper plate be surrounded with zinc dust and heated to 500deg. F. for about an hour, he has found that the two metals unite, and the plate becomes covered with a film of zinc, even though the temperature has never been within 200deg. of the melting-point of the latter metal. The surface of the plate becomes hardened to such an extent that it cannot be readily scratched. In the same way iron and steel articles can be covered with a uniform homogeneous layer of zinc, and, in fact, galvanised, though the advantage is claimed for this process over that of ordinary galvanising that the temperature employed being much lower the temper of steel articles is not impaired. Objects treated by this process must be free from scale, but red dust does not matter, while grease seems to be rather an advantage, so that machine work, such as bolts, nuts, and screws, may be subjected to the Sherardising process immediately after being machined, without preliminary preparation. On a large scale the operation is carried out by packing the articles to be treated in an iron drum full of zinc dust, and heated; preferably this drum should be airtight and exhausted of air to prevent formation of too much zinc oxide, or, alternatively, about 3 per cent. of carbon in a fine state of division may be added to the zinc dust.

The Municipal Tramways Association.—At the annual meeting of this association held last week in the Berners Hall, Islington, a report was considered as to the advisability of uniting the Municipal Tramways Association, the Tramways and Light Railways Association, and the Association of Tramways and Light Railways Officials. The report stated that a special joint committee, consisting of two representatives from each association, had unanimously decided in favour of the unification of the three organisations under the title of the Municipal Tramways Association. The basis of membership to this would have had to be broadened, and the other two associations would then have ceased to exist. The joint committee indicated that the municipalities could at any time hold a special meeting, at which only their own representatives would be present, in order to consider any question of policy where differencies with tramway companies would be likely to arise. After a heated discussion, however, the proposal was not accepted, and an amendment was carried referring the report back. It seems to us that this was a mistake, as one strong association would be of much more service to the tramway industry as a whole. The election of officers for the ensuing year took place at this meeting, and the following gentlemen were elected: Mr. G. B. Hamilton (Leeds), president; Councillor Boyle (Manchester), vice-chairman; and Messrs. A. L. C. Fell (L.C.C.), J. Dalrymple (Glasgow), P. Fisher (Dundee), and C. J. Spencer (Bradford), were appointed to fill vacancies on the executive committee.

Electricity and the Black Art.—There is still a lingering suspicion in the lay mind, at any rate in regard to the uneducated section of the public, that the wonders of electricity are not entirely free from the occult. This spirit of medievalism appears in the recent action of the Old German Baptists of Indianopolis, U.S.A, who at a recent conference adopted a resolution ordering all the members of the sect to discontinue the use of the telephone. The decree seems to have been received without demur. The reason given for this curious proceeding is that no warrant for its employment is to be found in Holy Writ. There is even a suggestion on the part of the sect that telephony was invented by the Evil One, though the records of the Patent Office contain a different version. Remembering the feat of Moses and the Egyptian magicians in converting rods into serpents, this reactionary community would, in logic, be bound to repose implicit belief in the legerdemain of the conjuror; but it is incapable of realising the evolution that has taken place in economic conditions since the period of the Scriptures, and presumably would bann, not only the telephone, but the telegraph, railways, tramways, and other modern developments. Marconi has cause to congratulate himself that he belongs to this age; a few centuries ago he might have shared the peril of the alchemists. The incident is more humorous than anything else, as no rational being can question the ethics of man utilising, for the benefit of the human race, the genius bestowed upon him by the Creator; but it is rather surprising that such superstition should continue to-day, even among communities noted for their eccentricity.

More Popular Science.—A writer in the issue for July 8 of our entertaining contemporary *Tit-Bits* discourses upon the repair of telegraph wires, and his omniscience so far impressed the editor that the contribution is accorded a place in "Our Premium Page" at double the usual rate of remuneration. The scribe tells how faults are located in such lucid terms that we cannot do better than reproduce his own description: "The explanation is very simple. It requires force to send electricity through a wire. The longer the wire is the greater is the force required. This force is measured; but, instead of calling it pounds, as in measuring the pressure in a boiler, electricians call the units of electrical force 'ohms.'" It will be observed that the writer lays considerable stress upon the definition of the ohm, and as he is obviously so well versed in the subject of electrical measurements it may be lamented that his knowledge was not available when the question of units and standards was recently discussed before the Institution. Still, it does come as something of a revelation to learn that the ohm is the unit of electrical force, and this prompts a correspondent at Bournemouth, in forwarding us the cutting, to inquire about the fate of the volt, so that he may keep abreast of the latest developments. Our impression is that the status of the volt has not undergone any alteration, and we are therefore constrained to infer that the writer in question has become somewhat confused in his theories. It is not necessary, or even desirable, that in a popular periodical scientific subjects should be handled precisely as they would be in a technical journal; but in these days of universal knowledge one scarcely expects to find such errors on a point with which the average schoolboy is acquainted.

Regulations for Tramway Employees.—At the fourth annual conference of the Municipal Tramways Association last week, Mr. H. E. Blain, manager of the West Ham Corporation tramways, presented a paper on "Rules and Regulations for Tramway Employés." The author necessarily treated the subject on more or less general lines, but some of his remarks in regard to rules for motormen are worthy of note. He emphasises the importance of a careful examination of the cars on their being brought out each time, the motormen at West Ham being allowed 15 minutes' pay for this. He then alludes to the economy in current that can be effected by careful driving, and the danger of accidents that may be minimised by a thorough understanding of the brakes, and a list of the instructions issued to the motormen at West Ham is given. In regard to the rectification of irregularities on the road, he points out that while it is unwise for motormen to cause delay by

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endeavouring to rectify serious breakdowns, there are many little irregularities which can be localised and put right by a well-trained man. It strikes us that the essence of this latter point resides in Mr. Blain's expression, "a well-trained man." No doubt some of the motormen are quite capable of attending to these little jobs, but it is a question into which the "personal equation" enters largely; and until the motormen as a whole have been educated up to a certain standard, we doubt the wisdom of entrusting them with any but the most rudimentary repairs. Apparently West Ham does not intend to lag behind in increasing the efficiency of the drivers in this respect. In conclusion, Mr. Blain recommends that all drivers should be furnished with a guide containing explicit instructions with reference to the fall of trolley, telegraph, or telephone wires.

Heat Insulation.—Messrs. R. S. Hutton and J. R. Beard read a paper before the Faraday Society last week on the heat insulation of the materials used in furnace construction. They pointed out that too little attention is paid to the quality of the refractory materials used in furnace construction both by the manufacturers and the users. Experiments were made in the physical laboratory of Manchester University on a large number of materials such as are used in connection with metallurgical furnaces. The heat conductivity of these was found to vary over a very considerable range. Thus the material having the highest conductivity was a white Calais sand, the figure being ·00060. The lowest conductivity was that possessed by kieselguhr, which is an infusorial earth, the figure being ·00013. Firebrick was experimented with and showed a position about midway between these two as far as heat conductivity was concerned. Certain grades of magnesia were also remarkable for low heat conductivity. It is pointed out that it is by no means advisable to choose materials for furnace lining from the information obtained as to heat conductivity only, but that, other things being equal, the choice might be guided by these figures. For example, neither the light magnesia nor the infusorial earth mentioned above can withstand high temperatures for a considerable time without losing their efficiency and shrinking to a very considerable extent. In making the experiments the heat required was produced in an electric circuit. The authors conclude that whilst bricks and, generally, jacketing materials for furnaces should be of low thermal conductivity, it is of no less importance to choose crucibles, retorts, and other containing vessels which are heated externally of as high conductivity as is feasible in conjunction with their other necessary qualities. By a judicious use of the different materials and a stratified form of construction, it should be possible usefully to employ such excellent insulators as infusorial earth without risk of the damage which is inevitable if they be permanently subjected to too high a temperature.

City and Guilds of London Institute.—The full report of the council of this institute for the year ending 1904 is worthy of careful reading by all interested in technical education. It shows that the work carried on by the City Guilds of London as educational authorities is on the increase, and that the character of the education given also tends in an upward direction. The first part of the report deals with the financial question, and we regret to see that one or two of the City Companies have reduced their annual contributions to the funds. A special effort is being made to induce these companies to alter their decision, and it is pointed out that the enlargement of the Technical College at Finsbury and the larger number of students taken both there and at the Central Technical College calls for a larger degree of financial support from the various guilds. We see in the report indications that this will be forthcoming, but united action is required. The reports for the individual colleges are satisfactory, and most of the information concerning them which appears in the report has already been referred to in our columns. At the Central Technical College Prof. W. E. Dalby, M.A., M.I.C.E., has undertaken the professorship of the mechanical engineering section, which was previously held by Prof. Unwin. We are pleased to see, however, that the executive committee have appointed Prof. Unwin Emeritus Professor and that he will continue to use the laboratories of the engineering department for research work. The extensions of the mechanical engineering department of the Finsbury College were commenced when Prof. Dalby was head of the department, and will greatly extend the facilities there. It is interesting to note that the electricity required for driving the machinery in this department as well as for illuminating purposes are to be taken from an outside authority, and that special generating plant will not be laid down for the purpose. The other undertakings of the institute seem to be in an equally flourishing condition, and we are pleased to see such good reports as to the success of students who have been educated technically by the various colleges.

Physical Society.—At a meeting of the society on the 30th ult. a paper on "The Comparison of Electric Fields by Means of an Oscillating Electric Needle" was read by Mr. D. Owen. This paper describes experiments which show how an "electric needle" may be used to measure electric fields in a manner similar to that in which a magnetic field is measured by an oscillating magnetic needle. The needles used were cylindrical in form, of aluminium or of brass, and were suspended by quartz fibres three or four inches in length. The couple on the needle when disturbed from the direction of the field is proportional to the square of the field strength. For small displacements the needle vibrates isochronously, the frequency being proportional to the electric force. It may be used in alternating as well as in steady fields, and may be applied to illustrate many of the laws of electrostatics. The disturbing effect of the needle upon the field is considered; in particular its effect when placed in a uniform field. It is shown by experiments that the disturbing effect falls off rapidly with the distance from the needle, and is inappreciable (in the case of a needle 1½cm. long) at a distance of twice the length of the needle. With regard to the effect of the dimensions of the needle upon the frequency (for given field), while the restoring couple decreases rapidly with decrease of size, yet the moment of inertia decreases more rapidly, so that the smaller the needle the greater the frequency, and also the smaller the disturbing effect. The shielding effect of some dielectric materials was examined in the following way: A needle was suspended centrally in the uniform field between a pair of parallel plates. A thin-walled cylinder of the dielectric was placed around the needle, and the shielding action denoted by a fall in frequency of the needle. Glass and mica were found to effect perfect shielding. Ordinary paper shields; but when thoroughly dried by heat the electric field is transmitted undiminished, only to fall off to zero after a minute or two's exposure to the air. Dry paper soaked in melted paraffin-wax transmits the field perfectly and for an indefinite time. The paper concludes by pointing out that an electric needle suspended between a pair of parallel plates forms a simple means of measuring high voltages, since the frequency of vibration is simply proportional to the voltage between the plates.

A Novel Device for Flicker Advertisements.—The *Elektrotechnische Zeitschrift* describes a neat device recently put on the market by the Allgemeine Elektricitäts

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Gesellschaft. It is in the form of a lamp socket, with one end suitable for insertion into an ordinary incandescent lamp-holder, and the other end arranged to take the lamp itself (Fig. 1). The socket contains a circuit-breaking device, as shown diagrammatically in Fig. 2. This circuit breaker consists of a small heater, similar to the heating spiral of a Nernst lamp, and of a Bregnet spring made up of two thin strips of dissimilar metals welded together.

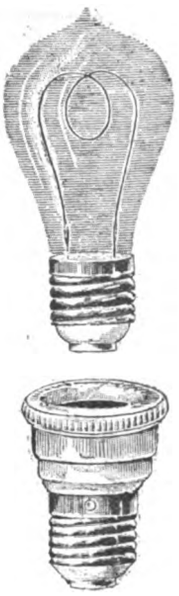

FIG. 1.

The two metals are chosen so as to have distinctly different coefficients of expansion, and in the cold state the spring is upright and closes the circuit, as shown in Fig. 2. As soon as the lamp is inserted, the current passes through the heater and the spring, and causes the spring to bend into the dotted position and so break the circuit. The spring then immediately commences to cool, and again closes the circuit. This cycle of operations repeats itself

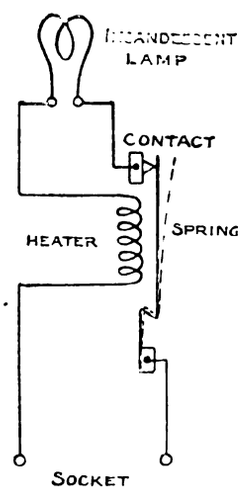

FIG. 2.

automatically at regular short intervals, and if a number of lamps fitted with the device are arranged to form an advertisement a novel and attractive effect is produced, for, though all the lamps repeat the cycle in the same time, they do not all light up or become extinguished at the same instant.

The Big Power Bill. — The promoters of the Administrative County of London and District Electrical Power Bill scored on the second reading in the House of Commons last week by the tolerably substantial majority of 40. Mr. W. R. Bousfield, in moving the second reading of the measure, stated the case for the promoters in conspicuously lucid terms. As the arguments in favour of the project are well known now, it is unnecessary to follow the hon. gentleman in detail, but it may be observed that he emphasised the possibilities of the scheme in aiding the industries of the Metropolis. He predicted, among other things, that a supply of cheap energy would revive and develop the smaller industries, which have fallen, by the way, partly through the cost of power. He showed again how the promoters would be in an advantageous position for generating current, mentioning that they had arranged for a supply of seaborne coal at a maximum price of 8s. 6d. per ton, which is much lower than the existing companies are able to purchase at. The promoters had met the objection as to their measure not containing a purchase clause by agreeing to the insertion of one which should provide for the acquisition of the undertaking on behalf of the public without any consideration for goodwill or prospective value. Mr. Bousfield concluded by remarking that if the Bill were rejected without consideration by a Select Committee, a great injustice might be done to London. Mr. Remnant moved the rejection of the Bill on the ground, apparently, of its magnitude and unfair competition, and Mr. John Burns seconded the rejection with a piece of breezy oratory. The scheme had been made in America, and had travelled to London *vid* Newcastle. He was sceptical as to the benefits it was to confer upon the unemployed, and his view of the matter was summed up in the sentence, "Better the devil you know than the devil you don't know," the existing companies presumably representing "the devil you know." Mr. Bonar Law, Permanent Secretary to the Board of Trade, defined, in a temperate speech, the attitude of that department towards the Bill, which was that it should be considered on its merits, as the question was not a political one. Personally, he was not much impressed by the pleas put forward on behalf of the municipalities and the existing companies. The former would not be justified in embarking upon an enterprise to which a certain element of speculation must attach, while the existing companies contention as to unfair competition was largely discounted by the fact that their statutory powers confined them to certain areas, and, moreover, the promoters of the new scheme, before paying any dividend, would have to supply power at a rate the present companies had never done. Further, in regard to the municipalities, he regarded their true function as residing in the supply of light, not power, and he held that they could do this to the best advantage by taking a supply of current in bulk. He thought, therefore, as did subsequent speakers, that the promoters had at least made out a case for consideration by a select committee, and this view prevailed by the majority mentioned above. This, we may add, is our own view, and the complete discussion which will now proceed of the scheme in all its bearings is to be welcomed.

The Telephone Transfer.—An announcement as to the attitude of the Select Committee towards the question of municipal telephony was made last week, when Mr. Stuart Wortley, the chairman, stated that the committee did not intend to be drawn further into the question of the management of telephones by municipalities. The question of municipal against national service would be settled on a higher ground than the consideration that municipalities may have made mistakes. Sir George Murray, secretary to the Treasury, intimated that the Treasury approved of the agreement. It was necessary to come to an early arrangement by which the company might fairly develop their business until the end of their license, and then hand their plant over to the Post Office, so that business might go on without check. Sir Robert

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Hunter, secretary to the Post Office, agreed with Mr. Gaine that the Post Office could not grant new licenses to municipalities before 1911 for periods extending beyond that year without entitling the company to a corresponding extension. That was a privilege granted to the company by Parliament, and could not be taken away unless a substantial consideration was given in exchange for it, but the inability of the Postmaster-General to grant new licenses to municipalities before 1911 would not, in the long run, prejudice the question of municipalisation. It would be easier to grant new licenses in 1911 than it was now. Mr. Babington Smith, secretary to the Post Office, stated that with regard to the abolition of the unlimited service and the substitution of the measured rate, it was natural that large users should object to this because now the large user paid too little and the small consumer paid too much for his service. The past experience was too short to say what the cost of a municipal service would be, because the first year of such a service was in many respects the cheapest. If the agreement were adopted, he considered that the company would be in a less favourable position to compete with municipal authorities, because if they squeezed a local authority out the Post Office could acquire the municipal service and compete on more favourable terms. In reply to a question from the chairman as to the capital of the company being watered, the witness replied that one of the advantages of the agreement was that it entirely sets on one side any question of the company's capital, as nothing is to be purchased but tangible assets at their fair market value without any allowance for compulsory purchase or profits. Mr. R. A. Dalzell, chairman of the Central Committee of the National Telephone Staff Transfer Association, gave evidence as to the organisation of the staff. The association had a membership of 8,000, and practically included the whole of the company's staff throughout Great Britain and Ireland. He pointed out that the Postmaster-General had been receiving each year, without incurring any risk or capital expenditure, a royalty of 10 per cent. on the company's gross revenue from its exchange business, so that the staff had been partly working for the benefit of the Postmaster-General, and, through him, of the ratepayer. The claim put forward by his association was (*a*) continuity of employment, with the benefit of past services for all members of the staff in the company's service before Dec. 31, 1911; (*b*) compensation for loss of office; and (*c*) superannuation for all members occupying a post or office which, if occupied in the permanent Civil Service of the State, would entitle the occupier to a superannuation allowance or salary of £100 per annum and upwards. The Committee has adjourned till Monday.

Overhead Niagara-Toronto Transmission.—The construction of long overhead lines for the transmission of power has yet to be standardised in this country, but there is evidence that with the consent of the Board of Trade a considerable amount of such work will be done by our power companies in the near future. Thus, the South Wales Power Company are extending their distribution system in this way, and the County of Durham Power Company have in contemplation no less than 40 miles of overhead lines. This work is, however, small when compared with that now being undertaken between Niagara and Toronto. The lines in question are being erected over a private right-of-way 75 miles long, which will also be used for a high-speed electric railway to connect Toronto with Niagara. The right-of-way is 80ft. wide, and the grade at the Toronto end is not expected to exceed 15ft. per mile. Near Niagara Falls grades up to 53ft. per mile are encountered. Two independent lines of steel towers are to be erected to carry four circuits. This will allow for the transmission of 40,000 h.p. at 60,000 volts. Between the two lines of towers there will be a clear way of 34ft. for the double track of the high-speed railway. The steel towers are being placed 400ft. apart on the straight, but this distance is decreased considerably on curves. With the minimum radius of 1,637ft. the towers are placed 50ft. apart, with a change in the direction of not more than 10deg. at each tower. With wider radii the length of span is increased, being, for instance, 232ft. with a 3deg. angle between the wires, and 300ft. when the degree of change is one half. The longest span is one of 625ft., where a deep gorge has to be crossed at Twelve Mile Creek in the Erie Plateau. As regards the towers themselves, they are 46ft. from the foot to the top of the lower insulators and 51ft. 3in. to the tops of the higher insulators. The lower 6ft. of the tower is embedded in the ground, so that the insulators are respectively 40ft. and 45ft. 3in. above the ground level. The erection of these towers has been carefully thought out and the cost reduced to the lowest

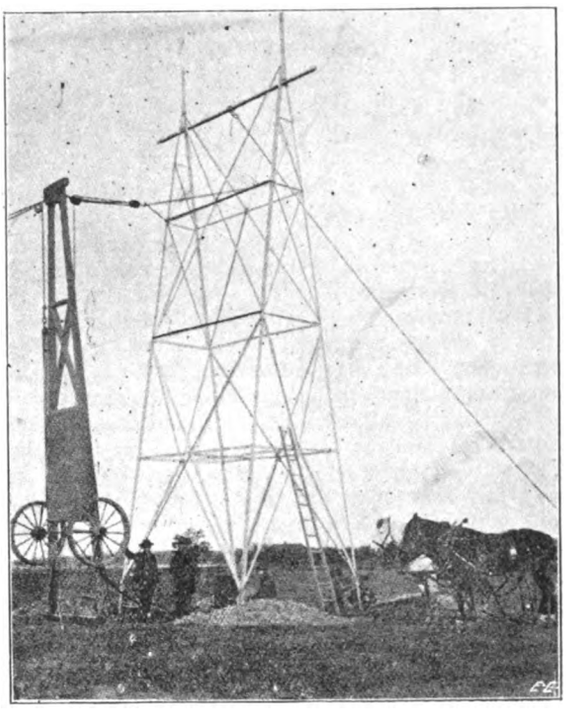

figure possible by the method shown in the accompanying illustration, which we reproduce from the *Electrical World* of New York. Each tower is brought to the place where it is to stand with all of its parts assembled, save that the extensions of the legs that go into the ground are detached. These extension pieces are first fixed in the ground with their ends projected to receive the legs of the tower. For hauling the towers a four-wheel wagon with a timber body about 30ft. long is used. When it is desired to raise a tower, two of the wheels with their axle are detached from the timber body of the wagon, and this body is then stood on end to serve as a sort of derrick. This derrick is guyed at its top on the side away from the tower, and a set of blocks and tackle is then connected to the top of the derrick and to the tower at a point about one-fourth of the distance down from its top. A rope from this set of blocks runs through a single block fixed to the base of the derrick, and then to a team of horses. On driving these horses away from the derrick, the steel tower is gradually raised on the two legs of one of its rectangular sides until it comes to a vertical position. The next operation is to bring the legs of the tower into contact with the extension pieces that are fixed in the earth, and then bolt them together.

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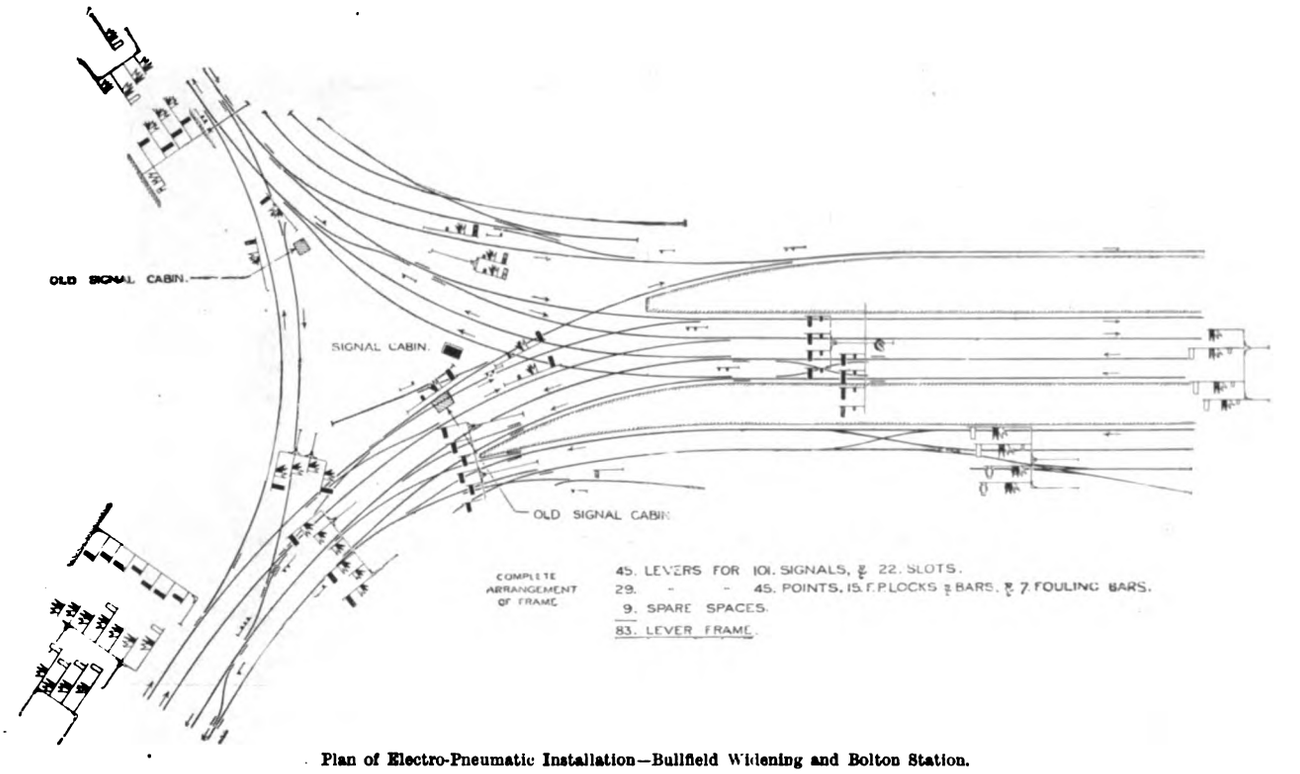
LANCASHIRE AND YORKSHIRE RAILWAY—BULLFIELD WIDENING: BOLTON.

BY VERAX.

About 64 years ago railway communication was opened through Bullfield tunnel, and during the intervening years three notable improvements have been effected. First, the main lines between Bullfield and Lostock were duplicated, whence traffic to and from Blackpool, Liverpool, or Southport could be dispatched henceforth along parallel tracks for a distance of three miles instead of being blocked outside Lostock Junction. The second distinct improvement occurred about 18 months ago, when Bolton new station, commanding the eastern entrance of Bullfield, was finished; and the splendid accommodation consequent upon the remodelling and widening of lines, marked an era in the railway affairs of this busy northern town. On the completion of the alterations before mentioned, Bullfield resembled a "bottle neck," in the sense that trains were frequently cooped inside or delayed outside the tunnel in the height of the holiday season. This serious disability will be removed on Sunday, July 16, 1905, when fast lines will be opened coincident with the demolition of the tunnel roof above the old main line, thus concluding the third and final improvement. The application of electricity for expediting and more safely controlling the traffic at Bullfield is hereafter described, and though we still hear the hackneyed phrase "electricity is only in its infancy," the readers of the *Electrical Engineer* need scarcely reminding that on a railroad, as elsewhere, electricity has passed its infantile stage; it has acquired a vigorous and fully-developed youth.



Plan of Electro-Pneumatic Installation—Bullfield Widening and Bolton Station.

Electric Signal Lamps.—It is a general aphorism amongst engine-drivers that nowhere on the line are more satisfactory signals displayed than at Bolton. This consensus of opinion is doubtless due to (*a*) the system of lighting and (*b*) the method of signalling. Some particulars of the former are here given, and reference to the latter will be considered later on under the heading of "Electro-Pneumatics." The lantern behind the red and green spectacles is fitted, inside the lid, with a hard-wood patras, from the centre of which is suspended a flexible twin cord—$^{35}/_{40}$ gauge—and a 5 c.p. 220-volt incandescent lamp connected thereto. The object of providing a short flexible cord is to protect the lamp filament from rupture when high winds are prevalent, because signal posts are subject to oscillation at such times, notwithstanding that a plentiful supply of guy wires are fixed at the resultant points. In our illustration (Fig. 1) two groups of signals are distinctly visible near the façade of Newport-street Bridge, and a somewhat similar set of semaphores are fixed at the opposite end of Bullfield. All these are electrically lighted from a pair of wires led through suitable fuses to the main switch in the signal box. It happens, however, that midway between the east and west ends there are several home signals and ground discs for the protection of numerous facing and trailing points and a cross-over road respectively; but what with grimy surroundings and high walls on either side, the efficient lighting of the signals in question required special consideration, as it would be obviously a waste of electrical energy to illuminate *all* the lamps at one moment irrespective of varying conditions. Consequently a simple rearrangement was made whereby these dozen or so lights could be left burning an hour or two longer in the morning and switched on a little earlier in the evening, independent of the remaining 700 lamps on the installation. Herein lies the advantage of electric signal lighting over other forms of illumination. Not only is it of value to be able temporarily to "light up" when the gloom preceding a thunderstorm manifests itself, but those of our readers familiar with railway work will be aware that industrial sidings, shunting necks, and carriage loops are sometimes closed for a period of four or five hours during the night, and hence, with the provision of an additional switch manipulated at the signal cabin with discretion, current can be economised with *safety*. This idea is scarcely practicable with a gas or oil system, for it is a moot point whether the cost of retaining a lampman on duty to extinguish and relight odd groups of signals would not more than counter-balance the price of gas consumed or of oil wasted. The farthest signal remote from the railway company's power-house is approximately 800 yards. Allowing for a fall of five volts at the end of the circuit, we have a system of lighting superior in brilliance to either gas or oil—a light which is not liable to be extinguished by the severity of a gale, nor the lens of the lantern obscured through smoky lampwick.

Track Circuits.—Rail treadles have rendered excellent service in past years, and even yet have a range of usefulness under certain definite conditions, but they have been superseded at Bullfield by track circuits, which perform a similar function in a more effectual manner. A treadle is an apparatus fixed to the rail itself, and actuated by the depression of the rail caused by the weight of a train passing over the spot where the treadle is fixed. This depression is utilised to complete an electrical circuit which rings a warning bell and simultaneously operates a visual indicator. It will only protect a limited distance, not ex-

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ceeding one rail length, whereas a track circuit can be made to isolate a section 400 yards long quite as easily as four yards, and *vice versâ*. Lieut.-Colonel Yorke, R E, in his report on

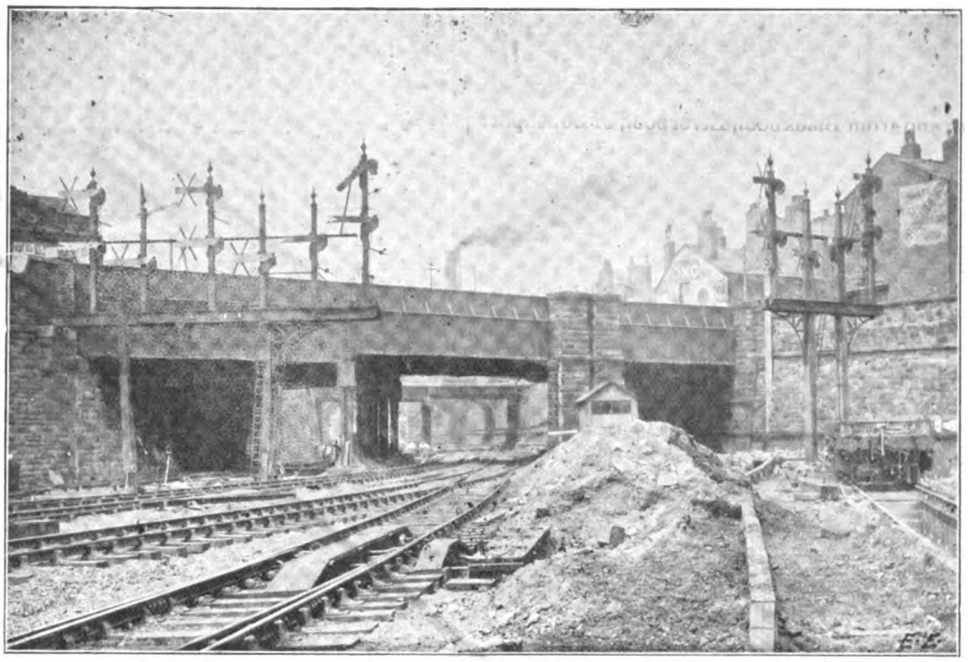

FIG. 1.—Signals commanding the entrance to Bullfield—Electrically lighted and Electro-Pneumatically operated.

a visit to America, addressed to the President of the Board of Trade—which report, by the way, was presented to both Houses of Parliament by command of his Majesty—observed that "track" circuits were extensively used in

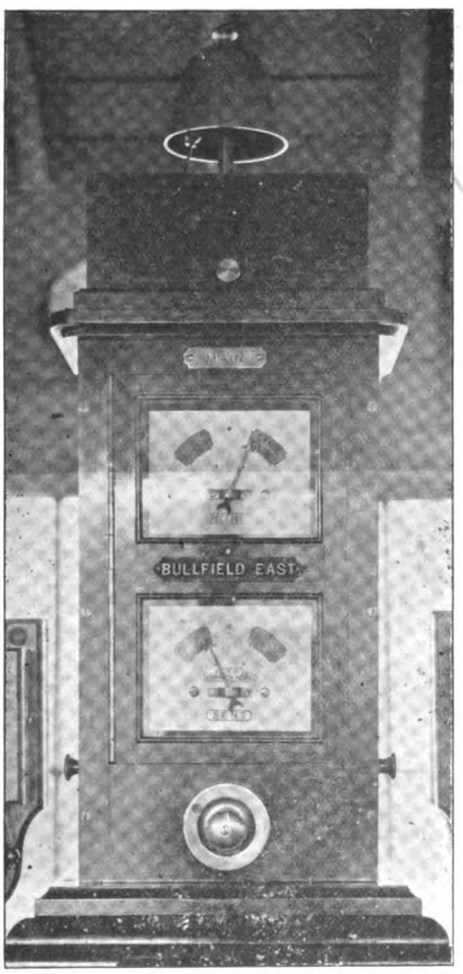

FIG. 2.—Standard Block Telegraph Apparatus, L. and Y. Railway.

the United States, and the account which that distinguished officer gave of this system is reproduced below in a brief paragraph at once cogent and explanatory: "The most modern and satisfactory mode . . . is by means of a 'track' circuit. A low-tension current flows from a battery along one rail of the track through a relay and back to the battery along the second rail. The relay makes and breaks a local circuit which controls the electric mechanism, or whatever it may be, for operating the indicator. When the current is flowing along the line, the relay completes the local circuit, and the indicator is held off. When, however, an engine or vehicle with metal wheel and axles is in the section, a short-circuit is established in the track circuit, the relay becomes inoperative, the local circuit is broken, and the indicator returns to danger." Insulated rail joints are fixed at each end of the track, and all intermediate joints are bonded to maintain good electrical continuity. In actual practice a battery of the "gravity" type has proved the most reliable for this class of work, though there was a tendency for the electrolyte to freeze in the depth of winter and thus crack the glass cell. This difficulty was surmounted by dispensing with the glass cell altogether, and a substantial teak box, dove-tailed and coated inside with marine glue, has been adopted in lieu thereof. Instead of burying the battery in a well below frost line, according to American practice, it is now placed in a wainscoted sawdust-lined cupboard 2ft. 6in. above ground, and no failure has since occurred from atmospheric causes.

Block Telegraph Apparatus.—In the accompanying illustration (Fig. 2) a combination bell and double needle telltale instrument is shown which controls the main fast lines between Bullfield and Bolton, a similar set regulating the slow line traffic. This instrument was standardised several years ago, and has undergone no modification since that time, for the simple yet sufficient reason that it combines simplicity with reliability. Where economy in shelf accommodation is not a desideratum, the block bell is always placed alongside instead of above the double-dial apparatus. The down line block needle in the top dial is actuated by the signalman at Bullfield, whilst the lower or "up" line needle repeats each movement of the commutator from Bolton West box. The plunger or ringing key works through the centre of the commutator, engaging with a vertical steel line spring inside the instrument. One 10-cell Leclanché No. 2 battery suffices to ring the bell, and four similar sized cells are ample to bring the block needles right over to the stop pins. Formerly a cumbrous route of aerial telegraphs existed, but this has been replaced by a number of air-spaced dry-cored cables laid in pitch-pine troughing along the wall side. The multifarious purposes which these cables serve may be gathered from the fact that 70 stations or cabins are connected telephonically to the signalman at either end; that local telegraph circuits, slot indicators, and repeater wires pass along this route, besides leaving a moderate margin of Post Office wires, maintained by the

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railway company, whereon simplex, duplex, or quaduplex working is in full operation; and, furthermore, we understand that the introduction of superimposed telephone apparatus on these telegraph circuits is at present under consideration.

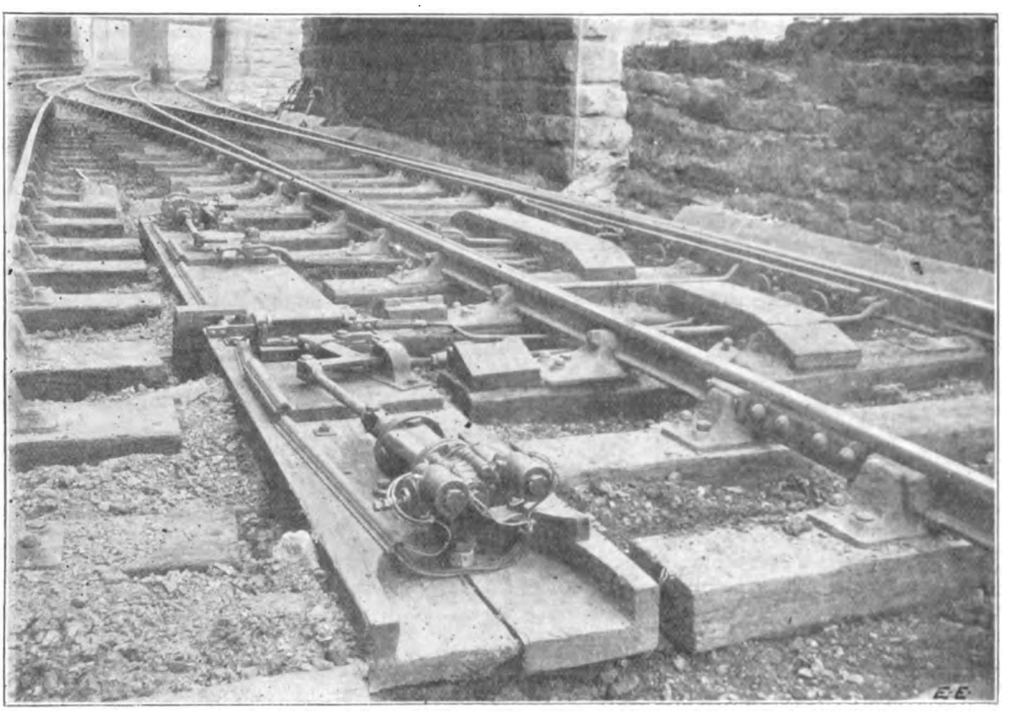

FIG. 3.—Cross-over Road Points worked by Electro-Pneumatic Power, Bullfield.

Electro-Pneumatic Signalling.—What is known in this country as the "manual" system of interlocking points and signals was in vogue along the entire length of Bullfield tunnel until about two years ago, when the whole of the mechanical appliances were scrapped, and concurrently a method of signalling was substituted on the "electro-pneumatic" principle. We have previously observed that fast lines will be opened on Sunday, the 16th inst. This new section has also been fitted with "electro-pneumatic" apparatus, and a feature worthy of note is the complete absence of signal wires, pulleys, stumps, and point rods throughout the installation—an item of moment to shunters. Engine-drivers are also satisfied with this form of signalling, because there are no "doubtful" semaphores to contend with. A signal arm must either stand at "danger" (90deg.) or "clear" (55deg.), and it is an electrical impossibility for an intermediate position to be displayed. Compressed air is utilised to actuate the points and signals, and it is the function of electricity to govern the inlet and exhaust valves of the air-cylinder by means of electro-magnets energised from the levers in the signal box. The combination is termed a motor, and such a piece of apparatus may be seen in the photograph reproduced in Fig. 3. Dry air, maintained at a pressure of 50lb per square inch in summer and 10lb. higher in winter, is transmitted through a 2in. iron pipe, and thence by branch connections to the auxiliary reservoirs located near each motor bed, where it is available as required. Current is derived from a battery of seven secondary cells joined in series, having a potential difference of 14 volts. There is an average consumption of one Board of Trade unit per day, and the fluctuation is very small at any season of the year. The reason of this will be obvious when it is explained that a current is always "to line" in the case of a point motor no matter whether the points are set in a "reverse" or "normal" position. This remark does not apply to signals because the electromagnet is only excited during the time the semaphore is held "off," and when the pointsman restores his lever to a normal or vertical position the electrical circuit is interrupted, the exhaust valve is opened, allowing the compressed air to escape from the motor cylinder, and the signal returns to danger by a counter-balance weight. The apparatus in the signal box is so contrived that the points are reversed by the first part of the stroke of the corresponding point lever in the locking frame, and when the point movement is complete, but not before, a return current from the points unlocks the point lever in the signal box, so that the signalman can only then complete its movement, and until this is done the levers operating signals in connection with those particular points cannot

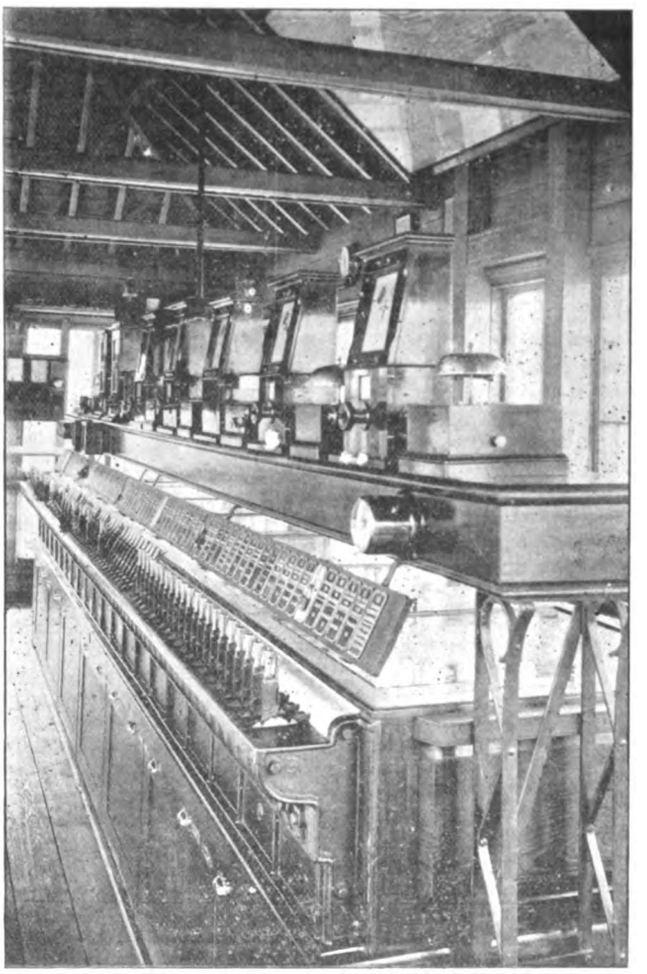

FIG. 4.—Interior of Bolton West Box.

be actuated. This is clearly a desirable safeguard, as the following incidents will show. On two occasions last winter the services of the lineman were requisitioned to attend a pair of points similar to those set forth in Fig. 3, the lever

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movement for which could not be completed. In other words, "no indication" had been received in the signal box to show that the points had been properly reversed. A cursory glance as to the cause of the trouble revealed an accumulation of snow wedged between the points, and communication could not be restored until the obstruction was removed. Before concluding this article, reference should be made to a novel arrangement adopted by the railway company at their generating station in connection with the air-compressors, which latter are situate near the dynamos and booster. The old cylindrical bellows for cleansing electric machinery has been discarded in favour of a long flexible tube connected to a cock on the air-main, whence dry air at 50lb. pressure is periodically blown through the armature windings. Electrostatic action has been responsible for an accumulation of dust particles in the neighbourhood of the positive 'bus bar, and also for a discoloration behind those switchboard panels of similar polarity. It was a difficult matter to satisfactorily remove this deposit of dirt from among the live mains until compressed air became available, but under existing conditions an occasional application of dry air never fails to produce excellent results. The most noticeable contrast, however, between the old and new systems of signalling is at the pointsman's cabin (*Fig.* 4), where the present levers measure 6in. as against 45in. in the manual system; and, what is of greater importance, the physical effort required to move an electro-pneumatic lever is practically "nil" compared with the former kind, which demanded an expenditure of muscular energy in proportion to the distance of the signals or points from the cabin levers, assuming, of course, proper lubrication of the working parts.

TROLLEY STANDARDS: THEIR LIABILITY TO BECOME DANGEROUS TO THE PUBLIC, AND SOME DEVICES FOR RENDERING THEM SAFE

BY P. J. PRINGLE.

There has always been a difference of opinion as to the means which should be taken, in the interests of public safety, for preventing or assisting to prevent the possibility of a shock being obtained from the upper deck of a tramcar fitted with a trolley standard. There are many ways in which the trolley standard can become alive. For example, a blow on the trolley head resulting in injury to the insulating bush, dampness getting into same, or the trolley cable getting frayed inside the standard and the insulation finally breaking down.

Elaborate precautions are, as a rule, taken in all parts of a tramway system to safeguard the public against the risk of a shock, but the danger existent with the trolley standard has to some extent been neglected. The voltage which the trolley standard may get above earth may be anything up to the full voltage on the line, but as a rule, if the initial fault is a slight one, it very soon develops until the trolley standard is at full line potential. The top deck handrailing is, or should be, always earthed. It is very easy for a passenger to grip both it and the trolley standard at the same time. The iron legs of the seats are often in contact with the standard supporting the handrailing, and a person's foot may be placed on same while contact is made with the standard. The inside legs of the seats in some constructions are in metallic contact with the outer legs just referred to, so that passengers in passing down the centre of the top deck may easily come in contact with these legs and the standard at the same time. Any of these conditions would result in a more or less bad shock, but should it be raining and passengers' boots wet the dangerous area is increased.

From tests made between a "live" trolley standard and the metal leg of a seat (1¼in. away from handrail standard) there was a potential of 430 volts, and between the same and a metal plate, equivalent in area to that of two boots (3in. away from handrail standard and placed on the wood slats), there was a potential of 80 volts. If the metal plate was placed on the flat part of the roof (without slats), the potential was the same at 5in. distance. These potentials fall gradually, and at 2in. away from the trolley standard the potential was only 35 volts. These tests were made on the top deck thoroughly wet and on a 3ft. 6in. gauge car. Unless water can freely collect on the top deck, the potential, it will be noticed, rapidly falls off as one leaves the nearest earth connection, the handrail standard. The Board of Trade have realised this danger by requiring in their earlier regulations the fitting of ruby lamps in series with the standard and earth for approximately indicating if there is any potential on the standard. They are such firm believers in the principle of earthing to ensure absolute safety that no doubt they have considered the same principle would be best here; and the fact that they have not insisted on this is probably owing to the difficulties which might result from so doing.

The lamp method is only an approximate indication of danger, and may readily be unnoticed by the conductor or motorman for a considerable time. The revised Board of Trade regulations issued in January, 1905, require the following: "The trolley standard must be connected with earth by a low-resistance fuse or automatic switch, and the warning signal, when the fuse or switch opens, should be an electric bell." This certainly ensures that the danger shall be immediately notified, owing to the signal being audible instead of visual. At the same time, if the conductor has his car full of passengers, however smart he may be, some few seconds must elapse before the trolley can be pulled off the wire and safety ensured. One of the devices in use is the placing of a fuse in parallel with the ruby lamps, so that normally the standard is directly earthed. On the standard becoming alive, the fuse is blown and the lamps are illuminated. In another the fusing of the fuse or the operating of an automatic switch or circuit breaker may ring a bell. Another supplements this by the automatic renewal again of the earth connection by means of a switch.

The defect which would seem common to these is that the standard is earthed, and, therefore, safe as long as it has no potential on it, but immediately there is leakage sufficient to operate the fuse or automatic switch, this safeguard is removed. In the last case referred to above this removal is only for a very short instant of time, as the earth is again renewed, but it is feasible to assume that a serious shock might be obtained under these conditions. Fuses are not desirable, and have been known when working under the conditions indicated above to give a good deal of trouble. There is always a possibility that the renewing of them may be overlooked when repairing the fault. Earthing the standard, with no fuse, automatic switch, or other device in circuit, *ensures absolute safety under all conditions*, and it is only necessary to consider how this can be arranged so that the traffic and power supply conditions on the average tramway system can be met.

In some cases the trolley has been directly earthed by a continuous cable, but serious traffic difficulties have resulted from this, owing to the impossibility of bringing the car to depôt and the requisitioning of another car for this purpose. In other cases a switch has been inserted or the cable has been pulled out at the terminal to allow the car to be driven to depôt, but these arrangements are somewhat crude. If earthing the standard is to be thoroughly and efficiently carried out, the following conditions must be complied with: (1) that it is not possible for the earthing arrangement to be interfered with or removed, excepting by those authorised to do so; (2) that the earth can only be removed after danger has been declared, and not before; (3) that if the earth is removed, warning, both audible and visual, should be given; (4) that it should be impossible for the danger signal or sign to be set to safety without the earth being automatically renewed, as the omission of this important point would be serious; (5) that the leakage of a few amperes up to any current which would pass on a dead short, should operate the indicating device equally as well; (6) that it is impossible to disconnect the earth as long as any current is passing by the earth-wire. If the above combination can be obtained, it should be possible for the direct earthing of the standard to be carried out without any wilful or careless mistake being made in its operation, and traffic and power supply conditions not seriously interfered with.

On the Burton-on-Trent Corporation tramways, with

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which the writer is connected, the usual ruby lamps are fitted, and while fully in sympathy with the improved regulations of the Board of Trade to ensure a more reliable indication of danger, he feels that, when meeting these requirements, they might with advantage be supplemented to give increased safety. The illustrations (Figs. 1, 2, and 3) show the device designed by the writer to fully comply with the conditions referred to above. The indicating and

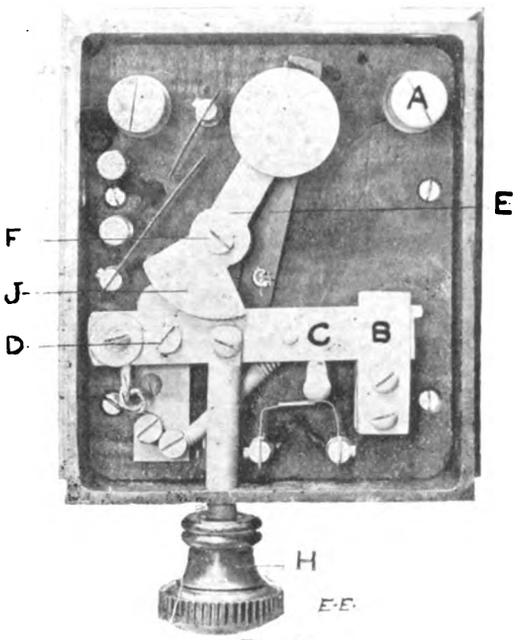

Fig. 1.

earthing apparatus is entirely enclosed in a cast-iron box, and the lid of same can be screwed down or locked if desired. The oval window shown in the cover permits a red danger flag to be shown when the apparatus is at half and also full cock. The earthing lead on the trolley standard is taken to the terminal, A, which is in connection with the switch contact, B The switchblade, C, pivoted on the screw, D, is directly connected to earth

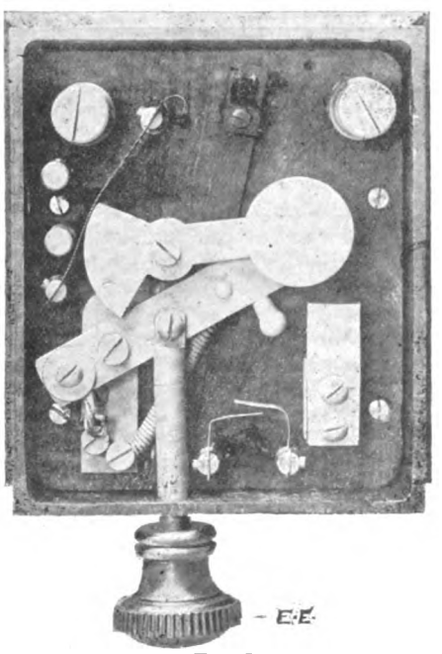

Fig. 2.

through a solenoid attached to the back of the baseboard shown. E is the indicating lever pivoted at F, fitted at its lower end with a segment piece, and at its upper end with an indicating red flag and a catch-piece which engages in the armature, G. The solenoid is wound round an iron core and G is attached to its lower end, the upper end being normally a short distance away from the pole-piece. When the indicating lever is in the position shown in the illustration, the segment piece, J, locks any movement of the earth-switch handle, H, making it impossible for the earth switch to be opened. Should a leakage develop in the trolley standard, and a small current such as three or four amperes pass to earth, this is sufficient to attract the armature, G, and release the indicator lever, E, so that it falls into a half-cock position. It is held there so long as the current continues to pass through the solenoid. When in this position, the segment, J, still continues to lock the switch handle, H, otherwise it would be possible to open the earth switch in error before the trolley is removed from the wire, with risk of danger to passengers and damage to the apparatus. As soon as the indicator lever has got to the half-cock position, the red disc becomes visible, and the two contact springs to the left of the indicator lever are brought into contact and ring either the electric car bell or a supplementary one. On the conductor removing the trolley from the trolley wire, the armature, G, regains its normal position and the indicator lever falls to full cock, the bell circuit continuing to be rung.

The interlock is now taken off the handle, H, and the earth switch can be opened. On opening the switch sufficiently far, the catch-piece at the end of the blade interlocks with the fallen indicator and is held there (Fig. 2). The opening of this switch breaks the bell circuit, but the indicator flag still shows "danger." If desired, a ruby lamp can, of course, supplement the danger indication. Once the handle, H, has been pushed up, the

Fig. 3.

earth switch is locked in the open position with the indicator at danger, and neither can be interfered with until the car has returned to depôt for repairs. On the repair being undertaken, and it is desired to remove the danger indication, all that is necessary is for the indicator lever to be pushed into its normal position, as shown in the illustration, when it is interlocked again by the armature piece. The action of moving this lever releases the earth switch blade, and a spring automatically pulls it into its normal position, causing the earth connection to be again renewed. The earth switch handle, H, is always at earth potential, the only part of the device having any potential when a leakage occurs being the switch contact, B. In the event of the fault being a comparatively small one, this usually develops quickly into a dead short, or the initial fault may be a dead short. When this is so the circuit breaker or breakers supplying the section on which the car is become operated, the solenoid demagnetised, and the indicator lever falls straightway to its full-cock position, the cycle of actions and operations being the same as before. The solenoid in an earthing device suited to the Burton-on-Trent tramways will operate with a leakage current of three to four amperes, and carry a short-circuit discharge current of 1,500 amperes.

The usual custom when a trolley standard has become alive, is to clear the top deck and proceed with the journey as far as is necessary and then return to depôt. It is always possible under these conditions for a passenger to

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ascend the top deck while the conductor's attention is withdrawn. To avoid this possibility, the writer has devised in connection with the above apparatus the use of chains or bars at the bottom of both staircases to prevent access to the top deck. Arranged in conjunction with each of these chains or bars will be a contact normally closed and in parallel with the bell operating contacts connected with the earthing switchblade. With this arrangement the bell would continue to ring until both exits had been barred, the action of placing the chain or bar across causing the bell contacts to become opened. Should the earth switch be opened before the exits are barred, the alarm would still continue to ring, drawing the attention of the car attendant to this omission.

Many of those responsible for the management of tramways do not fully realise the latent danger connected with the trolley standard; that this exists there is not the shadow of a doubt, and when evidenced by the presence of 500 volts, past experience as to what this voltage can effect renders the points one which can no longer be safely ignored.

The simple device herewith described should, therefore, appeal to those whose desire is to promote the efficiency of their system, to study the public safety, and at the same time their own interests.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

Thirteenth Annual Meeting—Dortmund and Essen.

[FROM OUR SPECIAL CORRESPONDENT]

(*Continued from page 916, Vol. XXXV.*)

The reading of reports drawn up by the various committees is always more or less tedious except to those immediately concerned, but that business through, the remaining time is generally available for papers and discussion thereon. Not so, however, on this occasion, since a second rigmarole of welcoming speeches had to be gone through when the time arrived to meet in the Krupp-Saal of the Städtischer Saalbau, Essen, on the third day. What was said in the course of those speeches, though all very nice, need not be repeated here. The next real business was to confirm certain recommendations by the council in regard to the constitution of the Board. For the first time it was agreed to admit a member who is not an electrical engineer, but a solicitor. It is believed that benefit will be derived from this policy, since many legal questions crop up in connection with the work of the Verband, and professional advice thereon cannot fail to be of service. It was decided to accept an invitation from Stuttgart to hold the next annual meeting there. Then the president, Prof. Budde, expressed thanks to the general secretary in terms which reflected great personal appreciation of Dr. Kapp's services on behalf of the Verband during the past 11 years, and regret at his leaving them. Needless to say, these sentiments were heartily endorsed by the meeting.

It may be mentioned here that Herr G. Dettmar (formerly engineer to Messrs. Körting Bros., of Hanover, and more recently with the Lahmeyer A.G., of Frankfort) has been appointed to take over Dr. Kapp's duties as secretary to the Verband. It is well known that the editorship of the *Elektrotechnische Zeitschrift* was included in Dr. Kapp's work, but with the new arrangement this dual capacity attaching to the office ceases, I understand.

The reading and discussion of papers followed, varied by visits to works, a whole day being spent in doing the round of Krupp's large establishment. That was Wednesday. On the fifth and last day of the meeting, back in Dortmund, the programme of papers was resumed. Special reference may be made to one by Herr E. Ziehl on "Double-Field Generators for Single and Polyphase Currents." It described at some length a new form of alternator of which the Berliner Maschinenbau A.-G. have already made several examples. In construction the machine very closely resembles an ordinary slip-ring induction motor or asynchronous generator, but its method of operation is quite distinct from that of the latter. The name "double-field generator" has been selected because instead of one part—either rotor or stator—being solely employed in magnetisation, as has been the case in all electrical generators hitherto, both rotor and stator windings take part in the generation of the output current, and each of these windings, considered alone, therefore produces a field of its own. If the stator terminals of an ordinary three-phase induction motor are connected to an alternating supply, whilst the rotor is on open circuit, a current will flow so as to produce a rotating field which will set up the necessary back voltage nearly equal to the supply voltage, and also so as to supply the iron losses due to this rotating flux. Alternating voltages of the same periodicity as that of the supply are also set up in the rotor, and if the rotor windings are closed through resistances currents will be set up, and an electrical transformation of energy will take place just as in the case of a static transformer. If the rotor is set in motion mechanically, the rotor periodicity would either increase or decrease, according as the direction of rotation is against or with that of the rotating field. Thus, as the speed is increased from zero to synchronous speed—*e.g.*, 1,500 r.p.m. in the case of a four-pole motor with 50 ~ supply—in the *same* direction as the rotating field the periodicity of the rotor currents will fall from the periodicity of the supply to 0. If the speed is increased still more in the same direction, the rotor periodicity increases again until, when the rotor

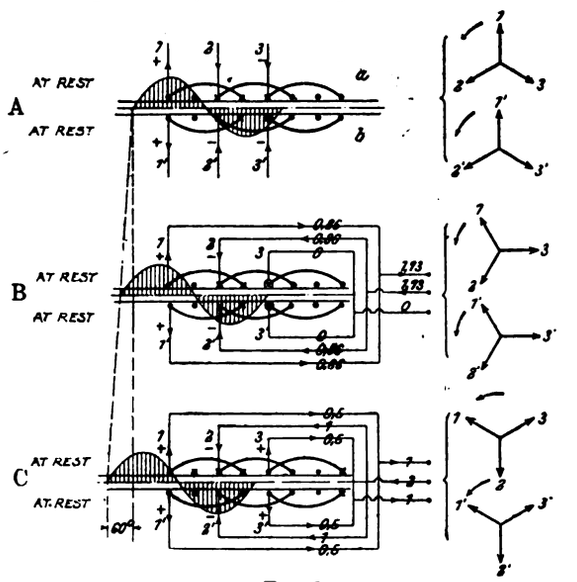

FIG. 1.

is running at double the speed of the rotating field and in the same direction as the latter, the rotor periodicity is again equal to that of the stator. Under these conditions the machine is acting partly as a transformer and partly as a generator of electrical energy, and since the frequencies in rotor and stator are alike, the attempt to make both participate in the generation of the current is at once suggested, and this suggestion forms the basis of the new generators.

In Fig. 1 *a* and *b* represent portions of the stator and rotor windings of a three-phase machine, and the stator winding, 1, 2, 3, is assumed to be equal to the rotor winding, 1′, 2′, 3′. Suppose, first, that both stator and rotor are at rest, and that in some way a rotating field moving from right to left is set up in the machine. At the instant when this field is represented by the shaded area in Fig. 1A the currents in rotor and stator will be as indicated by the dots and crosses shown, and, assuming sine wave currents, they may also be represented by the vector diagrams at the side, the upper one being for the stator and the lower one for the rotor. The currents in phases 1 and 1′, 2 and 2′, 3 and 3′ are in each case equal in amount and the same in direction; they are in phase, and rotor and stator can, therefore, be connected either in parallel or in series. In Fig. 1B, which represents the conditions after the rotating field has moved on 30deg., the phases are shown connected in parallel. Fig. 1C shows the effect of a further movement of 30deg., and it is clear that the two sets of windings behave exactly like two transformers connected in parallel.

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Suppose, next, that the rotating field is produced in some way in the rotor and moves from right to left as before, but that the rotor itself is mechanically rotated in the opposite direction (left to right) at a speed which is double that of the rotating field. The stator windings will now be cut by a field rotating in the opposite direction from that shown in Fig. 1, but at the same speed as before, so that the E.M.F.'s induced in them, whilst remaining of the same amount, will be opposite in direction. The rotor windings, however, will still be cut by the same field, both as regards speed and direction, as in Fig. 1. Fig. 2 represents the new condition. Fig. 2B indicates the instant when the rotating field has moved 30deg. to the left, whilst the rotor, as a whole, has moved 60deg. to the right, producing 30deg. phase change both in the stator and in the rotor windings. The direction of rotation of the stator vector diagram is, however, reversed relatively to Fig. 1, whilst the rotor diagram remains unchanged. If the two sets of windings are again to be connected in parallel, it will be necessary (1) to interchange two of the phases of one of the windings in order to retain the correct phase equality at the junction points; and (2) also completely to reverse one of the two windings—stator or rotor—because the direction of field rotation relatively to the stator windings has been reversed.

In Fig. 2B the phases are shown connected together in this corrected manner. The rotor phases have been reversed,

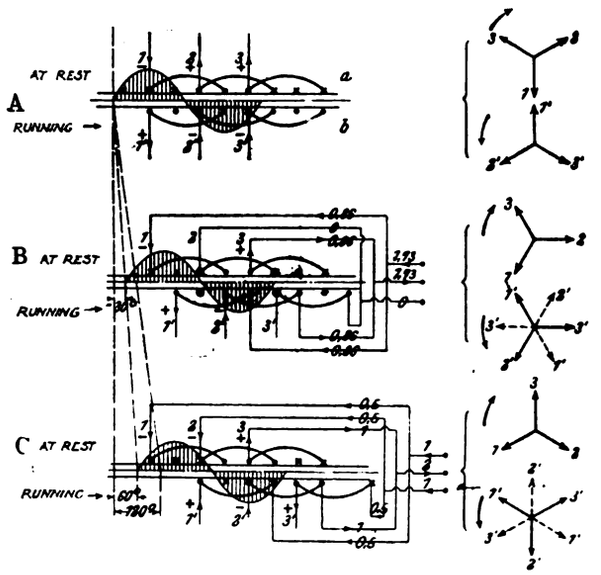

FIG. 2.

and stator phases 2 and 3 interchanged. The reversal of the rotor phases is shown by the dotted vectors. With these alterations it is clear from Figs. 2B and 2C that the two windings will theoretically again work perfectly satisfactorily together. A further interesting result is noticeable if the dots and crosses are compared in Fig. 1 and Fig. 2—viz, that in the latter case at every instant the currents on the stator are exactly equal and opposite to the corresponding rotor currents. In other words, the currents in the two windings will have no effect on the working field which passes through both in common, and there will be no armature reaction. The machine is, therefore, a compensated one, and the compensation is inherent, not artificial, as in the case of the usual type of compensated machine.

The above figures refer to a three-phase machine, but the same results, qualitatively, are obtained if a two-phase machine is considered, whilst in the case of a single-phase one (which is equivalent to Fig. 2 with phases 2 2′ and 3 3′ omitted), though the compensation is not quite complete, it is very nearly so. Under these circumstances the original rotating field would remain unaffected by armature reaction between no load and full load, and, except for the small ohmic and inductive drop in the windings, the machine would be self-regulating. The required rotating field, whose presence has been assumed above, can be introduced in various ways and will only necessitate the expenditure of a small amount of energy—viz, that corresponding to the losses which occur in an induction motor when standing still with the rotor on open circuit and the stator connected to the normal supply volts.

The most obvious way of setting up this rotating field would be to place a quite independent three-phase winding on either the stator or rotor, and to connect this to some independent three-phase supply so as to produce the field in the required position and direction. As can be seen from Fig. 1 and 2, at the instant when a particular phase has its maximum voltage, the centre of the rotating field pole must be 90deg. away from the centre of the coil of that phase, so that if the exciting energy is to come from

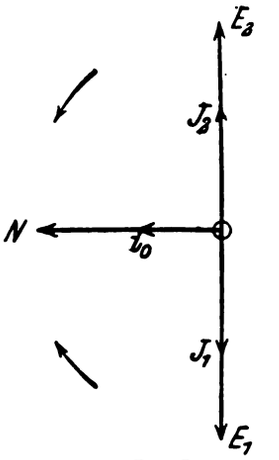

FIG. 3.

the same 'bus bars as those which the machine is to supply, it would be necessary to place the separate magnetising winding at 90deg. to the main windings, supposing that the current in the magnetising winding were in phase with the volts at its terminals. This last relation would, however, seldom exist, and as, moreover, a quite independent source of excitation has been assumed, the exact position of the exciting winding is not important, for the phase of the existing voltage would only have to be altered, so that with the particular position of exciting coils selected the required 90deg. phase difference between the field and the main winding shall be obtained.

The simple vector diagram of such a machine is shown in Fig. 3 for non inductive load and in Fig. 4 for inductive load. O N is the vector of the rotating field

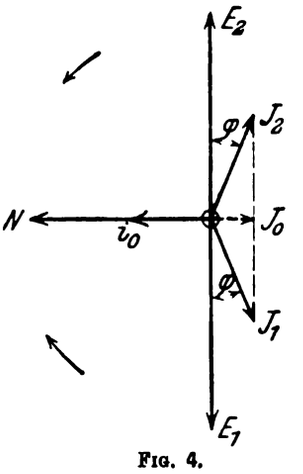

FIG. 4.

set up by the current O i_0 in a separate exciting winding. O E_1 is the induced voltage in the winding, 1′, 2′, 3′, lagging 90deg. behind the field, whilst O E_2 represents the E.M.F. induced in the other set of windings, 1, 2, 3, in opposition to O E_1, and also lagging 90deg. behind the field. The output currents are represented by O J_1 and O J_2. The two arrows indicate the opposite direction of rotation of the field relatively to the stator and rotor windings. If the numbers of turns in stator and rotor are alike, the values of O J_1 and O J_2 will also be equal. In the case of the inductive load (Fig. 4), with a lag of ϕ degrees between output current and voltage, it will be seen that the two currents are no longer in exact opposition, and so leave a

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net armature reaction tending to weaken the field. As however, this field is an alternating one, it will have to maintain its full value so long as it is supplied at a constant voltage, and it will do this automatically by means of an increase in magnetising current exactly equivalent to the weakening effect of the component O J_0 (Fig. 4). In this way, even with an inductive load, the effect of armature reaction is multiplied, and, in order to maintain a close voltage regulation, it is only necessary to reduce the self-induction (leakage) of the two windings by the same means as are employed in induction motor design. When the main windings are closed-circuit ones, it is possible to discard the additional exciting winding, and use the main winding both for generating and exciting purposes. This is shown in Fig. 5, where the thick circle

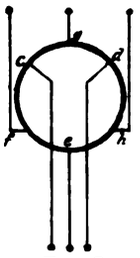

FIG. 5.

represents the closed winding on either rotor or stator with the main connections at *f g h*, and with the exciting current led in at points *c d e*, midway between the main connections. In some cases it may be worth while to produce half the excitation in the stator and half in the rotor, as this is quite possible and would tend to reduce the leakage.

All special provision for excitation (both separate windings and separate connections to the main winding) can, however, be omitted if the generator is used in parallel with one or more ordinary synchronous alternators to supply a circuit of definite voltage. The machine then acts like any other induction motor running at over synchronous speed, and takes its own exciting current automatically from the line. In fact, a "double-field generator" with a single stator and a single rotor winding used in parallel with other machines is little more than the ordinary asynchronous alternator, for in the latter it is always possible to transform up the rotor currents and use them in parallel or in series with the stator currents, or even to let the stator supply one circuit and the rotor another. The vector

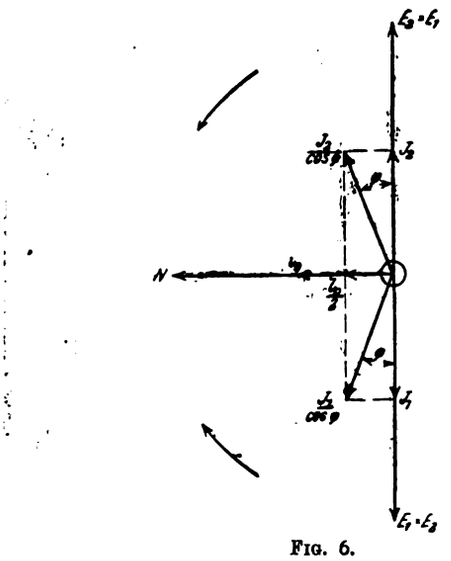

FIG. 6.

diagram of a double-field generator without separate excitation is shown in Fig. 6. Besides the load currents, J_2 and J_1, each winding (stator rotor) would have to take up a wattless current, $\frac{i_0}{2}$, equal to half the necessary magnetising current of the machine. The actual currents in the two windings would be the resultants of these two currents, and would equal $\frac{J_1}{\cos\phi}$ in the stator and $\frac{J_2}{\cos\phi}$ in the rotor, where ϕ is the angle of lag between the current and the terminal voltage in each case, and depends on i_0, or the magnetic resistance of the motor. This angle, it will be seen, is only half as great as it would be in the same machine used as an induction motor, because the stator only has to supply half the excitation. The power factor of such a generator would, therefore, always be very high. If the network on which such a generator is running is to supply an inductive load, the double-field generator would take no part in producing the necessary wattless currents. This machine would continue to supply $\frac{J_1}{\cos\phi} + \frac{J_2}{\cos\phi}$ amperes, whilst the wattless currents would have to be supplied from the network—*i.e.*, from any synchronous alternators with direct-current excitation or synchronous motors with direct-current excitation that may be on the same mains, and without at least one such machine the new generator without separate exciting circuit would be impossible.

Parallel Running.—There is no difficulty whatever about paralleling the new generators, for, if on closing the switches the phases are not correct, the effective self-induction of the two windings becomes very great, and the rotor is quickly dragged into the correct position relatively to the rotating field. Experiment has repeatedly proved this to be the case, insomuch that it is quite unnecessary to use any synchroniser. It is found sufficient if the two speeds are roughly alike as shown on a tachometer, and the machine

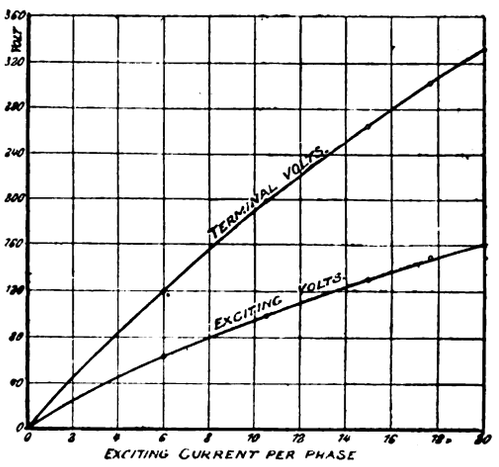

FIG. 7.

can then safely be switched direct on to the full supply voltage. When in parallel the new machines behave just like ordinary synchronous alternators, to which class they, of course, belong, seeing that they have to run absolutely synchronously. Every addition in load must be produced by a tendency on the part of the prime mover to increase the speed, and *vice versâ*, just as with ordinary alternators. If the prime mover runs too slowly, the generator becomes converted into a motor.

The properties of the new generators may be summed up as follows: In every case, whether one of the new machines is running alone or in parallel with others, and whether the excitation is produced by a separate winding or by the main windings, there must be some additional current source for the wattless currents of the machines themselves, and also for those of any other apparatus supplied from the same network. This current source may be: (1) a synchronous alternator with direct-current excitation coupled either electrically or mechanically with the double-field generators, and either taking part in supplying the load on the network or merely supplying the excitation of the double-field generators; or (2) a synchronous motor with direct-current excitation brought into synchronism with the double-field generators in some way, and then allowed to run freely in parallel with these; or (3) a combination of (1) and (2), or of (1) and (2) and a Heyland compensated and compounded asynchronous alternator, or the latter type of machine alone.

In the next place, the speed of these generators for a given number of poles and a given periodicity is double that of an ordinary alternator—*i.e.*, for a given periodicity and speed the new machines will have double as many

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poles as the ordinary machines. In some cases—*e.g*, in the case of steam turbine-driven alternators—this is an advantage, for it enables either higher speeds than hitherto to be employed, or, for a given speed and periodicity, it allows more poles and a consequently lighter construction to be used. Thus, for 50 ~ a two-pole double-field machine

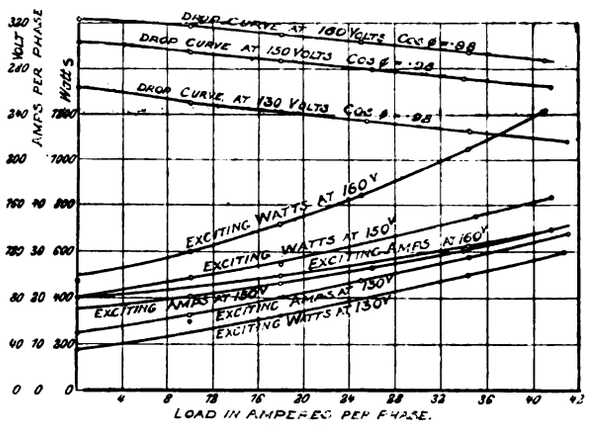

FIG. 8.

would have to run at 6,000 r.p.m. and a four-pole one at 3,000 r.p.m., instead of 3,000 and 1,500 revolutions as hitherto.

In conclusion, the results of some tests made on two of the new machines will be of interest. Figs. 7, 8, and 9 refer to tests on a 17·6 kilovolt-ampere, six-pole, double-field gene-

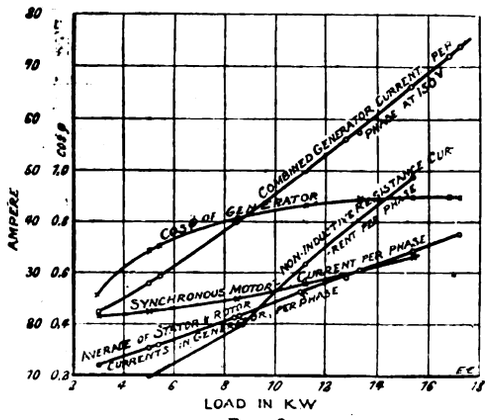

FIG. 9.

rator run at 1,600 r.p.m. and 40 ~, 300 volts, 30 amperes. This machine was built from the parts of a normal three-phase motor of 1,000 r.p.m., 50 ~, 190 volts. The rotor diameter was 300mm. and its breadth 130mm. The single air-gap was 1·25mm. Both rotor and stator had 54 slots (three per pole per phase). The rotor had 144 conductors per phase of 3·6mm. diameter wire, and the

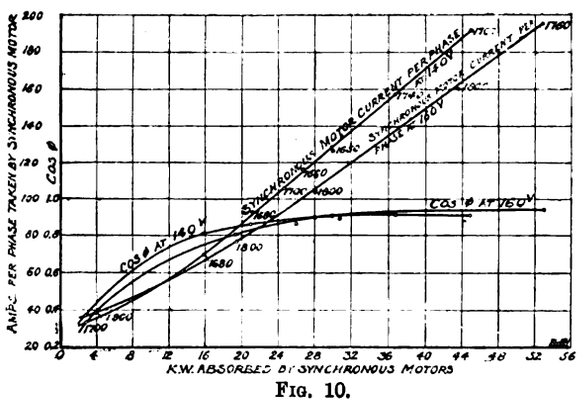

FIG. 10.

stator 141 conductors per phase of the same diameter. The exciting winding was arranged on the stator (which had enlarged slots for the purpose) at the side nearest the bore, and consisted of 141 conductors per phase of 1·8mm. diameter wire. For the tests in Figs. 7 and 8 the machine was driven by a synchronous motor, and the excitation was obtained from the same source as that supplying the synchronous motor. The main winding on the stator was connected in series with that on the rotor, so as to form a single star system. Fig. 7 shows the open circuit magnetisation curve, whilst Fig. 8 gives the voltage drop curves with various excitations, and also the curves showing the corresponding automatic increase in exciting current and exciting watts. This automatic increase is somewhat larger than would be expected, probably because the exciting winding was not quite symmetrically arranged, and gave rise to considerable leakage. The percentage magnetising current was also large owing to the large air-gap.

In Fig. 9 a test on the same generator is shown, but with the rotor and stator main windings connected in parallel for 150 volts, and with the exciting winding disconnected altogether. The generator was partly employed in driving a synchronous (direct-current excitation) motor which served to supply the wattless exciting current, and partly in supplying a non-inductive resistance load in parallel with the synchronous motor. Fig. 10 records some readings taken when the above generator and another larger generator of 32 kilovolt-amperes were running in parallel driving a synchronous motor which could be loaded up to any required extent by means of a direct-current dynamo coupled to it. The double-field generators were run at about 1,700 revolutions 42½ ~, and at 140 and 160 volts. The rotor and stator windings were in each case coupled in parallel, and no separate exciting winding was used. During the test first one machine and then the other was speeded up, and the load was transferred from one to the other. The various speeds measured are shown against the curves. In all cases both machines acted properly as generators.

(To be concluded.)

ELECTRIC TRAMWAY AND RAILWAY EXHIBITION.

(Continued from page 24.)

THE CALLENDER CABLE AND CONSTRUCTION COMPANY, LIMITED, have a splendid exhibit which well covers the wide range of cables and accessories manufactured by the firm. We noticed that there even was a tramway pole with section insulators. This was erected to show the method adopted by the company when connecting underground cables to trolley wires. The cables manufactured by this firm are so well known that a detailed description of the same would be redundant. The same cannot be said for the feeder pillars for lighting and traction work. These are exhibited in considerable variety, and special attention should be paid to the same. Amongst the most interesting is the combined distribution and transformer pillar of the type which has been supplied by the company to Hong-Kong. The pillar is made in three parts, the lower of which contains the sealing-in boxes into which the cables are led. In the next section both high and low tension fuses are placed. From these sealing-in boxes indiarubber insulating cables are taken up to the high and low tension 'bus bars in the middle section of the pillar. The high and low tension gears are carefully insulated the one from the other, and mechanically divided by an insulating shield. In the pillar we inspected there was quite a number of high-tension distributing cables provided for on the 'bus bars, which will be subjected to a working pressure of 3,000 volts. The sides of the pillar are hinged at the bottom edges, and their inner surfaces are lined with corrugated indiarubber. Thus, when the sides are let down, this rubber insulation can be stood upon, and it affords additional protection to the operators. The fuses in the high-tension connections are carried in tubes provided with the usual holes for extinguishing any arc formed. The contacts are also shielded with porcelain so as to prevent an arc striking across on to the iron framework of the pillar. The low-tension fuse gear is placed back-to-back with the high-tension distributing fuses. It is of the standard Callendar-Ward type, which is now well known. All the fittings in this pillar, and in others on the stand, are supported from the framework by two porcelain insulations. The third and upper section of the pillar is used to contain the transformer, and which can be as large

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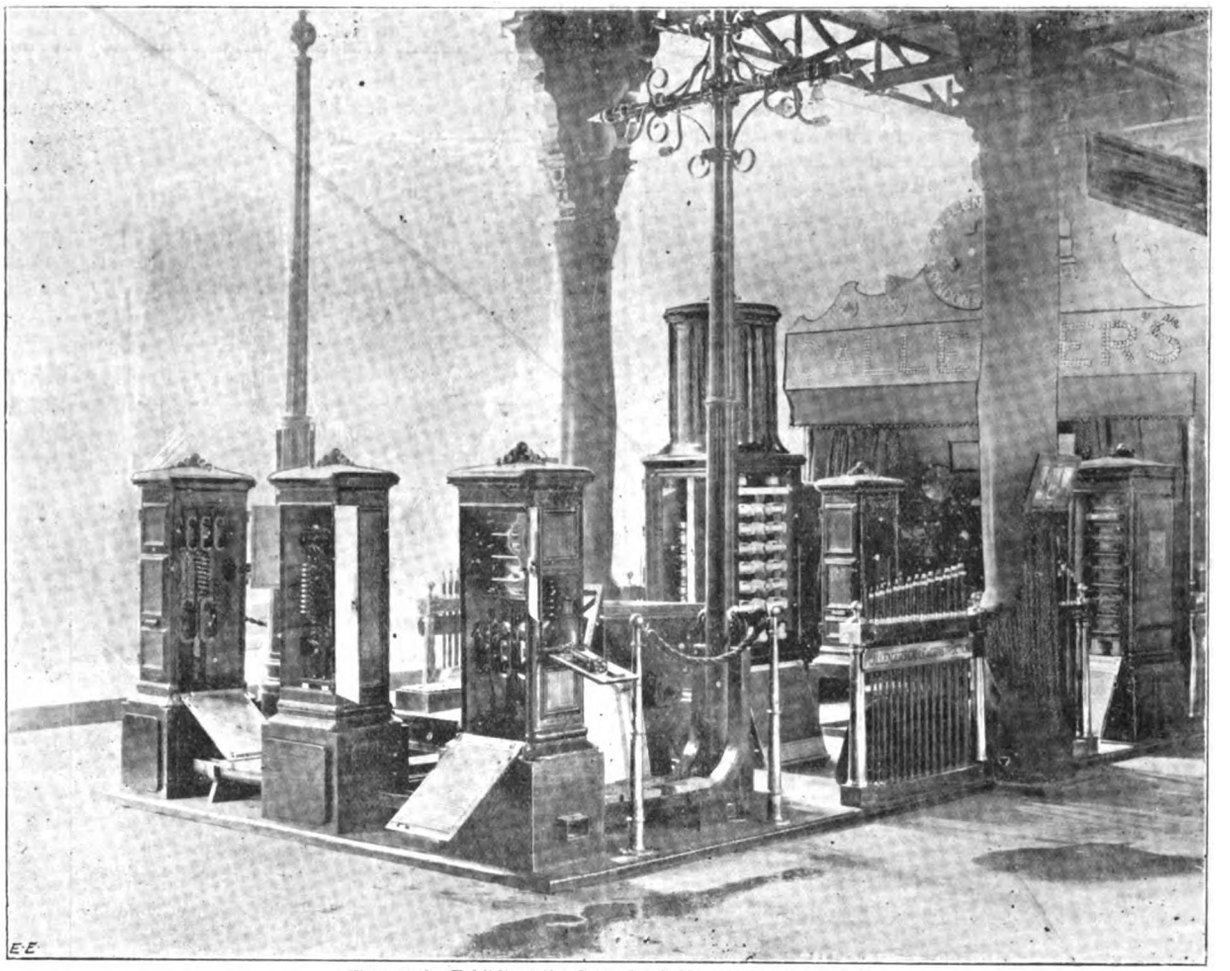
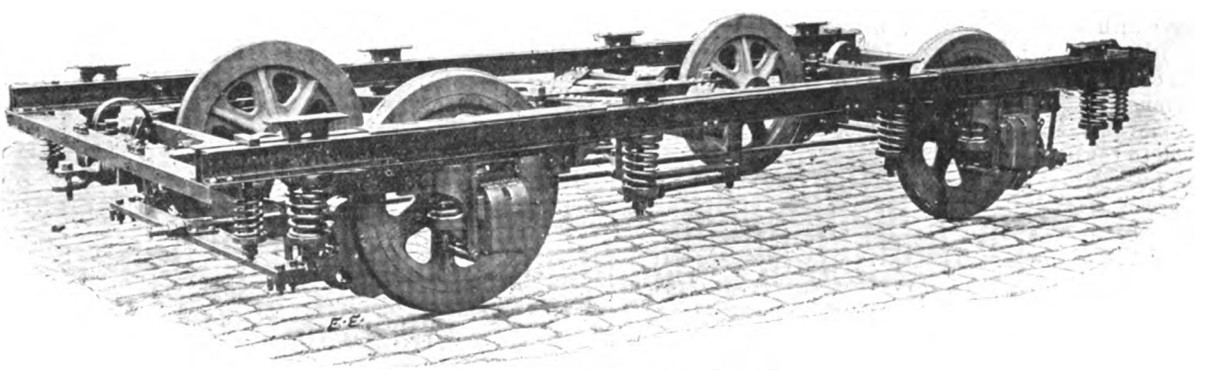
as 50 kw. Above this an arc lamp column can be carried if required. We also noticed one of the more recent forms of street boxes made by the company on the diving-bell principle. This was designed for a three-wire system, and fuses were provided in the outer conductors. Under each fuse a porcelain tray was arranged, which served a double purpose. It was so designed as to break up a band of molten fuse metal as it ascended. It also caught all of the metal, and prevented the same from being scattered over the surface of the sealing-in compound. At one end of the stand a full-size model of a tramway track to be worked on the surface system was shown to illustrate the laying of Callender cables on the solid system to such contacts. The stand itself, as shown in the photograph, was artificially fenced in by samples of cables of the great variety of types the firm have now on the market.



View of the Exhibit of the Callender Cable and Construction Co.

MESSRS. MOUNTAIN AND GIBSON, Elton Fold Works, Bury, are showing motor trucks, improved trolleys, etc., on Stand No. 24. Their "M.G." radial truck (illustrated herewith) is constructed in such a manner that the axles are free to take up independently positions radial to any curve which the truck may enter. Each of the axles is mounted in a separate sub-truck, free to pivot about a king-pin attached to the main frame of the truck, the weight being carried on eight hardened steel rollers, each of which is enclosed in a separate oil-bath, being mounted in gunmetal bearings. The sub-trucks are provided with horn blocks in which the axle boxes work in accordance with standard practice. The under side of the intermediate frame is provided with hardened steel rub-plates, bearing upon the rollers described above. The end sills of this intermediate frame are constructed of two channels with webs together stiffened over the axle boxes by means of H-section joists pressed on to them hot and then allowed to shrink. The car body is carried on eight or more spiral springs hung underneath the side sills of the intermediate frame with a view to reducing the total height of the truck. Each sub-truck is provided with a buffer arm, which bears against two strong buffer springs firmly attached to the end sills of the intermediate frame. In designing this truck, the principal aim had been to reduce the friction between the part that turns and the part that does not turn, and this has been achieved to a remarkable degree by means of the rollers which are mounted on the sub-trucks. The friction having been reduced to a minimum, it becomes possible to introduce buffer springs which are powerful enough to take up the shock experienced when a car meets a curve, thus saving considerable wear and tear on the flanges and rails and



Messrs. Mountain and Gibson's "M.G." Radial Truck.

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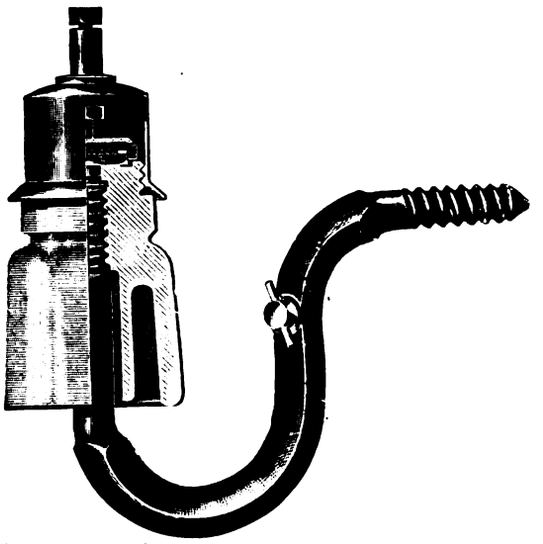
considerable inconvenience to the passengers. Beyond this, the general system of springing is designed in such a manner as to ensure easy riding both with the car empty and full, while the general construction of the truck is exceedingly stiff and strong, although simple and comparatively light. The sample exhibited is arranged as a trailer truck, being one of an order received from Messrs. G. C. Milnes, Voss, and Co. for shipment to Durban. The motor truck is very similar in design, excepting that the drawbar stays, being unnecessary, are cut out, and the motors are supported in the usual manner upon a transverse bar carried on springs supported by the end sills of the sub-trucks.

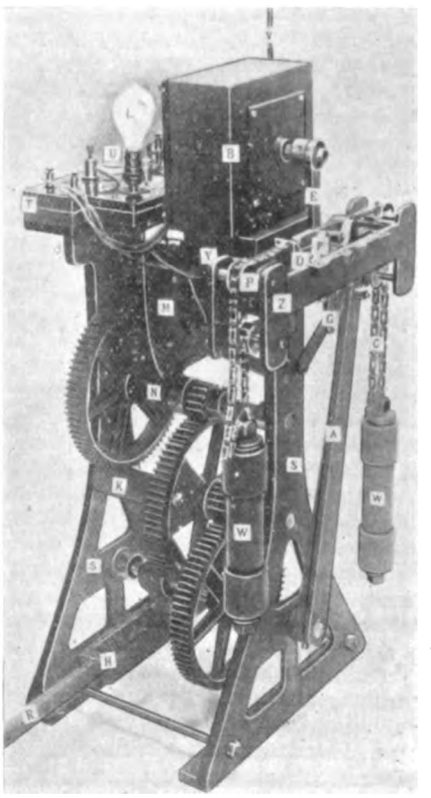
Amongst the exhibits of the BERLINER TELEPHONE COMPANY which we were unable to illustrate in our last week's issue is a combined lightning arrester and insulator for the terminal spans of telephone and electric traction lines. This is illustrated herewith. It will be seen that the arrester consists of two carbon discs, the surfaces of which are cut into V-shaped grooves, those on the lower disc lying at right angles to those on the upper. The discs are separated by a ring of mica. The whole is protected from the weather by a metal cap which screws home on to



Berliner Combined Terminal Insulator and Lightning Arrester.

an indiarubber ring, and ensures a perfectly watertight joint.

HADFIELD'S STEELFOUNDRY COMPANY, LIMITED Sheffield, make a good display with some of their specialities for tramway work, including improved patent points, 100ft., 200ft., and 250ft. radius, in best toughened cast steel with "Era" manganese steel inserts; and of solid construction in manganese steel, as supplied to the London County Council and other important corporations. These points can be supplied in any length up to 15ft., and are so designed that the tongues are of the maximum strength consistent with smooth running, inasmuch as they are the same width on the base for their full length. The box on the side of the point not only gives efficient drainage, but is so arranged that it is suitable for the mechanism of either a movable or an automatic point, and the conversion from one to the other can be performed in a few minutes without interfering with the track or interrupting the ordinary car service. A very interesting exhibit is a set of the company's steel-tyred car-wheels which gave a mileage of 79,680 on the Sheffield Corporation tramways before being taken out of active service. Each of these wheels is composed of a cast-steel centre, fitted with a special rolled-steel tyre. A working model of Le Rossignol's patent unbroken main-line cross-over, as adopted by the Newcastle Corporation, is included in the exhibit. This is an exceedingly simple device, and has given complete satisfaction in use we understand. But from an electrical point of view a more interesting item is Parr's patent automatic electrical point controller. This device, which we are able to illustrate herewith, is the invention of Mr. G. D. Aspinall Parr, M.Sc., M.I.E.E., etc., and has already been adopted on several large tramway systems. It is put into operation by the driver of any moving electric car or train simply actuating the ordinary motor controller employed by him in driving, and is not injuriously affected by damp, being a thorough engineering appliance, at once understood by any ordinary mechanic. Moreover, the point controller can be "set" so that the driver cannot operate and "take" his points above a certain prearranged car speed, and is unaffected in its action by a variation of 150 volts in 550 volts. The whole machine is mounted on two strong standards, S S, which carry an electromotor, M, capable of driving a train of spur gear wheels. The bottom shaft of this train actuates the rail point, the hauling rod, R, and link, H, also the conductor point in either underground conduit or surface systems, whilst by a flexible or other suitable hauling rope, V, it actuates the conductor point in overhead systems. The direction of rotation of the motor, M, and hence the position of the points, is controlled by a reversing switch fixed to the front of the box, B This switch is of simple construction, has an exceedingly quick break, and its spindle is actuated by the arm, E. This arm, E, is in turn actuated by a stout phosphor-bronze slider, D, which is worked by one or other of two falling weights, W W, attached to it by strong chains, C. The slider, which works



Parr's Automatic Electrical Point Controller.

on a guide bar, is caught and released by the plunger of a specially designed electromagnet, Y, and the arm, E, is controlled by a double-ended latch, F, itself released by an arm, G. The slider, its guide bar, the latch and pulleys, P, over which the chains roll, are all carried by the stout frame, Z. An arm, A, actuated by the bottom shaft, raises the weights, W, alternately, moving with the points from one side to the other. A terminal board, T, carrying the necessary terminals, fuse block, U, and lamp or other resistance, L, interconnects the reversing switch, motor, electromagnet, and source of supply. The box, B, contains nothing but the necessary spring for controlling the arm, E, while affording convenient bearings for the spindle of the switch. The motor, M, is of the enclosed type, with self-lubricating bearings, carbon brushes, and is non-sparking. It would be quite sufficient to oil this once a year, and other moving parts once a month. The machine is contained in a neat cast-iron street box, 19in. square by about the usual height of the ordinary street feeder box. This box is specially designed to enable the whole machine to be got at in less than half a minute, and the controller can, if necessary, be actuated from the

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outside of the box, in case the driver passes the overhead contact with current *off* or *on* when it should have been otherwise. A light contact is attached to the electrical conductor through the medium of which the auto-controller is operated.

(To be continued.)

SHEFFIELD UNIVERSITY.

The new buildings of this university were opened by the King on Wednesday last. They contain provision for the teaching of a wide range of technical subjects, including electrical engineering. The physical laboratories have a superficial area of 9,950 square feet, and are self-contained on three floors connected by a spiral staircase and apparatus lift; the rooms on each floor being arranged on either side of a central corridor except those on the lower ground floor, which, owing to the slope of the ground, are confined to the quadrangle front. Accommodation is provided for all the various departments of physics, except electrical engineering, which is housed in the buildings for applied science in St. George's-square.

The various laboratories and lecture-rooms are connected by air-insulated bare stretched copper wire to an exchange board on the middle floor, so that it is possible to connect any apparatus in one room with one in another, either for calibration, time signals, arbitrary E.M.F.'s, or similar purposes. An eight-volt circuit for galvanometer scale lamps is led round each room where such lamps are required. Two continuous circuits, each of 60 volts, and two alternating circuits of 200 volts, differing 90deg. in phase, are also laid down throughout the laboratories, the continuous circuit consisting of twisted twin cable. The alternating circuit is served from the Corporation mains.

The rooms in this department on the lower ground floor are the battery and dynamo rooms, the workshop, and a constant temperature room with double walls and ceiling. The battery-room contains two batteries of 32 L. 15 E.P.S. cells; in the dynamo-room is a Siemens dynamo, driven directly by a Thomson-Houston 7½-h.p. motor; also a Whitehead compressor and a Brin air-liquefying apparatus, driven by the same motor. The workshop, which comes next to the dynamo-room, is fitted with various lathes, etc., driven by a 1½-h.p. Thomson-Houston motor, from a shafting independent of the walls, the design being to equip it so that it may be used not only for the construction or repair of ordinary apparatus, but to manufacture special apparatus for purposes of research.

The upper ground floor is only a ground floor on the park or west side. On this side, going from north to south, are a large balance room for ordinary students, and a room, with north outlook, to be used for magnetic measurements. The room contains a standard clock, which is, for rating purposes, to be connected by an underground wire with the standard transit instrument in the park, presented to the university by Pembroke College, Cambridge.

The new buildings allotted to the engineering department consist of four floors; the lowest floor or basement contains a large extension of the original laboratories. The main engineering laboratory contains a plant which can be used both by mechanical and electrical engineering students; the equipment of this laboratory provides for an all-round training in the practical study of the leading types of prime movers, including steam, gas, and oil engines, air-compressors, and hydraulic machinery. There is also a very complete electrical equipment in the new building to demonstrate the applications of electricity to lighting, traction, and power transmission. The upper floors of this building are fitted up as administrative offices, lecture-rooms, and laboratories. The older part of the building contains all such appliances and machinery as are required for the training of mechanical, civil, and electrical engineers.

The King, replying to an address of welcome from the city, said: "I have great pleasure in receiving, on behalf of the Queen and myself, your loyal and dutiful address. We retain a pleasant recollection of our previous visit to Sheffield, and are glad to be present here to open the university buildings, and to inaugurate a work which I am well assured will tend to promote the advancement of knowledge and the spread of culture among all classes of my people in the city. I have no doubt that the establishment of the university in this large commercial centre will also afford facilities for the technical training which is now essential to success in every industrial enterprise. We shall follow the progress of the university with warm interest, and the welfare of your city will always be the subject of our sincere good wishes."

In reply to an address from the Chamber of Commerce, he said: "I feel assured that the establishment of the university in Sheffield will do much to foster that spirit of enterprise which has been so distinguished a characteristic of British commerce in the past, and to encourage the spread of that technical and scientific training which is more than ever necessary to enable this country to hold its place in the field of commerce amongst the nations of the world."

DARTFORD TRAMWAYS.

The ceremony of laying the first rails of the Dartford tramways took place on Wednesday last at the terminus of the Bexleyheath track, a number of guests being witnesses, at the invitation of the chairman of the Tramways Committee, Mr. S. K. Keyes. The event is noteworthy in that it marks gratifying progress with the time's requirements. In some districts inter-urban communication by tramways has been checked by petty jealousies between neighbouring authorities, but not so in the case under notice. When the Dartford tramways are complete, there will then remain but a short gap to break the continuity of track between Gravesend and London, a distance of over 20 miles, while the branch systems to the north and south will act as feeders to the main line of route. The Dartford tramways will link the existing track of the Bexleyheath Council with the Gravesend system. They will be of single-track construction with turnouts, the total length being about 8¾ miles. Messrs. J. G. White and Co., Limited, are the contractors for the whole of the track work, overhead equipment, and cars. The rails, to be laid on concrete, will be supplied by the North-Eastern Steel Company, all special track work being by Messrs. Hadfields Limited, and continuous rail joints are to be used. As regards the overhead work, chiefly bracket-arm construction with double trolley wires is to be employed. On the flat the track will be paved with Norwegian granite bordered with Guernsey granite in the town proper, while Welsh non-slippery granite will be used on the hills. The stiffest gradient is about 1 in 12. The contract for the cables has not yet been settled, but it may be mentioned that the feeders are to be laid solid under the footways. Additional plant is to be installed at the Urban District Council's existing electricity works to meet the requirements of the traction load. This plant will comprise a Lancashire boiler by Messrs. Ruston, Proctor, and Co., Limited, a 200-kw. Fowler generator coupled to a high-speed engine by Messrs. Browett, Lindley, and Co., Limited, an E.P.S. battery, a booster which will be supplied by the Lancashire Dynamo and Motor Company, Limited, and a Ferranti traction-type switchboard. The rolling-stock will comprise 12 cars of the double-deck type, each capable of seating 50 passengers. These cars are to be supplied under a sub-contract by Messrs. Dick, Kerr, and Co., Limited. They will be fitted with Westinghouse magnetic brakes. The Council have entered into a separate contract for the construction of car-sheds.

It remains to add that the Council have arranged to lease the tramways when completed to Messrs. J. G. White and Co., Limited, for five, ten, or fifteen years at the option of the Council, the company on their part guaranteeing interest and sinking fund on the capital outlay, in addition to 20 per cent. of any profit which may be made on the working of the system. Under their agreement the Council will supply current to the company on a sliding scale of 2d. for the first 100,000 units, 1¾d. for the next 50,000 units, and 1½d. for any excess, as metered at the station switchboard. The consulting work in connection with the scheme is in the capable hands of Messrs. Hawtayne and Zeden,

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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GLASGOW AND BOSTON TRAMWAYS.

Mr. Hayes Robbins has contributed a long article to the American *Journal of Sociology* on the question of municipal tramways. The author in this attempts to draw firm conclusions as to the relative efficiency of municipal and company mangement from a full comparison of the tramway systems in Glasgow and Boston respectively. The task would have been no light one had the two systems been in one country, as even then local conditions have to be allowed for when making comparisons. With two towns—one in Scotland and the other in the States—the figures are influenced by so many engineering and social differences that they can never be comparable. Still, the author has taken a great deal of trouble over the matter, and some of his points are worthy of consideration. They show clearly the great difference between the two systems. The Glasgow figures quoted are rather old, but this does not introduce any great error into the comparison. The author credits Glasgow with 139 miles of single track, with an average cost of £20,623 per mile. As against this the Boston Elevated Railway Company operates 440 miles of single track, on which the capital averages £22,000 per mile. This is said to show that the Boston company is not over-capitalised, but it does not indicate the well-known fact that the power station and plant of the Glasgow tramway department are very much larger than is required. The following averages as to the services rendered by the two systems are of interest:

"Glasgow has one mile of track for every 7,200 of population, in round numbers; Boston, one mile for every 2,270. The Glasgow system in 1902-3 carried 177,179,594 passengers; the Boston company carried about 236,000,000 paying passengers, of whom 130,000,000 used free transfers, making 366,000,000 separate trips furnished. The average daily traffic is: Glasgow, 485,000; Boston, 1,000,000. The Glasgow rolling-stock consists of about 680 cars of all kinds; the Boston company owns over 3,300. The average number of cars operated in one day in Glasgow is now about 450; in Boston, 1,300. Thus Boston operates one car for every 770 passengers carried each day; Glasgow, one car for every 1,077. This difference is reduced, however, by the fact that practically all the Glasgow cars are 'double-deckers,' seating from 50 to 55 passengers."

Such double-deck cars have not met with favour in the States. The author does not mention the passengers carried each year per mile of track, which works out to 1,275,000 in Glasgow as against 832,000 in Boston. The density of the traffic is thus quite 50 per cent. higher in Glasgow than in Boston, which speaks well for municipal organisation. The question of fares is also dealt with, and the author favours the American system of uniform charges almost irrespective of distance. He considers that our system prevents the spread of population into the rural areas. Be that as it may, the Boston public cannot ride anywhere for less than a twopence-halfpenny fare, whilst at Glasgow for the period in question 36 per cent. of the passengers paid one halfpenny only and 56 per cent. paid one penny. The remaining 8 per cent. paid more and rode further. The distances one can travel on the Glasgow tramways are less than those on the Boston system. Thus the most distant suburban point to which the Glasgow tramways extend is Paisley, 6·95 miles. To get there costs 3d., or 3½d. from the centre of the city The next farthest point is Clydebank, 6·39 miles, fare 3d Three other suburbs are between four and five miles, and one about three and a third. From Park-street Station, Boston, a passenger may ride 9·53 miles to Arlington Heights for 2½d., 9·83 miles to Charles River Bridge,

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8·23 miles to Arlington Centre, eight miles to Waverley, 7·9 miles to Melrose line, 7·36 miles to Milton, 7·3 miles to Neponset, 6·32 miles to Woodlawn, and 6·04 miles to Lake-street, and the uniform fare for any one of these journeys, or for any two of them in combination, through free transfer, is 2½d.

These figures are interesting, but any reduction in the fares for the long-distance journeys in Glasgow would only affect a very small proportion of the travelling public. On the other hand, the halfpenny fares and the longer penny stages provide travelling facilities which are universally enjoyed. Other parts of this article deal with the contributions to the public funds out of profits, the rates of wages paid to employés, etc. Mr. Robbins concludes that while public ownership and operation of street railways, under the favourable civic conditions of British municipalities, in most cases give a better and cheaper service than was afforded by the various private corporations it supplanted, even this improved service is relatively meagre in extent and usually of mediocre quality compared with American experience, and that the municipalised enterprises would break down entirely if subjected to any such tests as are commonly required under American conditions. In our opinion, the first conclusion is justified, and it would apply equally in the States if civic government there was purified. There is nothing in the figures to justify the second and third conclusions. It would seem rather that the Glasgow conditions provide a denser traffic than is found in Boston, and this is dealt with at fares which are not approached in the latter town. More useful comparison will be possible when Chicago figures under municipal management are available.

REVIEWS.

Elektrisch betriebene Strassenbahnen. Taschenbuch fuer deren Berechnung, etc. By S. HERZOG R. OLDENBOURG.

Engineering pocket-books have multiplied to such an extent of recent years and the treatment of the respective subjects differs so under the compilers, that it has become necessary to place these works in one or another of at least two categories according to the treatment. On the one hand, we have the pocket-book which contains not only a collection of formulæ and tables of data, but which also gives in brief the theoretical basis of the formulæ and a certain amount of mathematics and pure science. Such books generally contain descriptions and diagrams of nearly all the attempted applications of the scientific principles dealt with in the book. On the other hand, we have the pocket-book which is almost entirely a compilation of tables of data, and of diagrams of arrangements and connections, and which as often as not also gives exhaustive lists of the principal dimensions of standard machinery and apparatus manufactured by leading firms. Books in this latter category do not, as a rule, contain many formulæ, and do not give any account of how the formulæ they do give are to be arrived at. Books which fall properly into this latter category are of especial use as handy books of reference to save calculation, etc., and are, no doubt, welcomed as such by draughtsmen and estimating clerks. Those in the former category, however, appear to have a somewhat wider range of usefulness, although as a rule they are lacking in those particular features which would make them invaluable time-savers in the class of work just referred to. The pocket-book under review aims at fulfilling the functions of both classes, and to a very large extent succeeds in so doing. While, however, the tables are remarkably complete and well arranged, so that they cannot fail to be appreciated in the drawing and estimating offices, the earlier parts of the book do not appear to be so well carried out.

The treatment is divided into five sections: (1) the design and erection; (2) schedules of statistics to be compiled and estimates of capital and revenue, specifications; (3) working regulations and estimate of working costs; (4) safety regulations and service rules; (5) tables.

Section (1) is remarkably complete, in that it takes in review the whole undertaking, from the central station and car-shed to the rails and bedding, not omitting the building requirements. But while it is thus exceptionally comprehensive, it is uneven in attention to details, and, what is much more important, it fails to discriminate sufficiently between those methods which have been attempted only (all of which are described) and those which experience has shown to be worthy of adoption in practice. This is noticeably the case in the portion dealing with systems other than overhead trolley wires. Apparently every surface-contact scheme and every conduit scheme that has ever been put into operation, even in an experimental way, is included and described, but no word is said to indicate that many of these have proved failures or have failed to passed the experimental stage. It may be urged that an engineer well knows which systems have and which have not proved successful, but this is surely just where the pocket-book should come in as a source of information. An engineer may well be expected to know the failure or success of the systems that have been employed in his own country, or in the most important cities of the world, but with electric traction spreading on all hands, and even, one may say, to the most remote corners of the earth, few, indeed, are the engineers who are able to keep themselves conversant with *all* that is going one. Hence, too, arises the necessity for very frequent revision of such pocket-books as fall partly or entirely in the first of our two categories. The first portion of the book is also somewhat weak in dealing with the regulating devices for governing turbines, while the various arrangements so largely in vogue in the present day are inadequately treated. Most of the descriptions, on the other hand, are exceedingly thorough and clear, no pains having been spared in this direction to include illustrations of everything that could possibly be of use. The erection of trolley wires receives very complete and careful treatment. We do not remember having seen in any pocket-book such a really satisfactory and detailed description of the right methods to be adopted and the precautions to be made against the numerous pitfalls to be met with. The Board of Trade regulations in force in this country are, naturally enough, omitted, and this is a somewhat serious drawback to the usefulness of the book in this country, since these regulations and the details of the so-called Board of Trade panel, whatever opinion one may have of their real usefulness, should certainly receive careful attention in such a work.

The annealing of cast solid joints is very properly insisted upon, and the processes are well described and dealt with. On the whole, the earlier portion of the book is full of very excellent matter, with timely warnings against dangers and traps which the unwary engineer might fall into, and its chief fault appears to us to be the want of discrimination above referred to between what is present-day practice and what is merely experimental.

Section (1) is also weak in its treatment of turbine regulating devices; steam-turbines are dismissed in a brief page, and gas-engines in little more. Most of the remaining descriptions are good and clear, with the exception of that dealing with the overhead construction adopted on curves where a trolley bow is used instead of a trolley wheel. No reference is made to soldered rail bonds, which, in America at least, are now meeting with considerable favour.

The second portion dealing with the projecting of a tramway and with the calculation of the probable income from it, and with specifications for tender, is good, but does not appear to merit special remark, while the third portion is so superficial that it might almost be omitted. The fourth portion, dealing with various police and other regulations, has little or no reference to this country, and is of little service here except, perhaps, as affording a few suggestions by way of improvement in the existing British regulations.

In conclusion, the book appears to be a decidedly useful one, and the first and fifth sections alone should recommend it to the engineer and to the estimating office equally.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTOR LOAD FACTOR v. STATION LOAD FACTOR.

SIR,—There seems to be a delightful variety of ideas among our station engineers on the subject of tariffs. On the one hand, we find them giving discounts in direct proportion to the load factor of the individual consumer's motor, thus in great measure neglecting the station load factor, and, on the other hand, we have the Dundee system of charging, which practically bases everything upon the station load factor. I submit that neither of these is right. I will, with your permission, Mr. Editor, try to formulate a simple hypothetical case to illustrate the various relations of motor load factor, diversity factor, station load factor ("Cromptonian" sense), and standing charges.

Consider (1) a station which supplies 24 motors, each fully loaded throughout the 24 hours. Let the motors be of, say, 100 h.p. each. The station load factor is here 100 per cent., the motor load factor 100 per cent, and the diversity factor unity. Next consider (2) a smaller station supplying the same 24 motors, but in the following way: Each motors only runs for one hour, one motor being shut down before the next is started up. Here the motor load is $4\frac{1}{6}$ per cent. instead of 100 per cent.; the diversity factor is 24·0 and the station load factor is 100 per cent. The station capacity is, however, now only 100 h.p.; so, to put things on all fours as far as the two stations are concerned, let the number of motors (*i.e.*, consumers) be increased 24 times. We may then express results as follows:

	Case 1.	Case 2.
Number of motors	24	576
Horse-power of each	100	100
Units sold per consumer per annum, say	200,000	8,333, say
Diversity factor	1	24
Motor load factor	100 per cent.	$4\frac{1}{6}$ per cent. ($=\frac{1}{24}$)
Station load factor	100 per cent.	100 per cent.
Station horse-power	2,400	2,400
Total units sold per annum, say	4,800,000	4,800,000
Total horse-power connected to mains	2,400	57,600

Now consider the annual charges, and, for the sake of fixing proportions, take figures roughly, as for Brighton in 1900, and we have, say:

	Case 1.	Case 2.
Interest, etc., charges on central station	£10,000	£10,000
,, ,, ,, ,, feeders, mains, and service connections	10,000	say 50,000
Management charges	1,500	say 2,000
Clerical staff	1,200	say 28,800
Rates, taxes, and insurance	1,200	say 2,400
Motor readings and repairs	1,000	say 24,000
Repairs to mains and service connections	1,500	say 7,500
Net profit	5,000	say 5,000
	£31,400	£128,700
Add:		
Production costs at station	9,000	9,000
Preparation costs at station (ex. management, etc.)	10,000	10,000
	£50,400	£148,700

Some engineers who maintain that each consumer should pay an equal profit would put the item for net profit in Case 2 at £120,000, but, to spare the feelings of those who object to such a course, we will assume that it is a constant sum. The totals, it will be seen, are in the ratio of 1 to 3, and, as the total number of units sold in each case is the same, it follows that the average prices per unit must be fixed also in that ratio.

Of course, it will be objected that the case is a purely imaginary and greatly exaggerated one; but it shows that motor load factor and station load factor must each be used with judgment, the one to determine charges outside the station and the other those inside it. In actual practice it will be found that station load factor *diminishes* with a decreasing motor load factor, *even though the motor connections be increased in the inverse ratio*, as I have shown elsewhere. This would aggravate the cost per unit in Case 2.—Yours, etc.,

A. M. TAYLOR.

11, Ashfield-road, King's Heath,
July 10, 1905.

LIVERPOOL UNIVERSITY AND ELECTROTECHNICS.

Opening of a New Laboratory.

Last Saturday, July 8, being degree day at Liverpool University, the opportunity was taken by the council and senate to include in the day's programme the important function of formally opening the new laboratory of electrotechnics. The ceremony of conferring the degrees took place early in the afternoon in St. George's Hall, and was performed by the chancellor of the university, the Right Hon. the Earl of Derby, K.G., G.C.B., LL.D.

The opening of the new laboratory followed. Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S., now addressed the assemblage in reference to this important part of the day's proceedings. Reverting to 1880, Sir Joseph spoke of the immense strides which electrical engineering had made in the 25 years which had passed since then, and of how the profession of the electrical engineer as it stands to-day had come into existence. Electrical engineers, he pointed out, now formed a distinct class, which was represented by the organisation formed by more than 5,000 members of the Institution of Electrical Engineers, and outside of which there was a ten times larger body of organised and skilled artisans on which they made calls. Electrical engineering was, in fact, the most popular branch of a most popular profession, and undoubtedly was a pursuit which would be cultivated, and which must be cultivated if they were to maintain their position. The electrical engineer had now attained the distinction of being an absolutely indispensable person. Electricity was even yet in its infancy—an idea made still more impressive by the fact that this representative body of young men had to make productive an amount of capital which Mr. Gareke, who was an authority on the point, estimated at £230,000,000 sterling. Yet for want of a little more spirit coupled with knowledge, and painstaking to apply it judiciously, we had lost to our friends abroad some of the lead which we had had. There were many signs of rapidly increasing industry and changes, and it was well that Liverpool was preparing to participate in whatever advantages they might bring. Through the enterprise of Mr. Bromley-Holmes, they had for many years been familiar with the electric light in Liverpool, and Liverpool had been one of the first places in the kingdom to possess a fully equipped electric railway. More recently they had had electricity applied with great success and on a large scale in the street locomotive, so they were well acquainted with electrical progress, and were aware of its importance. He might almost say Liverpool had lived in the atmosphere of electricity. Sir Joseph Wilson Swan brought his address to a close by referring to the new laboratory, and expressing the hope that it might not only be of use to the students, but to the university itself and to the world. A Davy or a Faraday was, he said, a rare product, but there was nothing unreasonable in the assumption that other names might be identified with the new laboratory of Liverpool.

The proceedings in the hall now closed, but a large proportion of the audience went at once to the new laboratory. On reassembling in the lecture theatre, Sir Joseph Wilson Swan again addressed the gathering. He thought they might all unite, he said, in a general note of congratulation on the opening of that laboratory. Laboratories were often very small and inconvenient places; that place was both large and convenient. Sir Joseph proceeded to speak in some detail of the laboratory and of its need of equipment, and brought his remarks to a close by expressing the earnest hope that prosperity would attend it and those who worked in it.

With the opening of the new laboratory the teaching of electrotechnics at Liverpool entered on a new era, under conditions worthy of the city and of the branch of science to be taught and practised. Electrotechnics have formed a branch of study at Liverpool University for the last 12 years, but for the first seven of these years they were a branch of the physics department, and were controlled by the professor of physics. The work of the branch was carried on in temporary sheds, which stood at the back of the building which originally served as Liverpool's University College. In the year 1900 a lectureship of

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electrotechnics was established, and this branch of study was made a separate department of the college. Dr. E. W. Marchant, D.Sc., was appointed to the new lectureship. Meantime, steps were being taken to raise University College, Liverpool, to the status of a fully dignified university, and funds for the purpose were being contributed. One donor (Mr. David Jardine, of Liverpool) gave the sum of £10,000 to the funds, and expressed the wish that the money should be used to endow a chair of electrotechnics In accordance with this wish a chair was established, and Dr. Marchant, who had then been lecturer on electrotechnics for the university for about two years, was appointed to the professorship. Matters having reached this stage it became desirable that a suitable domicile for the newly-formed department should be found, and it was decided to erect an adequate building as a laboratory of electrotechnics. A site was obtained in Brownlow-street, adjoining the new building of the natural history and botanical laboratory which had been presented to the university by Mr. W. P. Hartley, of Liverpool. Designs were prepared by Messrs. Willink and Thicknesse, architects, and shortly after the erection of the building began, Messrs. William Thornton and Sons, of Liverpool, being the contractors. The sum of £12,000 was provided from the university fund to cover the cost of the building, and £1,000 was contributed by the Lancashire County Council towards the equipment. The building was designed for utility. The elevation which fronts to Brownlow-street shows a structure of four storeys and a basement in a substantial though plain modern style and with a liberal provision of windows, the building serving well as a completing wing to the natural history and botanical laboratory. The basement of this earlier building has been secured for use by the electrotechnics department, and, for the time, the two upper storeys of the new building will be used for other work.

Arrangements and Apparatus.

The basement of the new building, together, as aforesaid, with the basement of the natural history and botanical laboratory and the ground floor and first floor of the new building, will for the present be used for the purposes of the electrotechnical department. The dynamo-room, a standard testing room, a museum, rooms for special testing and experimenting work, and photometric and photographic dark rooms are in the basement. Dr. Marchant's private office and private laboratory, a galvanometer room, and rooms for senior students' experimental and test work are situated on the ground floor. The lecture theatre, classrooms, a reading-room and library, and rooms furnished with apparatus for pursuing investigations along special lines of electrotechnology, are situated on the first floor.

In the basement, the dynamo-room claims first attention. It is trapezoidal in form and averages 60ft. by 56ft. Two-thirds of the room form an extension of the main building, and have a glass roof. The walls are faced with white glazed bricks. The interior is accordingly very light and cheerful. The floor is of concrete, and on it have been built four rows of brick beds some 16in. high for the motors and dynamos. Near one corner of the room, on a separate brick bed, stands the principal power set. This consists of a two-cylinder Westinghouse inverted vertical gas-engine of 40 h.p., with enclosed cranks and rods, coupled direct with a Westinghouse standard direct-current four-pole generator. The capacity is 22½ kw. at 230 volts, the stated speed being 300 revolutions. This generator will produce current for lighting the entire building, and will also be used to charge accumulators, and for demonstrating purposes. A Schuckert electric tramcar truck stands in line with the engine and dynamo, a few feet distant from this main power set. The truck was presented to the laboratory by the Corporation of Liverpool. Wood supports have been used to raise the truck so as to allow of the motors and wheels being worked. The truck has two Schuckert motors of 25 h.p. each, and a Schuckert controller, and is fully wired for use. The connections between the controller and the motors have been made by the students.

A number of motors and dynamos are now in the room, some of them having been lent by firms for experimental work and testing. Among the machines are a Fuller and Wenstrom three-phase generator with 10 poles and rotating armature; a rotary converter by the same makers, capable of producing single, double, or three-phase current, stated as of 460 volts and 22 amperes, to run at 1,500 revolutions; a Johnson-Phillips dynamo with special winding; a continuous-current generator, by Siemens Bros., of 55 volts and 85 amperes, to run at 960 revolutions; two single-phase generators by Witting and Eborall; a two-phase motor-generator by the same makers; a Heyland single-phase motor and motors or dynamos by the Lancashire Dynamo and Motor Co., Crompton and Co., and J. H. Holmes and Co. Each of the beds on which the machines stand is provided with two pairs of foundation rails, so fixed that machines can be easily secured to the rails or be removed from them for experimenting or demonstrating All of the dynamos are driven by motors which receive current from the Corporation mains, the driving being at present done by belt to and from two main shafts. This method of driving will, however, give place to direct driving by motors. The wires from the Corporation mains are fixed overhead in the room, and are carried down in open view to the motors. The wires between the switchboards and the experimental machinery have been laid in troughs below the floor.

With regard to the provision for lighting the building, this is such as to admit of current being taken from the Corporation main or from the gas-engine generator. It is intended that the lighting system of the building shall serve an important purpose in connection with the work of the students. The system will be used as a "load" to be varied and studied as occasion may require, connections being provided which will admit of the load being so varied.

Two switchboards have been placed in the dynamo-room. One of these is used mainly to control the lights of the building. This board consists of two panels of slate enamelled black, and is fitted with three continuous-current meters of the International Electric Company's pattern, and with a massive change-over switch by the use of which the supply of current can be taken from the city main or from the generator. The other switchboard is larger than the lighting board, and has been designed and fitted to enable the students to make the connections required in the course of their studies in the dynamo-room. This board has four panels, the face being of very light-grey marble. Each panel is provided with a number of short screw-plug terminals. From the back of the board, wires attached to the plugs communicate with the different class-rooms and research rooms. At the front of the board the terminals project about 3in., each one being fitted with a screw plug. No switches of any kind appear on this board, the intention being that switching or changing over shall be done by the students, and by the use of the screw plugs and the terminals on the wires. By this means any of the experimental machines may be put in communication with any classroom, and the character of the current or particular effects be studied in the classrooms. All of the plugs in front of the board, and the leads from the plugs at the back of the board, are open to view, the intention as regards this board being that "there shall be nothing which the student cannot see." Ample space has been left between the board and the wall of the room to admit of the connections being seen with ease.

Adjoining the dynamo-room is a spacious workshop, which is well supplied with modern tools. Among these are two lathes, a drill, and a planing machine, which are belt-driven by a B.T.H. motor of 2 h.p. In order to transmit power from the motor, and to avoid the transmission of vibration to other parts of the building, a frame of light girder steel, consisting of uprights and cross-pieces, was erected, the uprights resting on the rock foundation, and the small main shaft being supported by the steel structure. This has given the shaft a support completely independent of wall or ceiling, and seems well suited to ensure freedom for the walls and the floor above from vibration through the working of the machine tools. Repairs and alterations to apparatus will be done in the workshop. It is expected that a considerable use will be made of the workshop by senior students in constructing apparatus for special work.

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A well-lighted apartment in the basement has been fitted up as a museum, and will, it is believed, prove of great service. Here are arranged specimens of materials used in the construction of electrical apparatus, specimens of telegraph, telephone, and supply cables, motor parts, insulating materials, electric lamps' parts, filaments, and photographs of electrical installations of particular interest. A senior students' laboratory, 34ft. by 28ft., is located near the dynamo-room. Transformer and alternating-current work will be carried on largely in this room. Here, two three-phase static core transformers of Witting and Eborall's pattern, a synchronous motor of Mather and Platt's construction, and other small machines, have been installed.

A room 35ft. by 13ft. has been set apart as a "high-tension" room, in which high-pressure currents and effects can be studied. For the purpose a 20,000-volt oil-cooled transformer, of Witting and Eborall's construction, has been installed. Current for this instrument will be obtained from the dynamo-room. Insulating materials will be subjected to "breakdown" tests, and the action of the materials under varying pressures will be studied. In the basement there is also a room in which the testing of iron and steel for magnetic properties and electrical conductivity will be carried out. Work of this kind will be done for firms outside, and reports as to the results be supplied to them. This room is provided with galvanometers, permeameters, and other instruments for performing such tests.

There are still some eight other rooms in the basement which will be used for particular branches of electrotechnical study. One of these rooms will be devoted to the study and testing of electric lamps, more particularly with a view to comparing the duration of life of different lamps. A special lampholder, in the form of a circular drum which can be revolved horizontally, has been constructed, and a switching arrangement has been made by which the current taken up by each lamp can be measured without breaking the circuit. A piece of apparatus has been constructed by the use of which the electrical pressure may be maintained automatically on lamps, at a constancy to within one part in four hundred. This is accomplished by varying the field of the generator. The generator is driven at a constant speed by a motor which receives its current from the accumulator. The regulating device consists of a dynamometer having a pointer attached to a moving system of light construction, the free period of the instrument being 1½ seconds. The pointer actuates a relay which closes the circuit of a motor attached to a movable resistance in the field of the generator. The object is to vary the frequency as rapidly as possible. This is accomplished by having a dynamometer with a quick period. The actual changes are but slow, and can be well followed, so that the whole variation in the lamp does not exceed one part in four hundred at any time. By means of this apparatus lamps can be tested under definite conditions as regards voltage. Variations in efficiency are determined by photometric tests. Lamps are tested under ordinary conditions—subject, that is to say, to the variations in pressure on the town mains. Another room is fitted for photometric work and with instruments to measure the efficiency of electric lamps and the amount of energy consumed. A room 39ft. by 35ft. has been set apart for standard instruments, which will be compared periodically with the standards at the National Physical Laboratory that accuracy may be maintained. A small battery of some 20 cells will be provided for use in standardising. Two other rooms, each 27ft. by 20ft., have been set apart for research. One of these rooms is provided with a high-frequency Duddell oscillograph for ascertaining losses occurring in dynamos and motors, especially in pole-pieces. Eddy currents will be a subject of special study. One room will be used as a test-room for meters. Many tests of this kind have been made by the department in the past. The energy required for these rooms will be controlled by a special switchboard in the meter-testing room. The board is connected with the main board, and can be connected with dynamos or cells or with any part of the building. The cables from the board to the dynamo-room lie in a trough filled in with bitumen, which passes below the surface of an outer quadrangle.

On the ground floor the galvanometer room claims, perhaps, first attention. Among the instruments in this room are three ballistic galvanometers, two of Crompton and Midgett's and one of Nasmyth and Mather's construction. Most of the work will, however, be done by galvanometers of a kind made at the laboratory. With these a spot of light is used to give the reading on the scale. The chief parts of the instrument are: a strip of celluloid on which the scale appears and which is fixed edgewise; below this scale is a small cylinder which contains a Nernst lamp; some 4ft. from the lamp there is another cylinder in which a small mirror is fixed. The light of the lamp is projected on the mirror and is reflected by the mirror on the back of the celluloid scale. The observer stands in front of the scale. Owing to the transparency of the celluloid, the spot of light shows distinctly through the scale. The movements of the needle can be observed by the spot of light even in daylight owing to the power of the Nernst lamp. Eight of these galvanometers are now in use. For special measurements and Wheatstone bridge work a galvanometer of Nalder Bros. and Thompson's make will be used.

A junior laboratory on this floor possesses an item of equipment worthy of note. This is a switchboard, with a face of light-grey marble, which is fitted in a manner similar to that of the experimental board in the dynamo-room, a number of screw-plug terminals appearing on the face of the board. When using this board, as in the case of the larger main board, students will have to make all desired connections by means of the screw terminals. No switches of the ordinary handle or lever types are provided. The board is connected with the main battery, which is in an adjoining room. The battery contains four sets of 10 cells each and two of nine each, there being Tudor, Chloride, and Electrical Power Storage Companies' cells. A pressure of 120 volts can be obtained from the cells. At the switchboard the cells may be connected in series or parallel, and may be connected with different rooms.

The lecture theatre of the laboratory is on the first floor. It is a cheerful room, with modern appointments, and will seat 130 people, and is provided with a lantern, screen, large blackboard, specially constructed demonstrator's table, and means of connecting instruments in use on the table with the dynamo-room, the main battery, and other rooms of the building. A connection may be made with any machine in the dynamo-room, so that a demonstration into which the individuality of the machine may enter may be given in sight of the students. Another room in this floor is provided with a valuable piece of apparatus in the form of a Duddell oscillograph, which will be used chiefly for showing the wave variations of alternating currents. Here, again, terminal connections have been provided by which current can be brought from any dynamo in the machine-room, and be made the subject of observation by the demonstrator and the students.

As the work of the department adjusts itself and develops, rearrangements of rooms and apparatus will no doubt be made. The facts which stand out most strikingly are that the present arrangements afford the use of many valuable modern machines and instruments, and special facilities in the form of connecting wires, by which the output of the generating machines may be available and the behaviour of the machines be studied in the lecture theatre and the classrooms. The electrical fittings of the laboratory, it may be mentioned, were supplied by Messrs. John Hunter and Co., of Liverpool.

THE MUNICIPAL TRAMWAYS ASSOCIATION.

Visit to Reading and Henley.

On Thursday, July 6, through the kind invitation of Mr. Councillor A. H. Bull, J.P., chairman of the Reading Corporation Tramways Committee, the members of the Municipal Tramways Association attending the conference in London journeyed to Reading by special train, leaving Paddington at 11 o'clock and arriving at Reading at 11.45.

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The members, who were accompanied by a large number of ladies, were received at the station by Mr. Walter Binns, general manager and engineer of the Reading Corporation tramways. The party were conducted to the town hall, which was tastefully decorated for the occasion, and at noon the party were received by the Mayor of Reading (Martin J. Sutton, Esq., J.P.) and Mr. Councillor A. H. Bull, J.P., and Mrs. Bull, in the Council-chamber, and the mayor formally welcomed the association to the ancient borough, expressing his gratification at the privilege of receiving the members of the association. Subsequently the party adjourned to the large town hall, where a first-class luncheon was provided through the kindness of Mr. Bull. The tables were magnificently decorated, and during the assembling of the guests and the luncheon the organist discoursed sweet music on the fine organ in the hall, which was highly appreciated by the guests, some of the pieces being encored. An interesting souvenir of the occasion was prepared by Mr. Binns, giving the names of the principal officers of the borough and members of the Tramways Committee, the menu and toast list, and a brief sketch of the tramway system and places of historic interest in connection with the ancient borough. The description of the beauties of the Thames from Caversham to Henley, and the chief points of interest seen from the river, was instructive and much appreciated by the guests, and will no doubt be retained by them as a pleasant reminder of what proved to be a most delightful excursion. A short toast list was gone through at the close of the luncheon, and the party then walked through the Forbury Gardens, where the flower beds were most beautifully laid out, to the ruins of the old abbey, where the whole of the party were photographed. The steam launch "England," the largest launch on the Thames, was requisitioned by Mr. Bull, and the party embarked at Caversham Lock and proceeded down the Thames to Henley, tea being served on board during the trip. On reaching Marsh Lock, Mr. C. R. Bellamy, of Liverpool, took the opportunity of expressing to Mr. Walter Binns, on behalf of the president and members of the association, their best thanks and appreciation of the admirable arrangements which had been made for their comfort and pleasure, and which had been so ably carried out, and assured him that they would long remember their visit to Reading, which had been so very enjoyable. Mr. Walter Binns in a few words acknowledged the vote of thanks, and stated that it had been a great pleasure to him to see the members of the association at Reading, and that what he had been privileged to do in making the arrangements for their visit had also been a very great pleasure. He also referred to the great kindness of Mr. Councillor Bull, who had so generously entertained the association, and who had spared no pains nor expense to make their visit an exceedingly happy and memorable one. The launch then proceeded towards Henley, and moored some little distance above Henley Bridge. Through the kindness of the Mayor of Reading members were permitted to go on to the lawns at Phyllis Court, for a nominal sum, from which a splendid view could be had of the regatta and, later in the evening, the fireworks, the lawns being opposite to the winning post. Concerts were given during the evening in the grounds. Members returned to London later in the evening, and all who took part in the day's proceedings will retain a pleasant recollection of the occasion for many years to come.

THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

Yesterday morning in the Westminster Hall this measure came on for consideration by a Select Committee of the House of Commons, consisting of Sir James Kitson (chairman), Sir Herbert E. Maxwell, Mr. Frank Edwards, and Mr. Rutherford.

The promoters were represented by Mr. J. D. Fitzgerald, K.C., Mr. Honoratus Lloyd, K.C., Mr. Charteris, Mr. Macassey, and Mr. Thomas Richardson. The Bill was opposed by the City Corporation, the London County Council, some of the borough councils, the Westminster City Council, the East and West Ham Corporations, some of the local authorities in the outlying districts, and several electrical, gas, and other companies. Mr. Balfour-Browne, K.C., Mr. Freeman, K.C., Lord Robert Cecil, Mr. Courthope Munroe, and Mr. Vesey Knox were among the counsel for the opponents to the Bill.

Mr. FITZGERALD, in outlining the Bill, gave a statement of the promoters' scheme, this necessarily being on much the same lines as those followed before the Lords' Committee. He stated it was proposed to establish three large generating stations on the banks of the Thames, where they, unlike the existing companies, would be conveniently situated for a supply of cheap seaborne coal and water for condensing. In regard to the plaint of the opponents respecting unfair competition, he mentioned that last year the existing undertakers only derived 8 per cent. of their income from the supply of power. Of the 456,000 h.p. used in the Metropolis for industrial purposes, the quantity of electrical energy so employed represents no more than 16,000 h.p. He reiterated the points made before the Lords' Committee regarding the economy in generation, saving of capital expenditure to individual concerns, and the facilities afforded to industries generally by a supply of cheap power, and instanced the case of the Tyneside Electrical Company, which in a large measure has supplanted steam. Further, the Lords' Committee had inserted additional protective clauses in favour of the existing companies beyond the usual clauses originally included in the Bill. As some of the opponents of the Bill had objected that the promoters might extend by specious methods the limited lighting powers asked for, the promoters had agreed that in no case should more than 20 per cent. of the energy supplied be used for illumination. New provisions inserted in the Bill as the result of the hearing before the Lords' Committee provided that where the promoters obtained leave to supply power in the same districts as the authorised undertakers, they shall do so under the same conditions as the latter; and that the Board of Trade shall have power to impose regulations upon the promoters regarding the compulsory laying of mains. Since the measure was before the Lords' Committee, the Stepney Borough Council, one of the most successful municipal electric light undertakers in the Metropolis, had provisionally agreed to take all energy which their present works could not generate on schedule rates expected to average 66d. per unit. The Council agree to supply power consumers at an average charge of 8d. per unit, at against the present charge of 1d. per unit. This would save contemplated extensions which were expected to cost £250,000. The Barking Council was prepared to transfer its undertaking to the company, and the Bexley Urban District Council had also come to an understanding with the promoters respecting the supply of energy, which was expected to result in current being provided to the consumer at reductions of 30 and 40 per cent. respectively upon those now ruling. The Wandsworth Borough Council have petitioned against the Bill on the grounds that they were not included in the industrial areas, as they should be. This showed that the Council appreciated the advantages of the Bill. It should be noticed that all the supply companies at present at work had their power stations either within the industrial area or outside the area of the Bill. He held that there would be no competition in the non-industrial area. The London County Council had called no witnesses before the Lords' Committee, and their chief objection appeared to be that there was no purchase clause. This was the case in all Power Bills, and the sliding scale was introduced in them to replace this clause. The company were willing, however, to introduce such a clause, and left it to the committee to settle now the wording of the same, and a reasonable period before it should become operative. In conclusion, he stated that the Bill was an effort on the part of a number of gentlemen in combination to give a cheap supply of electric power where it was most needed.

Mr. C. H. MERZ, under examination, repeated a great deal of the evidence given before the Lords' Committee as to the advantages of electrical power distribution. He dwelt at length upon the adaptability of electric motors for factory driving, and upon the low cost of repairs, as compared with isolated steam-engines. The Tyneside

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scheme had proved this to be the case, and it was most difficult for power distribution to succeed in areas where coal was cheap. Hence the London scheme would have an advantage in this respect. The coal required for electric power distribution was less than 2lb. per horse-power-hour, as against between 5lb. and 7lb. with small steam plants. The reason why certain of the Power Acts had not been put into force was because the promoters had given away too much in clauses. A number of tables were then put in as evidence and described in detail to show the probable power consumption within the area. The tables as to cost of supply were generally the same as those given before the Lords' Committee. The financial statistics relating to the existing lighting authorities were new, and were based on the evidence given by the opponents of the Bill in the House of Lords. The average expenditure on existing generating stations was given as £50·5, the works' cost per unit generated 0·98d., the total works' cost, including capital charges, 1·78d. Only 7·4 per cent. of the revenue now obtained was for the supply of power. The average size of the 419 engines now installed in the 51 stations was 331 kw. The average price obtained for power by the existing undertakers was 1·949d. per unit. There were special cases where a lower price was charged, and this was frequently below the cost price. The deficit was then made up out of the lighting or tramway charges. It was unfair to compare special charges to individual consumers with the average charge proposed under the Bill. The hire of motors and the giving of expert advice to intending consumers was essential to the success of a power scheme, and had conduced to the spread of the Tyneside undertaking. In certain cases guarantees were given as to the reduction in cost which would result from the change over to electric driving.

The committee adjourned until 11.30 this morning, when the examination of Mr. Merz will be continued.

PERSONAL.

The Corporation of Western Egypt have appointed as its general manager in Egypt Mr. W. C. Beckett, M.I.C.E., until now chief engineer of the Bengal-Nagpur Railway.

Mr. Joseph Dugdale has been appointed tramway manager to the Aston Corporation, rendered vacant by the retirement of Mr. A. Coveney, who has been appointed tramway manager at Erith.

The salary of the electrical engineer at Dover (Mr. L. W. Woodman) has been increased from £350 to £425 per annum, as from Jan. 1 last.

F. Scarr, of Melton Mowbray, has been engaged as switchboard attendant and driver at Loughborough at 25s. per week.

Mr. Robert Foster has been appointed resident electrical engineer at Aston at a salary of £300 per annum, the appointment to take effect as from Jan. 1, 1905.

We understand that the salary of Mr. D. Smith, the assistant electrical engineer of Tunbridge Wells, has been increased by £25.

The salary of Mr. R. E. Meade, electrician in the electrical department, Stafford Town Council, has been increased from £150 to £175 per annum.

FORTHCOMING EVENTS.

Permanent-Way Institution. — Summer convention begins on July 21, continuing till July 27, in the course of which a visit will be paid to Holland.

New Publications.—We have received the tenth edition, twenty-third to twenty-seventh thousand, which is considerably enlarged and well supplied with numerous diagrams and formulæ, of a text-book on practical physics by Friedrich Kohlrausch. The book is published, as its predecessors, by G. B. Teubner, Leipsic and Berlin. The formulæ are mainly arranged upon the proposals made by the German Physical Society, but in some cases the author has endeavoured to expunge inconsequences and to amalgamate differences so that as much as possible the same letter is used to denote the same constants. The *Physical Review* (New York) dated June contains Chapter II. of an article on "Infra-red Absorption Spectra," by W. W. Coblentz; "The Electric Arc in a Vacuum," by C. D. Child; and minutes of the proceedings at the twenty-eighth meeting of the American Physical Society.

TRADE NOTICES AND NOVELTIES.

Arc Lamp Lowering Gear.

The London Electrical Firm, of George-street, Croydon, have recently introduced an improved contact and suspension device for arc lamps, and also a self-sustaining winch which can be used in connection with the same. Both of these are illustrated herewith. The contact device, shown in Fig. 1, is exceedingly simple in its action.

FIG. 1.

The actual contacts are made between the two spring rings of the piston-ring type, which can be seen in the illustration, and two similar rings, which are contained in the fixed socket. The pin seen at the top of the plunger is used to take the weight of the lamp when in position. This pin engages in grooves, which are constructed on the inside of the socket in sufficient numbers to prevent there being any necessity for the plunger to have a definite angular position with respect to the socket. The shapes of the grooves are such that the pin engages irrespective of the angular position of the plunger. In order to lower the lamp, it has first to be raised slightly higher, and this carries the pin to points in the grooves at which free passages for lowering are obtained. This contact device looks somewhat bulky in the illustrations, but it is only 8¼in. long and 7in. in

FIG. 2.

diameter. The winch illustrated in Fig. 2 is a most interesting piece of apparatus, which we cannot describe in detail owing to the patents being uncompleted. The great feature of the winch is a new mechanical movement which gives a reduction of 4 to 1 between the handle and the drum containing the wire rope. For this movement no pawls or gear wheels are required, and yet the drum will sustain the weight of the arc lamp in any position. The winch for holding 40ft. of $\frac{3}{16}$in. wire rope or 20ft. of ¼in. rope is only 5¼in. diameter by 3¼in. deep. This will come into any ordinary arc lamp column, but the winch can also be fixed on the outside of the poles if desired. With this combination of winch and contact device, street arc lamps can be trimmed much more expeditiously than by means of a tower wagon, which involves heavy labour charges for transport.

APPOINTMENTS VACANT.

Borough Electrical Engineer, Cheltenham. Salary, £400 per annum. Applications by 18th inst. See advertisement in last issue.

Borough Electrical Engineer, West Bromwich. Salary, £300 per annum. Applications by July 17.

Lecturer on Electrical Engineering, Hull municipal technical school. Salary, £200 per annum. Applications, on forms, to J. T. Riley, D.Sc., director of studies, by 15th inst. See advertisement in last issue.

Electrical Engineer as manager to lighting and power contractors. See advertisement in last issue.

Assistant Electrical Engineer, Acton Urban District Council. Salary, £130 per annum. Applications by 12 noon on July 18. See advertisement.

Electric Light Canvasser, Limerick Corporation; £100 per annum.

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LEGAL INTELLIGENCE.

BIDEFORD AND APPLEDORE RAILWAY.

In the King's Bench Division on Monday the hearing of the action of the British Electric Traction Co. against Charles Chadwell, the contractor of the Bideford and Appledore Light Railway, in which the plaintiffs claim £8,000 for non-completion of works, was commenced.

Mr. JERVIS, the engineer of the railway, said he often remonstrated with defendant on the dilatory way the work went on. He replied that he was not getting his payments regularly, and that the local authorities threatened an injunction if he proceeded, and he also complained of the manner in which he had been dealt with in connection with his Devonport District Tramways contract.

After hearing further evidence the hearing was adjourned.

QUESTION OF FARES.

Before Lords Justices Romer and Mathew, in the Court of Appeal, on Monday, Mr. Roskill, K.C., applied on behalf of the defendants in the case of Ramsay *v.* the London United Tramways (1901) for a stay of execution pending an appeal from verdict and judgment before Mr. Justice Bucknill and a jury. The plaintiff's case was that for failing to pay his tramway fare of one penny he was taken into custody, as he said, by the direction of the tramway company, which was denied by the company. The plaintiff was charged by the police with using obscene language, and also by the tramway company with non-payment of the fare. At the trial a verdict was returned for the plaintiff for one farthing damages for the alleged false imprisonment and £20 damages for the alleged malicious prosecution. Their Lordships granted the stay on defendants paying £20 into court and paying the plaintiff's solicitors the taxed costs on the usual undertaking to return them if the company's appeal proved successful.

GARCIN RENAULT ELECTRIC CARS AND ACCUMULATORS.

The creditors and shareholders of this Company met at the Carey-street office of the Board of Trade, Lincoln's-inn, W.C., on Tuesday, when Mr. Winearls (assistant-receiver) reported that an approximate statement had been lodged under the liquidation, showing total liabilities £3,284, a deficiency of £2,703 in assets to meet the liabilities, and a total deficiency of £2,773 to the contributories. In the absence of a quorum, the matter was formally adjourned for a week, when, if no resolution is passed, the liquidation will remain in the hands of the official receiver.

COMPANIES' MEETINGS AND REPORTS

EDMUNDSON'S ELECTRICITY.

The eighth ordinary general meeting of this Company was held last week at the Westminster Palace Hotel, Victoria-street, S.W., Mr. Francis E. Gripper, M.I.E.E. (chairman and managing director of the Company), presiding. Particulars of the report for the year appeared in our issue of the 30th ult.

The CHAIRMAN, after reviewing the position generally, stated that the total investments in subsidiary companies, taken at par value, amounted to £1,253,789. The reserve against those investments had increased during the last year by £7,320, making a total of £172,705. 8s. 2d. This increase of reserve was much smaller than for the previous year, when a very large amount was added to reserve. The value of these investments was increasing from year to year, and the directors anticipated that it would not be necessary to continue to add to this reserve to so great an extent; in fact, they hoped that a considerable portion of the reserve that had been set aside in this manner would so increase in value that it may properly be taken at par value, and thus increase the profits during the next few years. He concluded by formally moving: "That the eighth annual report and statement of accounts for the year ended March 31, 1905, be, and are hereby, adopted, and that, as recommended therein, a final dividend at the rate of 9 per cent. per annum for the half-year be paid on the 70 000 old ordinary shares, making 7 per cent. for the year, and that a dividend at the rate of 7 per cent. per annum be paid on the 10,000 new ordinary shares."

The resolution was carried unanimously.

Mr. J. W. Edmundson was re-elected a director.

NEW GENERAL TRACTION.

The ninth annual general meeting of the New General Electric Traction Co. was held at the offices last week, Baron Emile B. d'Erlanger presiding.

The CHAIRMAN said that they would see that the policy of the Board of reducing expenses as much as possible had been pursued in the past year, and that the general expenses, which amounted to £3,272 in 1904 and then already showed a reduction on the year 1903 of some 20 per cent., had been reduced to £2,536, showing a further reduction of £686—practically a further 20 per cent.—so that in two years the general expenses had been cut down about 40 per cent. The amounts received in dividends from sub-companies showed an increase over the year 1904 of £2,675, and of £3,724 over the year 1903. The Philadelphia system was now completed, and they had received the whole of the securities to which they were entitled—*i.e.*, £170,000 bonds and £139,000 shares—and they would be creditors, besides, for the sum of £5,000, the Traction Co. having acted towards the subsidiary company in the capacity of a car trust company, receiving repayment by instalments. The Marborough Act had since the date of this balance-sheet been disposed of for the sum of £2,500, and the Company had been relieved of heavy contingent liabilities. The amount of cash in hand was £6,326, and the net result of the year had been a loss of £6,855, after paying all the interest on debentures and loans, which really was a loss of only £4,644, as, to compare with the previous year, they ought to have given themselves credit for £2,211, representing the dividend from Coventry. The Chairman said he thought they had now reached the minimum expense at which the business of the Company could be effectively carried on. Last year they estimated the fixed charges of the Company at £16,900; but to that must be added another £1,000 for interest on, in round figures, £20,000 of 5 per cent. mortgage debentures, so that the fixed charges were really £17,900. without taking into consideration any sinking fund for the debentures. Against these fixed charges of £17,900 they had this year a net income from the sub-companies of £12,089. For the year 1904 the Philadelphia tramways showed a net profit of £3,667; this year the gross receipts have shown a good expansion. The receipts up to June 18, 1904, amounted to £6 037; the receipts to June 18 this year amounted to £7,632. For the first half-year he was afraid that little of the increased gross represented net increase, because the 40 odd snowstorms in the city of Philadelphia during the winter had naturally entailed a considerable increase in the operating expenses. He had every reason to believe that during the summer they would reap the benefit of the increase in the gross receipts, which was satisfactory. The Norwich company was more or less *in statu quo*. The Eastern Counties had not shown any signs of increasing activity and returning prosperity, and the receipts of the tramways in Norwich were, consequently, affected by the bad times from which that important city was suffering, though a 3 per cent. dividend was paid for the year 1903-1904, against 2½ per cent. for the preceding year. Coming to the Coventry tramways, the Chairman stated the year 1904 showed a decrease of £1,232 in the net; but that decrease was entirely owing to the loss of earnings consequent upon the disorganisation of the traffic, caused by the relaying of the old lines and the construction of the extensions. That work had now been concluded, and so far the traffics were of a very promising nature. They would now understand that, after a few deferred payments that had to be made, both in respect of Philadelphia and Coventry, the era of large capital expenditure had been definitely closed, and the New General Traction Co. would depend entirely upon the revenues derived from its subsidiary companies.

The report was unanimously adopted, and the Hon. A. G. Brand, M.P., re-elected a director.

MARCONI'S WIRELESS TELEGRAPH.

An extraordinary general meeting was held on Tuesday at the offices, 18, Finch-lane, E.C., for the purpose of passing resolutions altering the articles of association in which was provided a clause having for its object the increasing of the Company's capital to £500,000 by the creation of 200,000 further shares of £1 each.

Mr. CUTHBERT HALL, who presided, formally moved the adoption of the resolutions. In doing so he observed that certain of the resolutions were brought forward in order to meet the wishes of the shareholders, who were desirous of seeing the shares of the Company quoted in the Stock Exchange official list. The resolution having reference to the increase of capital was considered necessary in view of expansion of the business, but any new issue of shares that might be deemed desirable would, in the first instance, be issued to the shareholders.

Major FLOOD PAGE seconded the resolutions, which were carried unanimously.

EASTERN TELEGRAPH.

The Eastern Telegraph Co. announce that, subject to final audit, the accounts show, after payment of interest on the 4 per cent. mortgage debenture stock, the dividend on the 3½ per cent. preference stock to March 31, and an interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31 last, a balance available sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both free of income tax and payable on July 26, making, with previous payments on account, a total distribution of 7 per cent. on the ordinary stock for the year ended March 31.

NATIONAL TELEPHONE.

The report for the half-year ended June 30, to be presented at the meeting on July 20, states that the income accrued in respect of the business of the half-year amounts to £1,086,507, an increase of £101,232. Working expenses for the half-year amount to £630,250, an increase of £67 190. The net result for the half-year (after deducting the Post Office royalties, amounting to £100,637) is a profit balance of £355,618, an increase of £24,146. The rentals carried forward for unexpired terms of running contracts amount to £1 018,882, an increase of £81,585. Out of the available balance of £268,616 shown by the net revenue account the Board recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock. It is also proposed to transfer £110,000 to the reserve fund and to carry forward the balance of £9,699. The sum of £477,166 has been expended on capital account during the half-year in the erection of 22,405 additional exchange and private stations and in the construction of underground works.

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NEW COMPANIES REGISTERED.

Johnson Secret Wireless Telegraph and Telephone Testing Syndicate, Limited.—Capital, £15,000. Objects: to acquire the interests and patents of the vendors in the Johnson system of secret wireless telegraphy and telephony, together with all subsequent improvements thereon by the inventor; to test and develop the said system; to promote an exploitation company, to be called the Johnson Secret Wireless Telegraph and Telephone Co., Limited, the nominal capital of which is intended to be £250,000. Registered office: 40, King-street, Cheapside, E.C.

Dewsbury Electric Manufacturing Co., Limited.—Capital, £5,000. Objects: to acquire the business of friction, derrick, and locomotive crane overhead traveller makers, machinery merchants, and general engineers, carried on at 22, Listerhills-road, Bradford, and elsewhere as Roberts and Kaye; to adopt an agreement with C. H. Kaye, W. G. Thomson, and J. Bentley, and to carry on the said business and that of electrical engineers, manufacturers of and dealers in electric, magnetic telegraphic telephonic, and other appliances and apparatus, etc. Registered office: Engineering Works, Kilpin-hill, Heckmondwike.

Musselburgh and District Electric Light and Traction Co, Limited.—Capital, £120,000. Objects: to carry on the business of railway and tramway proprietors, suppliers of electric light and power, electrical engineers, and the like; to adopt an agreement with the National Electric Construction Co., etc. Registered office: Queen Anne's-chambers, Westminster, S.W.

X Electric Accumulator Co., Limited.—Capital, £60,000. Objects: to acquire from E. L. Oppermann, of 21, Ashworth-mansions, Elgin-avenue, W., the benefit of certain existing inventions in relation to the manufacture of plates for secondary batteries or accumulators, etc. Registered office: Leadenhall-street, E.C.

Lien Registered.

Chiswick Electricity Supply Corporation, Limited.—Issue on June 21 of a debenture for £100, part of a series created by resolutions of Nov. 2, 1900, and March 8, 1901, to secure £50,000, charged on the Company's undertaking and property, present and future, including uncalled capital. Holder, Miss H. Heybourne, Clive Cottage, The Warren, Manor Park, E. No trustees. Total amount previously issued of same series, £33,700.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Leicester.—Tenders are required for telephone cables, etc., for the Water Committee. Tenders by July 17.

Bath.—The Corporation invite tenders for a storage battery. Tenders by July 17. See advertisement.

Turnu-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

West Ham.—The Council invite tenders for the erection of tramway offices and car depot, Greengate-street, Plaistow. Tenders by July 25.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct-coupled steam set. See advertisement.

South Shields.—The Town Council invite tenders for the laying of the permanent way for the service line to the car-shed in Dean-road. Tenders by 22nd inst.

Leeds.—Tenders are invited for the supply of lamp-pillars, irons, carriages and furniture, and glass for lamps for one year, for the Street-Lighting Committee. Tenders by July 18.

Brussels.—The Government Telegraph Department require tenders for 14,700 pine telegraph poles. Specification 76 may be obtained from their office at Brussels. Tenders by Aug. 9.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10 000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Loughborough.—Tenders are invited for the supply of materials and stores for the year ending July 31, 1906, for the electricity works. Tenders to the Borough Electrical Engineer by July 18. See advertisement in last issue.

Calanas (Spain).—The Municipality require tenders for the installation and working for 10 years from Jan. 1, 1906, of the electric lighting of the town. Tenders by July 27 to the Alcalde of Calanas, province of Huelva, Spain.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Neath.—The Rural District Council invite tenders for the supply, etc., of electric light and power mains, sub-stations, switchboards, feeding pillars, switch pillars, excavations, and other works in connection within their area. Tenders by July 17. See advertisement.

Leeds.—Tenders are invited for the supply of lamp-pillars, irons, carriages and furniture, and glass for lamps for one year. Forms of tender and specification may be obtained, and samples inspected, at the office of the Superintendent of Street-Lighting, Springwell-street, off Whitehall-road, from 9 to 11 a.m. daily. Tenders by 10 a.m. on July 18.

Stourbridge.—Tenders are required for the wiring of the workhouse buildings for electric light, also for the installation of a plant for working the same; also for the installation of gas-pipes and fittings, according to specification which can be seen at the Clerk's Office. Tenders to Mr. George Francis James, clerk to the Guardians, 12, Hagley-road, Stourbridge, by 12 noon on July 18.

Ebbw Vale (Mon.).—Tenders are invited for the following, for the Ebbw Vale Urban District Council: (Section A) cables; (B) overhead lines; (C) street lamps and fittings; (D) meters. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders to the Clerk of the Ebbw Vale Urban District Council by 12 noon on Aug. 5.

Dublin.—Tenders are invited for the supply of three electric locomotives for haulage of refuse wagons on the city tramways; nearly 1,000 yards run of street tram tracks and electricity mains, overhead trolley wires, with street posts and connections; two electric and one steam capstan, etc. Specification, etc., may be inspected at the office of the city engineer, Mr. Spencer Harty, City Hall, Dublin. Tenders to the Chairman, Cleansing Committee, 3, Cork-hill, Dublin, by 12 noon on July 25.

London, S.W.—The London County Council invite tenders for the roadwork and platelaying required for the reconstruction for electrical traction on the conduit system of the tramways (*a*) from the authorised tramways in Red Lion-street, via York road, Battersea Park-road, Nine Elms-lane, Albert-embankment, and Lambeth Palace-road to Westminster; (*b*) along Lambeth-road; and (*c*) along Falcon-road; and for the execution of certain paving works in connection therewith. Tenders by 18th inst.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Tenders by Oct. 23. See advertisement.

RESULTS OF TENDERS.

Darlington.—The Council have accepted the tender of Cox-Walker, Feethams, Darlington, for switchboard extension and booster.

Gillingham.—The Council have accepted the tender of Babcock and Wilcox, Oriel House, Farringdon-street, London, E.C., at £1,010, for one water-tube boiler and superheater.

Lynmouth.—The following tenders have been accepted for a 100-kw. hydro-alternator: Escher, Wyss, and Co., Zurich, hydraulic portion; British Thomson-Houston Co., Rugby, alternator portion.

Loughborough.—The Council have accepted quotations of the Union Electric Co. for four electric arc lamps at £25; and Hardy and Padmore, Worcester, for four lamp columns, at £11. 1s. each.

Bradford.—The Council have accepted the tender of the Webster Electrical Engineering Co., Thornton-road, Bradford, for the lighting of block A of the Grange-road new Council schools by electricity.

Mitcham (Surrey).—The Guardians of Holborn Union have accepted the tender of Ruston, Proctor and Co., Lincoln, at £725, for supplying and fixing at their workhouse, Western-road, Mitcham, Surrey, a new Galloway steam boiler.

Darlington.—The following tenders have been received for supplying and delivering at the electricity works seven tons of 12in. by 6in., and 12in. by 5in. steel girders, with angle plates, bolts, etc., for the Corporation: Cleveland Bridge and Engineering Co., Darlington (accepted). Also tendered: Teesdale Bros., Darlington; Wheatsoe Foundry Co., Darlington; Hall and Pickles, Newcastle.

London County Council.—The tender of C. J. Webb and Co., London, at £3,367. 9*s.* 8d., for the supply of the uniform clothing required for the year ending June 30, 1905, for tramway drivers, conductors, etc., has been recommended by the Stores Committee for acceptance. The Highways Committee have recommended that the offers of G. Skey and Co. to supply an additional 250,000 stoneware cable ducts for the sum of £3,193. 15s., and of Stanley Bros. to supply an additional 500,000 ducts for the sum of £6,800, be accepted.

Aston Manor.—The following tenders have been received for the overhead electrical equipment of the tramways, for the Corporation:—

Brush Electrical Engineering Co.*	£4,338 5 4
R. W. Blackwell and Co.*	4,436 5 3
Johnson and Phillips*	4,567 11 1
Brush Electrical Engineering Co. (accepted)†	4,505 15 7
British Insulated and Helsby Cables*	4,627 2 6
British Electric Equipment Co., 11, Queen Victoria-street, London, E.C.	4,651 17 5
R. W. Blackwell and Co.†	4,751 4 1
British Insulated and Helsby Cables†	4,902 6 6

*Including paper lead-sheathed cables. †Including vulcanised bitumen cable.

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Partick.—The Council have accepted the following tenders for the supply of plant at their electricity works: Babcock and Wilcox, boiler and coal conveyor; Cowans Limited, Springfield-lane, Salford, Manchester, switchboard extensions; British Insulated and Helsby Cables, Prescot, Lancs., feeder cables.

Stepney.—The Borough Council have received the following tenders for improving the ventilation of the engine-room at the electricity works: F. W. Potter and Co., Phipps-street, E.C., £74 (accepted); J. Keith and Blackman Co., Farringdon-avenue, E.C., £91. 10s. The tender of Gwynnes, Limited, 81, Cannon-street, E.C., at £73. 15s., for a motor-driven centrifugal pump, has also been accepted.

Burton-upon-Trent.—The following tenders have been received for the construction of permanent way, including paving for a route length of 1¾ miles of tramways, together with works in connection with the road widening and alteration of levels, for the Corporation:

G. F. Tomlinson, Derby (accepted)	£12,655 0 6
G. Holloway, Wolverhampton	13,495 10 4
A. Krauss and Son, Bristol	13,614 10 9
G. Law, Kidderminster	14,152 8 5
T. C. Starkey, Hull	14,231 11 6
G. Wimpey and Co., Hammersmith	14,678 14 6
Meredith Bros., Gloucester	14,679 10 7
A. Graham and Sons, Huddersfield	14,706 18 8
Dick, Kerr, and Co., London	14,765 6 7
Bennie and Thompson, Warrington	14,773 10 1
W. Underwood and Bro., Dukinfield	14,807 10 6
British Electric Equipment Co., London	14,897 6 8
E. Taylor, Blackpool	15,148 1 9
W. Griffith and Co., London	15,538 19 0
G. Freeman and Sons, Hollinwood	16,679 14 5
R. C. Brebner and Co., Edinburgh	16,708 10 10
R. W. Blackwell and Co., London	18,123 11 4

London, S.W.—The following tenders have been received for electric light installation, South Battersea station and Westminster (new) station, for the London County Council:

South Battersea station.

Tamplin and Makovski	£251 0 0
O. Clark and Co.	199 17 6
W. H. Johnson	195 0 0
Durell and Co.	189 15 0
Barlow and Young	185 0 0
F. J. Ooleby and Co.	182 10 0
R. Dawson Limited	182 0 0
A. H. Marshall, 270, High-road, Leytonstone (accepted)	155 10 0

Westminster station.

Tamplin and Makovski	326 0 0
O. Clark and Co.	290 19 0
W. H. Johnson	274 0 0
Durell and Co.	266 11 0
Barlow and Young	260 0 0
R. Dawson Limited	249 0 0
F. J. Ooleby and Co.	235 0 0
A. H. Marshall (accepted)	196 10 0

London, W.—The following tenders have been received for the repair of the electric bells and fire-alarms at the infirmary, for the Paddington Board of Guardians:

Tamplin and Makovski, 27, Charles-street, Haymarket, S.W.	£250 0 0
London and Provincial Telephone and Fittings Co., 78, Queen-street, Cheapside, E.C.	199 5 2
Donnison, Sillem, and Co., 116, Great Portland-street, W.	184 0 0
W. J. Bishop and Co., Faraday Works, Gladstone-road, Croydon	179 14 0
Beam Co., 55, Barbican, E.C.	179 0 0
Walsall Electrical Co., 116, City-road, E.C.	143 19 10
W. Winn, 106, Union-street, Borough, S.E.	120 0 0
F. W. Brock, 287, Shirland-road, Paddington	115 13 0
Comyn, Ching, and Co., 54-58, Castle-street, Long-acre, W.C.	109 0 0
Jackson Bros., The Broadway, Plaistow, E.	102 5 0
F. J. Ooleby and Co., 7, Thayer-street, W.	98 15 0
W. J. Fryer and Co., Bravington-road Works, Harrow-road, W.	97 0 0
Private Wire and Telephone Installation Co., 5, Palmer-street, Westminster, S.W.	91 15 0
Western Engineering Co., The Vale, Acton, W.	89 15 0
G. and H. Turner, 11, High-street, Harlesden, N.W.	78 6 0
R. H. and J. Pearson, 141, High-street, Notting Hill-gate, W. (accepted)	75 0 0
Telephone and Electrical Installation Co., 11, Queen Victoria-street, E.C.	75 0 0
Holmes and Cooper, 9, Balfern-street, Battersea, S.W.	71 5 0
J. Bryden and Sons, 90, Gloucester-road, S.W.	66 0 0
Electrical Engineering and Maintenance Co., 49, Lime-street, E.C.	49 0 0

The Lighting of Trains.—Although electrical illumination is making progress, it appears that compressed oil gas still holds the field in regard to trains. Over 150,000 carriages and 5,000 locomotives have been fitted with this illuminant as devised according to Pintsch's system, and experiments in the direction of improving it are still being carried on with satisfactory results. It is stated that Pintsch's Patent Lighting Co. have recently introduced incandescent burners which give a more powerful light and, at the same time, reduce the consumption of gas. The increase of illuminating power is about 300 per cent. compared with the old system, and the gas consumption is cut down by about one-half.

BUSINESS NOTES.

TRACTION.

Leeds.—The Corporation have pronounced against ½d. stages.

Bolton.—The Corporation have decided to grant the tramway employés a six-day vacation.

Sunderland.—The Tramways Committee are to consider the question of a tramway over the Wear.

Erith.—The Urban District Council have fixed the 24th inst. as the date for the completion of the tramway system.

North Lindsey.—The Light Railway Commissioners have approved of this scheme, which is expected to cost £80,500.

Wigan.—The line to Standish has now been completed, the construction having been expeditiously carried out by Messrs. J. G. White and Co.

East Barnet.—The Urban District Council and the Herts County Council are at variance over the street widenings in connection with the light railway scheme.

Bournemouth.—Representations are being made to the Corporation by the inhabitants of Branksome in regard to the proposed extension to that place now being carried out.

Brompton and Piccadilly Railway.—The London County Council have approved the company's plans for additional entrances and exits at Cranbourn-street Station.

British Electric Traction Co.—The directors propose to pay a dividend at the rate of 6 per cent. per annum for the half-year to March 31, making 6 per cent. for the year.

Scarborough.—There were 42,106 passengers carried on the trams during last week, compared with 30,740 during the previous week, and 46,798 during the corresponding week last year.

Nottingham.—The Tramway Committee do not recommend the introduction of motor 'buses for Sneinton, but the question of a tramway service is expected to be reconsidered shortly.

Durham.—The Town Council have decided to make strong representations to the Board of Trade as to the delay of the Electrical Power Distribution Co. in providing a tramway service.

Hastings.—A dozen cars have been dispatched from Preston by Messrs. Dick, Kerr, and Co. for the tramway system. Preliminary tests have been carried out in the Cambridge-road rails.

Holmfield and Southowram.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order authorising an extension of time for the construction of this line.

Swansea.—At a meeting of the Electricity Committee the engineer reported that the electrical energy for the working of the trams on the Brynhyfryd and Morriston sections would probably be ready by the end of August.

Ettrick Bay (N.B.).—The Ettrick Bay tramways extension has been completed, and was expected to be inspected by the Board of Trade's representative yesterday. A *plébiscite* is to be taken on the question of Sunday cars.

Broughty Ferry.—A staff of workmen last week began operations in connection with the construction of the tramway line between Dundee, Broughty Ferry, and Monifieth, at a point in the Monifieth-road near the Whinny Brae.

Darlington.—The receipts from the Corporation trams are slightly on the up grade. The return for May showed a revenue of 6·35d. per car mile. For the last five weeks the revenue was 6·98d. per car mile. Halfpenny fares are to be retained.

Reading.—The Caversham Urban District Council have passed the following resolution: "That a committee of five be formed from this Council to confer with the Reading Corporation with a view to the extension of the tramways to Caversham at an early date."

Blackpool Electric Tramways (South).—An extraordinary general meeting was held last week for the purposes of passing resolutions for dividing the assets of the company, and for the voluntary liquidation of the company. All the necessary resolutions were passed unanimously.

Middlesex County Council.—A further section of the County Council electric tramways from the High-road, Wood Green, through Hornsey, to the foot of Muswell-hill, and thence to the Alexandra Palace has been completed. It is anticipated that the cars will be running by the end of the month.

Oldham, Saddleworth, etc., Tramways Bill.—In the House of Commons on Monday the Examiners of Standing Orders ordered the Oldham, Saddleworth, and District Tramways Bill to be set down for second reading, the forms of the House having been complied with. The measure has already passed the Lords.

Bury.—At a special meeting of the Town Council a proposal to rescind a former resolution with the object of extending the Bolton-road tramways to the borough boundary so as to couple up *via* Black-lane with Radcliffe was considered, but the matter was eventually postponed in the absence of the chairman of the Tramways Committee.

Llandudno.—The Board of Trade have granted to the Llandudno and Colwyn Bay Electric Traction Co. an extension of time for the construction of the light railway from Llandudno to Colwyn Bay till the end of the present month, on condition that good progress is made in that time and that satisfactory assurances are given that the line will be completed forthwith.

Derwent Valley.—It is stated that the inquiry by the Light Railway Commissioners into the application of the Escrick and Riccall Rural District Councils for an extension of time for the compulsory purchase of lands for the projected light railway from Duffield to

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Stamford Bridge, which was to have been held at the end of this month, will not now be taken till the autumn.

New Paris Underground Railways.—The French Chamber of Deputies has approved of the establishment of two new lines of underground railways in Paris, connecting the north of the city with the south. The *Paris Bourse* announces that one of these lines will run from the Gare St. Lazare to the Saint Ouen Gate, and the other from the Gare de Montparnasse to the Porte de Versailles.

Stockport.—The new route of electric tramways between Stockport and Hazel Grove was officially inspected on Tuesday of last week on behalf of the Board of Trade by Colonel von Donop, R.E. Colonel Donop remarked that he had never seen a better track in England. Afterwards the Edgeley route was inspected. In the afternoon the route was opened for passenger traffic. The contracting engineers are Messrs. J. and W. S. Briscoe.

Lowestoft.—At the monthly meeting of the Town Council last week the Tramways Committee reported that the traffic receipts for the first three weeks in June amounted to £605. 0s. 2d., compared with £540. 19s. 10d. during the same period last year. The suggestion of running a service of cars along Denmark-road at certain hours of the day had been considered, but the committee were unable to recommend its adoption. The report was adopted.

Sale.—At the meeting of the Urban District Council the chairman announced that an arrangement had been arrived at with the Cheshire County Council whereby in connection with the proposal to lay the tramway along Northenden-road a minimum width of carriageway of 27ft. should be obtained by lessening the footpath width. There was a prospect of the Manchester Corporation proceeding with the tramway along Manchester-road to Altrincham boundary shortly.

Croydon.—The following minute of the Tramways Committee was approved at last week's meeting of the Corporation: "Read letter from the British Electric Traction Co., stating that an application had been made by the secretary of the Croydon General Hospital for consent to alms-boxes being placed in the cars, and submitting a sample box for approval. The committee recommend that the Council raise no objection to the boxes in question being fixed in the cars."

Chili.—The *Diario Oficial* of Chile of April 14 contains a decree authorising Messrs. Manuel and Horacio Valdes Ortúzar to construct and work an electric tramway (1·440m. gauge) for the conveyance of passengers and goods between Santiago and San Bernardo. The *Diario* may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C., any day between the hours of 10 a.m. and 5 p.m. (Saturdays 10 a.m. and 1 p.m.)

Wakefield.—The question of utilising tramway poles as sewer ventilators is under the consideration of the Town Council, and the city surveyor has been instructed to submit a plan to the Wakefield and District Light Railways Co. showing how the connections to the poles are to be made. The Wakefield and District Light Railway Co. have published notice of their intention to apply for an extension of time in which to complete the tramways authorised by their order obtained in 1902.

Newport (Mon).—It is found that the expenditure in working the trams is below the average of similar undertakings in the country, but the receipts per car mile are also below the average. For the past year there is a gross profit of £7,381. 1s. 7d., but after payment of interest and sinking fund (£7,976. 7s.), there is a deficit of £595. 5s. 5d. The Corporation, however, gives some very long stages. There has been considerable delay over the Port Tennant section, but it is expected that a trial trip will be run shortly.

Yarmouth.—At last week's meeting of the Corporation the general manager (Mr. Frederick L. Turner) reported that from June 2 to 23 122,283 persons had been carried at 1d. fares, 20,676 at 2d. fares, 2,280 workpeople, and 335 scholars; 955 parcels were also carried. The receipts amounted to £693. 3s. 10d., an increase of £124. 2s. 6d. compared with last year. The Corporation propose to link up the entire tramway system by going across the Haven Bridge, and the surveyor has been instructed to report on the subject.

Heywood.—At the meeting of the Bury Corporation last week, Mr. Spencer objected to a tender for six new cars, and submitted that the Bury Council were no nearer a settlement with Heywood than they were six years ago. They had no agreement with Heywood. Every agreement proposed either by Bury or Heywood had, so far, been wriggled out of in a most inconceivable fashion, and he considered it unnecessary to go forward with the provision of cars at the present time. The minutes were amended so as to read that tenders for the six cars should be obtained from several firms.

Mansfield.—The first trams ran through Mansfield Market-place and thence over the Albert-street and Nottingham-road route last week, the trial runs being very satisfactory, and the Board of Trade inspection was expected to take place on Tuesday. Nothing has yet been decided as to the service when the cars are running, but a half-hour service until 7 a.m. and subsequently one of 15 minutes will probably be tried first as an experiment. There will be no season tickets, but books of tickets can be purchased at a discount on the full charge, and scholars' tickets will be sold in packets.

Chicago.—It is reported that the Mayor of Chicago, discouraged by the opinions of Mr. Dalrymple as to the applicability of municipal ownership to Chicago, has come to the conclusion that the scheme which he has favoured for the management of the city's traction by the municipality must be dropped for the present. The proposal has been made to the mayor to hand the tramways over on a 20 years' franchise to a body of well-known Chicago citizens, and that the money for the company should be raised by public subscriptions. The city has the right to buy the property at any time at a valuation.

Weston-super-Mare.—The Light Railway Commissioners have held an inquiry into the application for powers to construct a light railway at Weston village from the terminus of the present electric trams to the top of Lansdown. Mr. Michell, representing the promoters, stated that the capital was £15,000, and the great object would be to give access from Bath and district to Lansdown, with its splendid views and bracing air. Mr. H. L. Godden, the engineer to the scheme, stated that he believed if the railway were constructed Lansdown would become a suburb to Bath like Clifton is to Bristol. The Commissioners intimated that they were prepared to sanction the line on the condition that the promoters widened Weston High-street.

Leicester.—On Tuesday afternoon, as the driver of a baker's cart was coming out of Gwendolen-road, in the direction of Humberstone-road, he noticed an electric car approaching him from the direction of Humberstone-road, and took a wide sweep to avoid it. He cleared it all right, but in doing so ran in front of a car coming from the direction of the Evington-road. This car, which had gained impetus while coming down the incline, dashed into the rear of the cart with considerable violence and pushed it into the tram coming from the opposite direction. The cart was sandwiched between the two cars and smashed to pieces. The driver and boy of the bread van were thrown violently out on to one of the tramcars. The driver was seriously injured, but the boy escaped with slight wounds.

Folkestone.—At the meeting of the Corporation last week, the town clerk reported that the committee appointed by the Council had attended the conference of representatives of the local authorities of Folkestone, Hythe, Sandgate, and Cheriton, when the following resolutions were passed: "That this meeting is of opinion it is desirable that a system of tramways should be established within the districts of Folkestone, Sandgate, Hythe, and Cheriton." "That in the opinion of this conference, the local authorities of Folkestone, Hythe, Sandgate, and Cheriton should work together in the matter of tramways, but this resolution is not intended to commit any of the local authorities to any particular scheme, and is subject to the approval or otherwise of the several councils here represented." The town clerk suggested that the Corporation should authorise the sub-committee to attend and take part in such further conferences between representatives as might be thought desirable, which was agreed to.

Pontypridd.—An encouraging report was made to the Tramways Committee by the engineer on the working of the undertaking during the first three months. He stated that, after paying working expenses and setting apart a sum for sinking fund, a profit of £35 had been made. In April the profits reach £51, but in May there was an adverse balance of £59. For the three months, however, they were still £30 to the good. At a meeting of the Electricity Committee Mr. W. Jones enquired on what authority the engineer charged the tramways 1½d. per unit, whereas the power cost them at the generating station 2d. per unit. The engineer remarked that he thought the price had been agreed upon. It was stated that no resolution had been passed, and Mr. Hopkin Morgan then proposed that they continue to charge the tramway department 1½d. per unit, and argued that in the near future they would be able to produce energy at even lesser cost. Mr. William Jones moved an amendment that 2d. be charged, maintaining that one department should not benefit at the expense of another. The motion was carried.

Sheffield.—The Corporation authorities had a car specially illuminated with electric light in view of the visit of the King and Queen. The decorative effect was quite brilliant, and aroused much admiration among the inhabitants. The work was carried out under the personal direction of Mr. Yerbury, chief electrical engineer; Mr. Marsh, electrical superintendent; Mr. Barrow, rolling-stock superintendent; and Mr. Nicholson, car erection superintendent. Another record has been established in the Sheffield tramway receipts for the past quarter. The income for the 13 weeks was £63,182. 6s. 7d., and the amount received in any preceding quarter which was anywhere near that sum was £62,182. 19s. 6d. for the third quarter of last year. The only other occasions on which £60,000 has been exceeded were the third quarter of 1903, when the total was £61,214 11s. 5d., and the second quarter of last year, £60,336. 19s. 9½d. For two weeks during the past quarter the takings were over £5,000. In no previous quarter's return has this occurred. For Easter week the takings were £5,141. 6s. 8½d., and for Whit week £5,557. 6s. 3½d.

Bootle.—At the meeting of the Town Council it was reported that the town clerk had had correspondence with the Liverpool Tramways Committee, who were now prepared to work the proposed tramways in Breeze-hill, Balliol-road, and Miller's Bridge, and the short length in Regent-road, upon the Corporation obtaining a provisional order therefor, and to continue the Breeze-hill line to Walton Church, and pay an additional rental in respect of that line, but that they were not prepared to operate the Linacre-lane and Aintree-road route at present, in consequence of the non-construction of Aintree-road, such new tramways to be constructed and worked under the existing agreement of Sept. 1, 1902. The Highways Committee were of opinion that the proposed Breeze-hill line should not be laid unless the Liverpool Council first agree that such line shall be used for passenger traffic only, but that the proposed line *via* Aintree-road, and that alone, may be used for goods traffic, and that the Council's resolution of Feb. 1, 1905, should be amended accordingly. The recommendation of the Highways Committee was substantially approved.

Cleckheaton.—The renewed application of the Yorkshire (Woollen District) Electric Traction Company that their powers, so far as they relate to the construction of the Hartshead Moor branch of their tramways scheme, shall be allowed to lapse, is meeting with determined opposition from Cleckheaton, where the delay in the commencement of this section has already caused some indignation. So far as Cleckheaton is concerned, this particular section is an important link in the traction company's Spen Valley scheme, and its speedy completion was regarded as so much a matter of certainty that the District Council laid a traction cable in Westgate, the main thorough-

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fare up the Hartshead Moor, at a cost of £500. As the situation stands at present, there is a goodly population between the Cleckheaton Market-place and Hartshead Moor and along Hightown Heights unserved by the cars, and so far as the company's line does run up from Liversedge to Hightown its effect is to tap the district for the benefit of Heckmondwike and Dewsbury. This is a sore point with the Cleckheaton tradesmen, who complain not only of a diversion of trade from this side of the valley, but also from the Gomersal side. The District Council have addressed a strong protest to the Board of Trade against the proposed lapsing of the traction company's powers.

Barcelona Tramways Co.—A meeting has been called for July 21 in order that a resolution may be submitted confirming an agreement, dated June 26, between the company and the Société Financière de Transports et d'Entreprises Industrielles for the sale of the company's undertaking. According to a circular issued to the shareholders, the purchase price is £637,000, of which a deposit of £5,000 has been paid; a further sum of £245,000 is to be paid on completion of the notarial transfers of the concessions, and the balance of £387,000 after the transfer to the purchasers has been completed with all necessary formalities. The company is to retain possession of the tramway until the final payment has been made; but the profits are to belong to the purchasers as from the date of payment of the £245,000, the company receiving 5 per cent. interest on the balance of £387,000 as from that date. The directors estimate that, after redeeming the outstanding debentures and debenture stock, providing for all charges and liabilities, and paying all expenses, the purchase price, plus accrued and accruing profits, will be sufficient to repay the preference capital at par, with accrued interest, and to make a distribution of at least £14 per ordinary share. Since the signing of the contract, a scheme for the unification of the company's concessions has been approved by the municipality of Barcelona. It is proposed that, in consideration of the special services of the directors in negotiating and carrying this contract into effect, a sum of £5,000 should be voted to them.

North-East London Bill.—The scheme for the construction of a railway, partly in tube and partly in the open, to serve the north-eastern districts of London was passed on Tuesday by the Select Committee of the House of Commons. The scheme is practically the same as that which came before Parliament two years ago, and was then rejected on financial grounds. The scheme is for a tube railway from the Monument to Hackney, and from the other side of the Hackney Marshes a continuation of the line as an ordinary electric railway in the open. Passing through Shoreditch, Hackney, Walthamstow, and Chingford, the line will terminate at Waltham Abbey. Its total length will be 14½ miles, of which about four miles only will be in tube. This has, of course, very greatly decreased the cost of construction, which is estimated to average about £275,000 a mile. In giving the committee's decision, the Chairman said that they passed the preamble of the Bill on certain conditions. The promoters must raise one-half of their capital from the date of the passing of the Bill and must have commenced construction within two years of the same date. Further, sufficient room must be left between the top of the tubes and the surface of the ground between the Monument and Hackney to allow of the construction of another set of tubes (presumably those of the Hammersmith and North-East London Co.), and the workmen's fares to Walthamstow from the City must not be higher than those of the Great Eastern Railway Co.

Aberavon.—The Bill confirming the order of the Board of Trade with regard to Aberavon tramways came last week before the Select Committee of the House of Lords. The Glamorgan County Council and the National Telephone Co. had petitioned against the Bill, but the latter withdrew their opposition. Mr. Forbes Lankester, on behalf of the County Council, raised the preliminary objection that the consent of the local authority had not been given to the use of the main road, and that, therefore, the Board of Trade had acted *ultra vires* in making the order. Mr. Ram, for the promoters, suggested that if the Board of Trade was wrong an injunction could be obtained from any judge sitting in chambers. The Chairman said the committee were unanimous in holding that the Board of Trade had acted *ultra vires*, and, therefore, they struck out the tramway upon the main road. Mr. Ram said he would consider with his advisers whether it was worth while going on with the rest of the scheme. After a brief consultation, Mr. Ram said he would prove the preamble of the Bill, and would ask the committee to pass so much of the Bill as was not affected by their decision. He called Mr. J. Morgan Smith, past mayor, and a member of the Corporation of Aberavon for 20 years, who said he believed it highly expedient for the well-being of the neighbourhood that the tramways set out in the Bill should be laid. The necessary meetings of the Corporation and of the ratepayers had been held, and the Bill had been approved by a large majority—practically unanimously. The Bill, as amended, was passed, and ordered to be reported to the House.

Sunderland.—The inquiry respecting the death of the boy Herbert Curry, who was killed in the tramway smash at Silksworth, near Sunderland, on Whit Monday, was resumed on Wednesday of last week. It may be recalled that, owing to the brakes not acting, the car dashed into the wall at the bottom of a hill. Just before the car started down the hill an inspector boarded it, and took charge of the brake handles. When the inquest was opened, one or two witnesses asserted that the inspector jumped off the car before the bottom of the hill was reached, but this he emphatically denied. The motorman, who was injured, now gave evidence, and said he did not see the inspector jump off, neither was he aware, as had been alleged, a passenger was standing on the driver's platform. The general manager of the Sunderland District Electric Tramways Co. explained that there were three brakes on all their cars—the electric brake, the hand brake, and the slipper brake. The two former on the car which ran away were in perfect working order, but some time before the accident one shoe of the slipper brake had been lost. He maintained that for all practical purposes the electric and hand brakes were amply adequate. "If the slipper brake had been efficient," he was asked, "might not the accident have been avoided?" His reply was "Probably." The jury returned a verdict of accidental death, and expressed the opinion that the causes of the accident were a defective brake, overcrowding of the car, and want of sufficient caution on the top of the hill. They informally acknowledged that the company was now taking every possible precaution in working the line.

Wolverhampton.—At the monthly meeting of the Town Council two reports were presented by the Electrical Tramway Committee—one including an abstract of the accounts of the undertaking for the past financial year, and the second containing a recommendation from the committee that the Council should enter into an arrangement with the British Electric Traction Co. for inter-communication between Wolverhampton and some of the townships outside. Alderman Mander opened the debate by moving the reception of the statement of accounts. He stated that they had made a profit of £192 this year, against a loss of £1,090 last year, a difference of £1,282. He thought they set aside too much for renewal of cars, etc., but he considered it was sound finance to do so. It was the way in which they kept their accounts that made them compare unfavourably with some other towns. If they had kept their accounts in the standard way, they would have a gross profit of £15,000 and a net profit of £4,983, instead of only £192. The receipts per car mile were 10·9d. against 10·3d. for Sunderland, which claimed a profit of £6,632. The total operative cost was ¼d. per car mile less than other undertakings, which spoke volumes for the efficiency of Mr. Shawfield and his staff. With the single exception of the number of units per car mile, Wolverhampton showed a better average in general figures than any other town, and the extra cost in units was accounted for by the better lighting utilised on the Wolverhampton cars. In conclusion, he said they wanted to educate the public into using the cars to the extent they did in other towns. He considered the report was very satisfactory, and should be acceptable to the ratepayers. After some discussion the report was unanimously adopted.

Tube Railways.—Three tube railway Bills were considered last week by the Select Committee of the House of Lords presided over by Lord Lauderdale. The object of the Charing Cross, Euston, and Hampstead Railway Bill is to empower the company to carry out certain modifications of the authorised works in connection with the construction of a station and entrance and exit thereto under the forecourt of the South-Eastern Railway Company's station at Charing Cross. Mr. Blennerhassett, K.C., opposed the proposal on behalf of the Westminster City Council, who desired that the entrance to the underground station, which the Charing Cross, Euston, and Hampstead Railway Company proposed to place on the western side of the forecourt adjoining Brewer's-lane, should be made in Villiers street, where it was intended to have the exit. Sir R. Littler, K.C., objected to the demand of the City Council. The committee, having heard evidence and arguments, decided that the Bill might proceed. The various clauses were adjusted, and the Bill was ordered to be reported to the House for third reading. In the Baker-street and Waterloo Railway Bill the promoters sought power to vary the works in connection with the construction of the authorised subway at Trafalgar-square (so as to give an entrance and exit at a point near to where the extension of the Mall opens out into Charing Cross, in accordance with the wishes of the Office of Works) and of the subway at the Elephant and Castle. The committee found the preamble proved, and ordered the Bill to be reported for third reading. The object of the Edgware and Hampstead Railway Bill is to authorise a deviation of the railway at Golder's Green so as to provide a more convenient junction there with the Charing Cross, Euston, and Hampstead Railway. Opposition was offered by the Golder's Green and Finchley-road Estate Co., but in the result the committee passed the preamble of the Bill, and inserted clauses for the protection of the opponents. The Bill was subsequently ordered to be reported to the House.

Newcastle.—At last week's meeting of the Corporation, the Tramways Committee reported as to an interview which they had had with a deputation from the South Shields Gas Co. with respect to the probable effects of laying the tramway lines on the pipes of the South Shields Gas Co. Plans were submitted, from a perusal of which the deputation maintained that it was obvious that frequent interruption of the tramway service would take place, and great expense result, if the permanent way were laid on the top of the gas-pipes, as the concrete bed of the tramways track would require breaking and reinstating. Furthermore, it was pointed out that the close proximity of the electric cables to the gas-pipes might cause considerable damage through the fusion of the latter, and in one part in particular some amount of risk would exist. The directors had come to the conclusion that the real solution of the problem lay in duplicating the gas-mains, so that they might be laid on both sides of the street and underneath the footpath or other approved position clear of the electric lighting cables. The company, however, could not bear the expense of these alterations, as the existing gas distributing system along the tramway routes provided an ample supply for present requirements. The committee recommended that the company be offered the sum of £1,000 if they would duplicate the gas mains throughout the tramway system, this amount to cover all cost to the Corporation in connection with their obligations to the company. Councillor Grant, in moving the adoption of the report, said that the estimated cost of duplicating the mains along the whole of the routes would work out at something like £5,000. The committee considered that they should in all fairness to the company contribute towards the cost of these alterations, having regard to the fact that the roads along which the tramways would be constructed were a network of service pipes. After some discussion, the committee's report was confirmed by 18 votes to 11. The returns for Race week show that all previous records have been outdistanced. The total takings of the week were £5,586, which is no less than £890

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more than the sum realised last year. The receipts per tram mile rose from 12·75d. to 14·82d.

London County Council.—The agenda for Tuesday's meeting of the London County Council contained a recommendation that a vote of £19,000 be made in respect of trackwork in the Aldwych subway, the standing orders having been complied with. It was also proposed that votes of £23,200 and £10,000 respectively be authorised in respect of the reconstruction of lines along the Woolwich-road on the conduit system, and the supply of stoneware cable ducts for the northern system, the latter to be supplied by Messrs. G. Skey and Co. and Messrs. Stanley Bros. At the meeting of the Bermondsey Borough Council last week it was decided to make representations to the County Council with a view to the early electrification of the lines in the borough, in accordance with the expressed wish of the inhabitants. The Lewisham Borough Council have carried a resolution asking the County Council to pave the space between the two tracks of tramways and the 18in. outside the tracks with wood paving, leaving the space between the rails of each track to be paved with Norwegian granite setts. At a meeting of the Wandsworth Borough Council last week the Highways Committee reported the receipt of a letter from the County Council stating that it was proposed to apply for powers to construct the suggested tramway from the present Streatham terminus along Streatham High-road with a loop line along Gleneldon-road, Bournevale-road, and Stanthorpe-road, to the county boundary at Norbury. The Highways Committee of the County Council had decided not to recommend the County Council to revive at present the suggestion for the construction of a tramway from Clapham Common to East-hill, Wandsworth, but they would give careful consideration to any representations on the subject which the Borough Council might desire to make. It was recommended that the County Council should be informed that the Borough Council regretted the decision not to proceed with the scheme for the construction of a tramway from Clapham Common to East-hill, that it should be pointed out that the part of the thoroughfare in the borough of Battersea had already been widened in anticipation of the proposed tramways, and that it was very desirable that the tramways at Clapham and Wandsworth should be linked up by a direct line at the earliest possible date. Councillor Cresswell moved that the County Council should be asked whether they proposed in the 1906 session of Parliament to apply for powers to construct a tramway from Clapham Common *via* Northside, Wandsworth Common, East-hill, and Wandsworth High-street, to the junction of West-hill with Upper Richmond-road. With this addition, the Borough Council confirmed the minutes. The County Council propose to adopt the conduit system for the following tramways: the existing tramways from North-street, Wandsworth, *via* York-road, Battersea Park-road, etc., to Westminster Bridge-road; the new tramways from York-road, Wandsworth, at its junction with North-street, *via* York-road, Red Lion-street, South-street, Garratt-lane, and Defoe-road to join the newly-constructed lines at Tooting; the new tramways from Queen-street, Hammersmith, to a point in Lower Richmond-road near the junction of that road with the approach to Putney Bridge. The road between the tramway rails will be paved with granite setts, as difficulties might arise if wood were used between the rails, owing to the closing of the slot by the expansion of the wood. Outside public buildings, churches, etc., some form of silent paving would be employed if the road authority desired. The Council only propose to pave the margins of the tramways for a width of 18in. with wood or granite, to correspond with the remainder of the surface of the roadway. A large part of the thoroughfares is at present macadamised, and the Highways Committee of the Borough Council are of opinion that the whole of the carriageways outside the rails should be paved with wood and the footpaths with artificial stone. The Borough Council's contribution of one-third (not exceeding £91,316) of the net cost of widening Red Lion-street, South-street, Garratt-lane, and Defoe-road was promised on the understanding that the paving works there would be carried out in this manner. The new tramways between Wandsworth and Tooting and Hammersmith and Putney are to be constructed as double lines throughout, and the County Council propose to reconstruct the existing tramways in York-road as double lines, except between Morie-street and Edgel-street and between Ferrier street and Alma road, where it is intended to arrange the existing single line portions as interlaced lines. The Hammersmith Borough Council decided on Wednesday to make representations to the Board of Trade in favour of the overhead trolley system being adopted on the portion of the County Council's Queen-street to Putney electric tramway to be constructed in the borough. In the House of Commons on Wednesday the County Council's Over-Bridge Tramway Bill was read a third time.

LIGHTING AND GENERAL.

Stafford.—The output of current during the last month shows an increase of 6 per cent.

Dudley.—An exhibition of electrical fittings and appliances will be held in November next.

Hayes.—The Hayes Electric Supply Co. intend to apply for a provisional order for the district.

Fochabers.—The Bellie Parish Council have resolved to light the town of Fochabers with the electric light.

Bray.—The question of appointing an assistant electrical engineer has been referred to a special Finance Committee.

Sale of Business.—Particulars of the sale of an electrical manufacturing business will be found in another column.

Removal.—The offices of Siemens Electric Appliances, Limited, have been removed to 12, Queen Anne's-gate, Westminster, S.W.

Woodbridge.—Messrs. Foote and Milne intend to apply to the Board of Trade for a provisional order to supply electricity within the area.

North Metropolitan Electric Supply Bill.—This Bill has passed both the House of Lords and the Select Committee of the House of Commons.

Halesowen.—The Empire Electric Lighting Co. propose to apply to the Board of Trade for a provisional order to enable them to supply the district.

New Title.—The name of the Electric Railway and Tramway Works, Preston, Lancs, has been changed into the United Electric Car Co., Limited.

Electricity Shares.—Shares of the London electric lighting companies fell after the second reading of the London Power Bill in the Commons.

Burgess Hill.—An application of the National Telephone Co. to lay underground pipes along certain streets has been acceded to on certain conditions.

Burnham.—The Slough and Datchet Electric Supply Co. intend applying for a provisional order to include this parish, and have asked the Council to support it.

Durham Electricity Bill.—The Bill introduced for the purpose of confirming the Durham district electric lighting provisional order has been reported for third reading.

Clacton.—The Urban District Council have received four notices from different companies of their intention to apply for orders to supply electricity in the district.

Obituary.—We regret to announce the death of Mr. John Thomas Connolly, one of the directors and one of the founders of the firm of Messrs. Connolly Bros., of Manchester.

Uckfield.—The Urban District Council have deputed the Highways Committee to consider the whole question of public lighting, and the possibility of effecting some improvement.

Newport (Mon.).—The Electricity and Tramways Committee have decided to recommend that on the motor installation account a sum equal to 7½ per cent. be set aside for deterioration of motors.

Seaton.—Messrs. J. and W. Purvis, electrical engineers, Exeter, intend to apply for an electric light provisional order for the area of supply of the urban district. The Council will oppose the application

Lowestoft.—During last month eight new consumers were connected to the mains, representing 279 8-c.p. lamps. There are now 627 consumers connected to the mains, representing 31,852 8-c.p. lamps.

Short Heath.—The Council have asked the Midland Electric Supply Co. if it was their intention to extend their mains into Short Heath district, and what would be the cost per lamp for public lighting.

Aspull.—The District Council are asking the Board of Trade to further extend their electric lighting order. It is stated that a satisfactory arrangement has been arrived at with the Wigan Corporation.

Iceland.—It is reported that the King of Denmark has granted to the Great Northern Telegraph Co. a concession for the laying and working of a telegraph cable between the Shetland and Faröe Islands and Iceland.

Weybridge.—The Urban Electric Supply Co. intend to lay cables from their works to the Weybridge boundary in Oatlands Drive. The surveyor has been asked to arrange with the company to commence the work at once.

Wisbech.—The Local Government Board have, we understand, refused to grant the application of the Corporation for powers to raise a loan of £25,000 for the purpose of establishing a municipal electric lighting department.

Cardiff.—The Electrical and Lighting Committee propose to erect, at a cost of £2,200, a sub-station in Cathays Park, near Park-street, to be exclusively used for the distribution of electric lighting and power within the park.

Alnmouth.—Mr. Percy Harvey, Collingwood-street, Newcastle, electrical engineer, has applied to the Board of Trade for a provisional order to enable him to supply electricity for all public and private purposes within the town.

Newton Abbot.—The Urban Electric Supply Co.'s estimate for wiring the Guardians' building and providing 42 lights is £26. 10s., and the cost of the current 4d. per unit. The estimates are now referred to the Building Committee.

St. Annes.—During May 35,271 units of electricity were sold, as compared with 42,694 in the corresponding period of last year. Up to May 31 there were 75,996 units sold, as against 87,477. The number of consumers is 339, an increase of 75.

Wallsend.—According to the local Press, the supporters of electric light are going to have another try to get part of the town lighted by electricity. The electric company are to be asked to give a price for the efficient lighting of certain new streets.

Wantage.—The Wantage Engineering Co. intend to supply the town with electric light. The Urban District Council do not object to the introduction of electric light into the town upon condition that the introducer apply for a provisional order.

New Issue.—The Northern Counties Electric Supply Co. are issuing at par £100,000 4½ per cent. first mortgage debenture stock, payable as follows: on application, £10 per cent.; on allotment, £40 per cent.; on Oct. 1, 1905, £50 per cent.

Houghton-le-Spring.—The Electric Lighting Provisional Order (No. 7) Bill, which will confirm an order granted to Houghton-le-Spring, has passed the House of Commons, and has been ordered to be reported for second reading in the Upper House.

Wakefield.—A sub-committee has been appointed to confer with the appointed representatives of the Sanitary and Electric Lighting

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Committees as to the cost of working the destructor and the allocation of such cost upon the several committees concerned.

Wakefield.—The Electric Lighting Committee have made a net profit on the past year's working of £1,283, of which £895 has been repaid to the general district fund in order to write off a loan, leaving a net amount of £392 to be transferred to the reserve fund.

Edinburgh.—Out of the ascertained balance of £21,139 on the electric light account £17,095 is to be credited to the reserve fund and £4,044 to streets account, towards the replacement and depreciation in the streets caused by the electric light department.

Loughborough. — The Gas and Electricity Committee have appointed a sub-committee to consider and report upon the question of a revision of the prices for current for power and lighting, and also on the question of the advisability of revising the existing regulations.

Dover.—The audited accounts of the electricity department for the working of the undertaking since the beginning of last year until March 31 this year show that, after paying all that has to be paid, the sum of £1,475 has been carried forward, leaving a balance of £1,231 in hand

Worksop.—The electrical engineer's plans and particulars of proposed additional plant at the electricity works, at an estimated cost of £800, have been approved. Application is to be made for sanction to acquire an additional loan of £3,000 for electric lighting purposes.

Wandsworth —The Council have decided to withdraw their opposition upon the promoters of the Administrative County of London and District Electric Power Co.'s Bill undertaking to amend the Bill so as to include the borough of Wandsworth in the industrial portion of the area of supply.

Direct United States Cable Co.—The directors recommend a final dividend of 3s. per share, with a bonus of 1s. per share, making a total distribution of 3½ per cent. for the year ended June 30. The sum of £6,000 has been placed to reserve, leaving a balance of about £2,525 to be carried forward.

Redcar.—The Urban District Council have declined to treat with the United Electric Construction Syndicate with respect to their taking over the order obtained by the Council four years ago, and the Council are now negotiating with the Cleveland and South Durham Electric Power Co. for the supply of electricity in bulk.

Bradford.—The Electricity Committee will again recommend the City Council to provide a motorcar for the electricity department. The committee consider that a car is required to enable the necessary constant supervision to be given to the work of mains extensions and also for the overlooking of the general work of the department.

Outing.—The employés of Messrs. Stegmann and Co., electrical engineers, St. John's-hill, Clapham Junction, had a most successful outing to Brighton. Through the unavoidable absence of Mr. Stegmann, the respected chief, the chair was taken by Mr. Stenford, the firm's manager, at the annual dinner, which was partaken of at the Queen's.

National Telephone Co.—The directors recommend the following dividends for the half-year ended June 30 last, after payment of the dividends on the preference shares: at the rate of 6 per cent. per annum on the preferred stock; at the rate of 5 per cent. per annum on the deferred stock, carrying £110,000 to reserve and about £9,500 forward.

Frome.—The Urban District Council have decided to borrow another £11,000 for the purposes of the electrical works. Mr. Medhurst, the Council's consulting engineer, in his last report states that the demand for electricity had been unprecedented for a town of the size of Frome. He hoped this additional £11,000 would carry the works to 1908.

Paisley.—The Gas Committee propose to instal electric plant for supplying power for coke conveyors. On Monday last the staff and employés of the Corporation electricity department, accompanied by the convener (Bailie Fisher) and the chief engineer (Mr. Parkinson), held a successful annual outing. This year the route chosen was the Loch Eck tour.

Ayr.—The burgh electrical engineer, Mr. Roland Marshall, in his last report gives the following figures: number of consumers as per last report 917, connected during month 6—total, 923; number of lamps connected as per last report 38,612, connected during month 158—total, 38,770; units generated as per last report 53,309, units generated during month 55,652—total, 108,961.

Change of Title.—The partnership hitherto existing between Mr. R. G. Tyler and Mr. W. E. Duncan has been dissolved owing to the latter having accepted an appointment in Canada. Mr. Tyler has taken into partnership Mr. E. H. Freeman, A.I.E.E., late of Johannesburg, and they will continue to carry on the business at 20, New Bridge-street, E.C., under the title of Tyler and Freeman.

Easthampstead.—The Mutual Electricity Supply Co. intend to apply to the Board of Trade for an electric lighting provisional order for the Sandhurst parish, and the Camberley Electric Supply Co., of Moorgate-court, Moorgate-place, London, also intend to apply for a provisional order to supply electrical energy for public or private purposes within the area of the jurisdiction of the Easthampstead Rural District Council.

Swansea.—Mr. Prusmann in his last report stated that there were 667 consumers on the books, that the engine, etc., had been removed to the destructor works, and that electrical energy for the working of the trams on the Brynbyfryd and Morriston sections would probably be ready by the end of August. Owing to the heavy cost of extending the mains, etc., he could not recommend the committee to electrically light Libanus Chapel, Cwmbwrla.

Louth.—An inquiry has been held into the application of the Town Council to borrow £17,000 for the purpose of installing electricity within the borough. Mr. Dykes, consulting engineer to the Corporation, said he estimated that the plant would be capable of producing electricity at 6d. per unit, to bring in a total revenue of £3,200 per annum. He estimated expenses at £1,075, leaving a balance of £2,125 to meet interest and sinking fund and depreciation.

Ledbury.—Messrs. Foote and Milne intend to apply for a provisional order to supply electricity within the Ledbury urban district. Two or three months ago a sub-committee was appointed to take into consideration the lighting of the town, and to canvass the townspeople to ascertain the probable number who would adopt electric lighting if established, the probable cost as compared with gas, and all other necessary information. We understand nothing has been done yet.

Croydon.—The borough electrical engineer's last report states that 36 applications have been received for private lighting, being equivalent to 1,444 8-c.p. lamps. Twenty-nine consumers have been connected, being equivalent to 958 8-c.p., and 945 yards of extensions of mains have been carried out. He adds the following figures: Current sold this year—public lighting, 27,357 units (corresponding period last year, 25,675 units); private lighting, 71,807 (68,217); traction, 133,521 (118,210).

Mitchelstown.—All the preliminaries in connection with the electric light scheme have been completed, and it now only remains for the No. 1 Council to invite tenders for the work. The ratepayers are very much in favour of the project, and at a recent meeting in the town hall a resolution to go on with the scheme was passed without a dissentient voice. A memorial in favour of the scheme, and promising to avail of it for domestic purposes, was signed by a large number of ratepayers recently.

Margam.—The District Council have agreed to an application of the South Wales Electrical Power Distribution Co. to run power mains through the district for 30 years, the Council to have the option of terminating the agreement at the end of five years, giving six months' notice to the company; the latter to pay 2½ per cent. on total energy supplied by them to users, minimum £50 yearly. The company is to lay down cables to suit future requirements of the district, and power not to be supplied for lighting.

Maidenhead.—From Sept. 30 next the Town Council will offer, as an alternative to the present flat rate of 5d. per unit for electricity, a sliding-scale rate on the basis of 7d. per unit for a consumption equivalent to one hour per day of maximum demand and 2d. per unit for all additional consumption. The present maximum rate for electricity for power purposes is 2d. per unit, and the Council are prepared to supply for these purposes to large users at lower rates according to the duration of the demand per day.

Felixstowe.—The number of electric light consumers have increased from 225 last November to 250 on June 24. Regarding an account of £120. 0s. 2d. for various works, as approved by the committee and certified by the engineer to the Suffolk Electricity Supply Co., Mr. Woodmancy suggested at the last Council meeting that it would be advisable to appoint the surveyor as deputy engineer to overlook any similar work in the future. Mr. Cowles, the chairman of the committee, said the committee would consider the suggestion.

Perth.—The Town Council have passed a report containing recommendations that on the Perth Bridge 19 incandescent lamps are to be replaced by four arcs fixed to the tramway poles at an initial cost of £10 each, and an annual cost of £11 each for lighting—a total of £44, and a saving of £22. 10s. per annum; and that in King-street 12 incandescent lamps are to be replaced by five arcs fixed on the tramway poles at an initial cost of £10 each, and an annual cost of £11, which would involve an annual increase of £13 on the present system.

Islington.—On the North Metropolitan Electric Power Supply Co.'s Bill coming before the Select Committee of the House of Commons, Sir Ralph Littler, K.C., for the promoters, asked for costs against the Islington Borough Council, who had not given notice of their withdrawal of opposition. The Chairman of the Committee said that the committee had no jurisdiction in the matter of costs. The Bill was now unopposed, and would, consequently, have to come before the Unopposed Bills Committee of the House, when the question of costs could be raised.

Stock Exchange.—The Stock Exchange Committee have been asked to appoint a special settling day in Electro-Pest-Ocal Co.'s 40,795 shares of £1 each, fully paid, Nos. 1 to 7 and 43,508 to 84,295; and to allow the following securities to be quoted in the official list: Cordoba Light and Power Co.'s £100,000 first mortgage sterling 5 per cent. bonds of £100 each; River Plate Electricity Co.'s 119,694 ordinary shares of £1 each, fully paid; 100,000 6 per cent. non-cumulative preference shares of £1 each, fully paid; and £194,684 5 per cent. debenture stock.

London County Council.—On Tuesday it was decided to lend the Battersea Borough Council £8,820 for electric light installation, and the Bermondsey Borough Council £6,796 for electric light installation. Tenders were received for supply, delivery, and erection of four sets of high and low tension switchgear for tramways sub-stations at Battersea, Clapham, Streatham, and Wandsworth; for supply, delivery, and erection at Battersea and Wandsworth tramway sub stations of low-tension feeder switchboards; and for roadwork and platelaying required for construction for electric traction of tramways from Wandsworth to Tooting.

Gillingham.—The resident engineer's last report shows that the equivalent of 7,846 8-c.p. lamps had been connected with the mains since the last meeting of the committee, including 7,745 at the Naval Hospital; that the equivalent of 24,000 8-c.p. lamps had been temporarily connected for the Kent Electric Power Co.; and that there are now, inclusive of the Kent Electric Power Co., 240 consumers, with 46,223 8-c.p. lamps connected. At the last Town Council meet-

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ing a letter was read from the Kent Electric Power Co. conveying to the Corporation the expression of the company's appreciation of the kindly manner in which the Corporation had rendered assistance to the company.

London Gazette.—Proofs and claims re the Yorkshire Electric Tramways Construction Syndicate are to be sent in by Aug. 19 to Mr. W. A. Andrews, 14, Victoria-street, S.W. A general meeting will be held at 1, Cheapside to receive liquidator's accounts of the Edmondson Electricity Meter Syndicate on Aug. 14. The last day for receiving proofs in the estate of Charles Aubrey Smith, trading as C. J. Smith, electrician, 23, King-street, Regent-street, and residing at 6, Granard-road, Wandsworth Common, is July 26. The last day for receiving proofs in the estate of Edward Lacy, engineering manager, 101, Oakley-street, Lambeth, is July 22. Mr. G. W. Chapman, Bankruptcy-buildings, Carey-street, W.C., is the official receiver.

Pamphlets.—We have received an interesting illustrated pamphlet from the Sunderland Forge and Engineering Co., Pallion, Sunderland, dealing with the induction motors manufactured by that firm. Curves are given showing braking tests of the 15-h.p. induction motor for 220 volts, eight poles, 50 cycles, 725 revolutions. Messrs. Mountain and Gibson (successors to the McGuire Manufacturing Co.), engineers, Eton Fold Works, Bury, Lancashire, have published an illustrated pamphlet descriptive of their works and of their specialities shown at the current Electric Tramway and Railway Exhibition, which include various types of tramway cars, electric motorcars, sweeping, watering, and sprinkling cars, motor trucks for tramways and railways, trolley poles, lifeguards, etc.

Finchley.—An inquiry has been held into the Urban District Council's application for sanction to borrow £23,500 for electric lighting purposes. Mr. Calvert, the electrical engineer, said there were now 496 consumers, averaging 47 8-c.p. lamps each. The Council supplied power to the tramways under a 12 months' agreement. They were under no obligation to supply the company, who had laid their own mains into the Council's works; the company had power of their own. Mr. Calvert then submitted details as follows: machinery, £5,450; water supply, £2 180; buildings, £350; coal, £1,200; sub-station, £5 200; mains, £1,320; distributors, £2,280; streets not specified, £1,770; service connections, £2,200; contingencies, office expenses, inspection expenses, and loan charges, £1,550 — total, £23,500.

Dublin.—The Lighting Committee required a loan of £60,000, £13,000 of which was needed to extinguish the balance of the original extension, and £47,000 to carry them over the work which was immediately pressing. The Local Government Board, however, suggested that instead of going in for successive loans and inquiries they should apply for a comprehensive loan at once. The Lighting Committee, therefore, recommend an application for a loan of £100 000, and that the work should be carried out by their own staff under the superintendence of the city engineer, with power to call in Mr. Hammond for consultation at certain specified fees, not, of course, 5 per cent. on the works as before. A motion to that effect is under consideration. The output of electrical power during the last 12 months has exceeded that of the corresponding period by about 1 000,000 units, and the increase is steadily continuing.

Longton.—The following is the report of the Electricity Committee for the year ending March 31, 1905: "In connection with the electric lighting station there have been added during the year, in incandescent and arc lamps, motors etc., an equivalent of 1,284 8-c.p. lamps, making a total of 6,462 8 c.p. lamps fixed to March 31, 1905. The working profit for the year amounts to £692. 15s. 11d. The balance brought forward from last year (£1,582. 17s. 4d.), together with interest and sinking fund charges £1,218. 7s. 6d.), and the amount of capital written off (£373 4s. 6d.), makes a total of £3 174. 9s. 4d. From this must be deducted £692. 15s. 11d., being surplus of revenue account, and £1,719. 12s. 5d., amount received from gas department, leaving a balance of £762 1s. Your committee also recommend that £300 be set aside as depreciation of plant, thus making a debit balance of £1,062. 1s. to carry forward."

Radiators.—The Sheffield Corporation electric supply department, in advocating the installation of radiators as a means of absolute prevention of down draughts, prints a letter from the Burngreave Congregational Church, in which the minister, the Rev. T. T. Broad, says that, after trying other means, the experiment was made of heating the upper air with 20 electric heater lamps hanging about 7ft. from the ceiling. He says: "The relief was immediate. After a trial lasting since the end of November, 1904, and during the severest months of the year, the testimony is uniform in all parts of the church that this new method of dealing with a great difficulty has been most successful. Before having the heater lamps fixed permanently, public invitations were given to the people to state if they still felt any down draughts. I am glad to be able to say that no complaints have been received, but that all join in declaring that the draughts have been stopped. It is a matter of thankfulness to us all that we have attained this efficient and satisfactory result. Perhaps you would like to know that the heater lamps are usually turned on half an hour before the commencement of the service."

Ipswich.—An inquiry has been held into an application of the Town Council for sanction to borrow £2,438 and £12,851 for purposes of their electric lighting undertaking. Mr. Will Bantoft, town clerk, explained that £2,438 was required for a 350-i.h.p. engine set, and equalising switch, two additional panels on switchboard, and additional pipework for the two new engines. The amount of £7,486 was for balances of retention money and outstanding liabilities on contracts, amounting to £978. 13s. 5d., and liabilities incurred for the additional boiler, engines, and dynamos, pipework and switchboard panels, and the feed-water well. The sum of £5,365 was required for mains extensions, etc. Mr. Ayton, the manager of the undertaking, gave some particulars regarding the enterprise. At the end of their broken financial year ending March 31, 1904, they had 98 consumers, representing 7,580 8-c.p. lamps. At the end of the following year the number of consumers had increased to 209, and the number of 8-c.p. lamps wired and connected to the Corporation mains was 27,557. At the end of June they had 29,927 lamps, and if they added the lamps applied for, the total would now be 30,081.

National Telephone Co.—At the annual staff dinner of the National Telephone Co. last week, Mr. W. E. L. Gaine, general manager, stated that there were 1,155 exchanges working in Great Britain and Ireland, an increase of 60 during the year, and 336,000 stations, an increase of 40,000. The messages numbered 1,000 millions per annum. Whilst their telephone messages had increased by 70 or 80 millions in the year, the total number of telegrams had gone down from 84½ millions to 82 millions. They had 725,000 miles of wire in Great Britain, two-thirds of which were underground. With regard to the negotiations with the Government for the acquisition of the company's undertaking, they had resulted in an agreement which, if it met with the approval of Parliament, would take effect in January of 1912. He regretted the omission from the agreement of adequate and fair provision for ultimately dealing with the company's staff. He added that the agreement as it stood did not represent the views of the directors. However, the last word on this matter had not yet been said, and the staff would have the opportunity of putting its own case before the Select Committee.

Fishing Vessels.—The steam line-fishing vessel "Vigilant," owned by Captain Forbes, Torry, has been fitted with an installation of electric light, and it is thought that the satisfactory results obtained after a thorough test are likely to lead to a general introduction of this system of lighting on small steam vessels. The "Vigilant" has been fitted with a high-speed single-acting steam-engine, coupled direct to the dynamo, on the same bed-plate, suitable for 30 to 35 16 c.p. lamps at 100 volts. This set has been specially designed for the lighting of small steam vessels. The space occupied is only 4ft. by 2ft., an important factor on small boats owing to the limited space available in the engine-room. The main switchboard is fitted close beside the dynamo, with switches to control all the signal lights, etc. The three signal lights are of 32 c.p. each. A portable cluster of three 32-c.p. lamps is fitted where the fishermen haul in their lines, and a similar cluster where they shoot their lines. There are five bulkhead lights in the engine-room casing and wheel-house for deck lighting, cabin, galley, fishroom, engine-room, etc. The wiring throughout the vessel is carried in galvanised iron tubing, and made thoroughly watertight. The installation was carried out within a week under the supervision of Mr. W. Walker, consulting engineer. After three weeks' trial the engineer of the "Vigilant" reports that there has been no increase in the coal consumption, and thus the lighting of the vessel will cost very little more that the initial cost of the installation. The engine, dynamo, and complete installation were supplied by Claud Hamilton Limited, Aberdeen.

Southwark.—The General Purposes Committee are considering a letter from the secretary of the County of London Electric Supply Company stating that they are prepared to submit proposals for dealing with the electric lighting undertaking of the Council on either of the following alternative bases: (*a*) to supply current in bulk for distribution by Council at a price cheaper than it can be generated by the Council; and (*b*) to take over the undertaking on lease and work it for a period of years, and guarantee a sum sufficient to provide sinking fund and depreciation on the capital expended. At the last Borough Council meeting the same committee reported upon a letter from the City of London Electric Lighting Company, in which it was stated that it having been publicly reported that the Council might be disposed to consider an offer to supply electrical energy in bulk upon terms which would enable the Council to produce a considerable annual profit, they would, if the Council supplied information as to their probable requirements, be pleased to state the terms on which they would be able to supply such bulk. Further, that the company being located in Southwark was evidently the best adopted for connecting up with the Council's area of supply, the only requirement being the laying of a feeder main or mains across the parish of St. Olave's. Subject to the work being carried out, the company would begin the supply at once. The committee were informed that the area of supply of the company does not touch the area of supply of the Council, therefore they recommended the Council not to take any action in the matter. This was agreed to.

South Wales Electrical Power Distribution Co.—"Electrics," the official publication of the company, gives the following particulars under the heading of "What the Generating Stations are doing": "In our first issue, under 'Bridgend,' we referred to the erection of a 70-kw. two-phase alternator. This work has now been completed, and is running on load. At Cwmbran the work on the extension is being actively pushed forward. The extension of feeders to Risca to supply the United National Colliery and other customers has been commenced. At Neath the agreements for the supply of electricity in bulk to the Urban District Council of Briton Ferry and the Rural District Council of Neath have been completed, as has also an agreement with the Urban District Council of Llanelly. The extension of the mains to Aberavon is now in hand. The Carmarthenshire Power Co.'s Bill has received the Royal assent, and work on the mains to supply this additional area will shortly be begun. At Pontypridd the third 3,000-h.p. steam alternator has been tested, and will shortly be running on load. The extension of mains to Ferndale is completed. In an article which appeared in our first issue on 'Haulage Gear at the Albion Colliery,' reference was made to the extensions of the system, part of this has now been done, a second 200-h.p. haulage gear being connected to the supply received from this station. The Locketts Merthyr Colliery Company have placed an order with the Westinghouse Company for electrical machinery for various purposes, amounting to about 500 h.p. Surveying is being proceeded with of the high-tension overhead lines from the Cambrian Colliery to the Ogmore Valley."

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Glasgow.—The Electricity Committee's accounts for the year ended May 31 show a gross revenue of £186,371. 13s. 11d. and a working expenditure of £71,721. 6s. 2d., which, with the deduction of interest on loans amounting to £38,182. 7s. 11d. and £15,475 to the sinking fund, leaves a balance on the year's working of £60,992. 19s. 10d. From this total there has been deducted £2 875. 10s. 11d., being the proportion of the cost of lamps and fittings supplied to consumers consequent on change of voltage, and the net balance over expenditure is thus £58,117. 8s. 11d. A sum of £41,840. 17s. 3d. has been written off as depreciation. This leaves a surplus on the year's operations of £16,276. 11s. 8d., from which £3,553. 19s., the sum at debit of profit and loss account brought forward from last year has to be deducted, which leaves £12,722. 12s. 8d. The revenue has increased by £28,181, while the working charges have only increased £10,982 The cost of generation and distribution shows a slight decrease in proportion to the quantity of electricity generated. Owing principally to economy in fuel and repairs the balance on the year's ordinary working is £60,993, as compared with £45,222 last year. The capital expenditure during the year amounts to £125,114. 18s. 10d., making the total capital expenditure as at May 31. 1905, after deduction of the depreciation noted above, £1,244 162. 12s. 10d. There is a noticeably large sale of current for power. The favourable results of the year's operations have justified the committee in proposing a substantial reduction in the charges for current used for private and stair lighting purposes, and the rates have been reduced from 6d. and 1d. on the maximum demand system of 3½d. for the first two hours and 1d. thereafter. For stair-lighting purposes the charge has been reduced from 25s. to 15s. per annum, while the charges for current for motive power purposes remain as last year. The quantity of electricity sold to private consumers during the past year was 16,642,253 units, as compared with 13,604,119 units during the previous year, being an increase of 22·36 per cent.

York.—Mr. C. A. Midgley, the city electrical engineer, in his annual report remarks that the income has expanded normally, but the expenditure of the past year has been heavy owing to the starting of new plant and the running of the old station without the condenser for eight months. He expresses every confidence that the current year will be a satisfactory one. The additional number of lamps connected to the mains during the year amounted to 9,819 8-c.p. lamps, making the total number connected 63,293. About 904,000 units were sold during the year, as compared with 776,542 units in the previous year, being an increase of 18 per cent. The revenue from the sale of the 904,000 units was £10,704, which works out at 2·84d. per unit sold. This is the highest rate received for the last three years. The income per unit for the year ending March 31, 1903, was 2·73d., and for the year ending March 31 1904, 2·76d. per unit. The gross profit was £5,021, being equal to a yield on the capital of the undertaking of 3¾ per cent. This figure is practically the same as the committee had achieved in previous years, but the increased interest and sinking fund account this year is £6,850, as compared with £3,799. 4s. 3d. in the year ending March 31, 1904. The number of motors now connected to the mains is 147, with a total horse-power of 660. This shows an increase in the year of 37 motors, with an increased horse-power of 130. The units sold under this section amount to 230,677, against 184,427 in the year 1903 4, being an increase of 25 per cent. The capital expenditure on motor letting is £4,960, and the income received from the rent of motors £460 per annum. The income derived for current power is approximately £100 per month, making the yield on the motor-hiring scheme 36 per cent. The income received from the sale of current for motors and the rent for the loan of motors will more than pay the coal bill for the whole of the station. The number of consumers now connected to the mains is 558, having increased from 470 in the previous year, being equal to an increase of 19 per cent. The maximum load on the station has increased from 661 kw. to 810 kw., being an increase of 24 per cent. The capacity of the plant is 1,860 kw., which leaves a sufficient margin without any extension for the coming winter. The first part of the alterations in the arc lighting is now completed, and there are now 27 Gilbert lamps put up in the centre of the city in the place of the old pattern lamp, and the improvement is admitted on all hands to be very great. The destructor during the past year has destroyed 10,657 tons of refuse, compared with 8,664 tons in the previous year. This plant has suffered very severely in the matter of repairs, and sufficient steam has not been procurable for carrying out the requirements of the department. There has not been a stoppage of the supply of electricity in the city during the last 12 months, and only one accident of a serious nature amongst the employés.

Bristol.—We extract from the accounts of the electricity department for the year ending March 25, 1905, as follows: The number of consumers on March 25, 1905, was 2,677, being an increase of 283 during the year. The total connections to the mains are equivalent to 274,166 30-watt lamps (as compared with 234,098 at the corresponding period of last year), made up as follows—viz: 79 886 taking energy at the power rate, 185,837 taking energy at the lighting rate, 8,383 representing the public street-lighting—this being an aggregate increase equivalent to 40,068 lamps, as follows: power connections, 22,651; private lighting, 17,411; public lighting, 105. The number of units sold was: private lighting, 2,400,392; power, 1,758,911; public lighting, 838,056—a total of 4,997,359 units; being an aggregate increase of 697,855. The use of electric motive power has continued to increase, the total units sold showing an increase over the previous year of 534,235. The gross receipts amounted to £59,687. 6s. 8d. and the gross expenditure to £31,935. 10s. 11d., leaving a gross profit of £37,751. 15s. 9d. available towards payment of dividends on stock and interest on loans and repayment of money borrowed, which amounted to £17,167. 19s. 4d. and £9,722. 18s. 3d. respectively. The net profit is £13,269. The total capital expenditure to March 25 last was £590,983, and the mortgage debt £499,240 after paying off or in stock redemption fund the sum of £74,840. The balances at credit of reserve fund and of depreciation and contingency account were £10 000 and £6,000 respectively, and £951 for unappropriated funds were carried forward. The following figures show that the number of consumers connected, etc., were: 1904 5, 2,677 (1903-4, 2,394); increase during year, 233 (297); equivalent in 8-c.p. lamps connected to date, 274,176 (234,998); added during year, 40,078 (51,964); number of units sold, 5 217,528 (4,299,504); revenue from lighting, £45,531 (£42,933); revenue from power. £9 084 (£6,634); revenue from public lamps (energy only), £3,918, (£7,317). Coal and other fuel in 1904 5 cost ·412d. (1903-4. ·59d.); oil, waste, and water, ·047d. (·05d.); wages of workmen, ·290d. (·30d.); repairs and maintenance, ·190d. (·17d.)—making a works cost of ·959d. (1·11d.). Rents, rates, and taxes absorbed ·158d. (·16d.); and management, salaries, office and legal expenses, and insurance, ·251d. (·31d.)—making the total cost 1·379d. (1·58d.). The maximum charges for private lighting during 1904 5 were 5d. and the minimum 2·33d., and those for private power, 1·5d. and ·83d. Mr. H. Faraday Proctor, the city electrical engineer, says with regard to fuel that last year he was able to report that the coal bill per unit sold had been reduced by 10 per cent., but the coal bill per unit sold has been reduced by a further 25 per cent., and each of the other items show a small reduction, the net result being a reduction in the total cost of generation and management from 1·58 in 1904 to 1·38 in 1905, being a reduction of over 12¼ per cent.; and whilst the average price obtained has fallen from 3·31d. in 1904 to 3·11d. in 1905, the net profit after payment on account of redemption of capital and interest on capital, amounts to rather more than ½d. per unit, being greater than that of any year since 1898, at which time the price charged was 6d. The second instalment of the works which was erected in the year ending March, 1904, has been completely equipped as regards the boiler-house portion, and in the engine-room the machinery foundations are completed and the auxiliary plant in place. Of the main generating plant, one set of 600 kw. will be supplied by Messrs. Siemens Bros. and Messrs. Parsons, and one set of 750 kw. entirely by Messrs. Parsons. These two sets will give alternating current for general lighting supply. Two remaining sets, each of 1 000 kw., are being supplied by Messrs. Willans and Robinson in conjunction with Messrs. Dick, Kerr, and Co., the whole of the before-mentioned machines being steam-turbine sets The last-mentioned will generate three-phase currents at a pressure of 6,000 to 6,600 volts (the existing high-tension alternating currents being generated at a pressure of 2,000 volts). These will be the largest machines yet installed by the department and will be used for running the motor-generators at Temple Back works and at other sub stations, and will also supply three-phase current in any outlying districts, where the distance from the generating station is too great to allow of economical transmission at the pressure of 2,000 volts. The four new boilers are of the same type as hitherto used—viz., Babcock and Wilcox water-tube boilers, working at a steam pressure of 200lb., and equipped with superheaters supplementing the natural temperature of the steam by an additional 200 deg. F. Each of these boilers has an evaporative capacity of 18,000lb. of water per hour when using a local slack coal; the heating surface of each boiler is 5,160 square feet, as compared with 4,784 square feet and 4,020 square feet heating surface, being the size of the respective instalments of boilers hitherto put in in these works.

PROVISIONAL PATENTS, 1905.

JULY 3.

13633. Improved central exchange telephone systems. Bertil Brander, The Deutsche Telephonwerke, Zeughofstr. 7, Berlin, Germany.

13638. An arrangement for raising electric tramcar windows. Clarence Adolphus Cass, York-street, Bury, Lancs.

13653. Improvements in or relating to liquid controllers. William Sylvanus Shields and William de Forest Jones, 111, Hatton-garden, London.

13676. Improvements in point shifters for tramways and the like. George Dudley Aspinall Parr, Norfolk House, Norfolk-street, Strand, London.

13677. Improvements in electric condensers. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13678. Improvements in signalling by electromagnetic waves. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13679. Improvements in aerials for the transmission and receipt of electromagnetic wave energy Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13681. Improvements in regulating mechanism for arc lamps. James Brockie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13682. Method and apparatus for the manufacture of electrical condensers. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Akt.-Ges., Germany.) (Complete specification.)

13688. Improved construction of electric switch. Carl Schmahl, 175, Fleet-street, London.

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13688. Improved method of braking cars propelled by alternating-current electric motors. Siemens Bros. and Co., Limited, and Francis Lydall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

13689. Improvements in the method of deviating or drawing out electric arcs or electric discharges, and also apparatus for chemical decomposition and combination of gases, for instance air, by means of such deviated or drawn electric arcs or electric discharges. Richard Core Gardner, 173, Fleet-street, London. (Johan Jetmund Thoresen and Filip Tharaldsen, Norway.) (Complete specification.)

13690. Improvements in electric furnaces. Paul Girod, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 4, 1904, being date of application in France.) (Complete specification.)

13696. Improvements in alternating-current electricity meters. William Hamilton and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

13706. Improvements in and relating to electric motors for use with either alternating or continuous currents The Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 4, 1904, being date of application in Germany.) (Complete specification.)

13707. Improvements in and relating to fluid-pressure brake systems for railway and tramway vehicles and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States. (Complete specification.)

13708. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.) (Complete specification.)

13709. Improvements in systems of motor control. Frank Edwin Case, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 2, 1904, being date of application in United States.) (Complete specification.)

JULY 4.

13713. Improved means for electrically or otherwise signalling from one part to another of a theatre, building, ship, and the like. Edward Broadley, 26, Paradise-street, Birmingham.

13779. Improvements in apparatus or appliance for more readily adjusting the trolley wheel of arm of electric cars to the overhead wires. Thomas Frederick Stidolph, 3, Malden road, Colchester.

13782. Inverted incandescent lamps. John Thomas and Arthur Edward Podmore, 53, Hanley-road, Stroud Green, London.

13794. Improvements in armatures for magneto-electrical machines or electric dynamos or motors. Felipe Saldaña, 72, Cannon-street, London. (Date applied for under Patents Act, 1901, July 5, 1904, being date of application in France.) (Complete specification.)

13796. Improvements relating to electrical signalling and controlling devices. Lorenz Kottmair and Rudolf Zwack, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13808. Improvements in the electrolytic production of metallic sheets, tubes, wire, strip, or the like. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

13815. Improvements in or connected with safety fuses for electrical conductors. William Oke Manning, 40, Chancery-lane, London.

13816. An electromagnetic reversing gear. Frantz Jensen, 40, Chancery-lane, London. (Complete specification.)

JULY 5.

13828. A new or improved receiving instrument for wireless telegraphy. Charles Vernon Boys, 66, Victoria-street, London.

13842. Improved trolley head for electric tramway cars. Henry Norris Davidge, 6, Piccadilly-mansions, Piccadilly-circus, London.

13856. Improvements in or relating to the electrical steering of ships. Bernard Parker Haigh, 111, Hatton-garden, London.

13874. Improvements in electrical transmission apparatus for causing the movements of any mechanism to be exactly repeated upon distant mechanisms. Everahed and Vignoles, Limited, and Sydney Everahed, 1, Queen Victoria-street, London.

13876. Improvements in or connected with anodes. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

JULY 6.

13909. An electric purifier for use in milling or any other trades to which it may be applied. John Lawson Lawson, 34, York place, Edinburgh.

13913. An apparatus for the application, control, and measurement of X-rays. Alfred Ernest Dean, 82, Hatton-garden, London.

13919. An improved switch and rheostat controller. Evelyn Banks, 70, Russell-street, Bolton, Lancs.

13918. Improvements in electrical junction boxes, switch boxes, ceiling-rose boxes, and the like. James William Brooks, trading as the Walsall Hardware Manufacturing Company, and Albert Edward Read, 128, Colmore-row, Birmingham.

13954. Improvements in and relating to electrical testing devices. George Harrison, 11, Southampton-buildings, Chancery-lane, London. (The Electric Railway Improvement Company, United States.) (Complete specification.)

13958. Improvements relating to transformers and dynamos. August Dr ssner, 7, Southampton-buildings, Chancery-lane, London.

13964. Improvements in apparatus for automatically opening or breaking an electric circuit or circuits and system of wiring in connection therewith. Percy Fullerton Corkhill, 6, Lord-street, Liverpool. (Complete specification.)

13973. Improvements in motor-driven machines. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13974. Improvements in fuse boxes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13975. Improvements in semaphore signals. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13976. Improvements in electrical indicating instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13977. Improvements in electric fuses or cut-outs The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

JULY 7.

14000. An improved method of cutting off electricity either automatically or at will. William Arthur Jones, 10, St. George's-crescent, Liverpool.

14013. Improvements in or connected with electrical distribution or junction boxes. Reginald Sydney Downe and Arthur Smith Black, 15, Water-street, Liverpool. (Complete specification.)

14033. Improvements in mercurial vapour electric lamps. Francis Harrison, 157, Grange Park-road, Leyton, London.

14047. An improved electric battery for use in treating the human ear. Augustus Royel, 11, Southampton-buildings, Chancery-lane, London.

14050. Improvements in electric quantity meters of the electrolytic type. Edward Jesse Piper, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14059. Improvements relating to the trolleys or current conductors of overhead-driven tramways and the like. Thomas Cowburn, 72, Cannon-street, London.

JULY 8.

14104. Improvements in and relating to relays. Hugo Mosler, Zürich-Langnau, Switzerland.

14126. Improvements in convertible cars. Robert George Dickson 4, South-street, Finsbury, London. (Michael Power, Canada.)

14129. Improvements relating to primary batteries. Caesar Gustav Luis and Francis Bothomley Lark, 7, Southampton-buildings, Chancery-lane, London.

14131. Improvements in the construction of sound-proof telephone cabinets and other chambers. Reginald Haddan, 31, Bedford-street, Strand, London. (Akt.-Ges. Industrie für Holzverfuog, Germany.) (Complete specification.)

14141. Improvements in electric signalling. Edward Richard Ernest Rotter, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 27.

1904.

12346. Electric switches. Zani.

14829. Electro-medical apparatus for the curative treatment of disease. Braun.

14876. Life-saving guards for tramway cars and the like. Ellis.

15283. Charging of electric accumulators for self-propelled vehicles. McLaren.

15289. Relays for direct-current automatic circuit breakers. Garrard, and Ferranti Limited.

15290. Electrical measuring instruments. Garrard, and Ferranti Limited.

15778. Contact stud and switch for use with surface-contact systems of electric traction. Griffiths and Bedell.

16326. Apparatus for use in the teaching of electric, telegraphic, and other signalling by means of the Morse or other similar codes. McDonald.

16846. Time element devices applicable to electric circuit breakers and other apparatus. Statter.

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18281. Electric motor-control systems. British Thomson-Houston Company, Limited. (General Electric Company.)

18538. Wireless electric signalling systems. Dymond. (Ges. für drahtlose Telegraphie m. b. H.)

20219. Electricity meters. Hookham.

27913. Telegraphy. Sheehy.

28122. Electric ignition devices for internal-combustion engines. Paxman, and Davey, Paxman, and Co., Limited.

1905.

811. Apparatus for testing electrical resistances. West.

955. Vapour electric apparatus. Ferguson. (Date applied for under International Convention, Jan. 18, 1904.)

1874. Apparatus for regulating variable-ratio electric transformers. Lydall.

2780. Tramway and railway points and switches. Leighton.

3195. Apparatus for controlling electric motors. Barr. (Date applied for under International Convention, March 7, 1904.)

3688. Electric stop motions for looms for weaving, warping machines, and the like. Whittington. (Armstrong.)

4041. Electric tools. Duntley.

4960. Electrical multiple influence or condenser machines. Imray. (Wommelsdorf).

5772. Starting devices for motors. Emile Michel Leopold Batisse and Paul Adrien Drevet. (Date applied for under International Convention, April 23, 1904.)

6194. Trolley stands for electric tramways and the like. Grasberger.

7655. Motor-driving arrangements for lathes. Barrow.

7874. Apparatus for the control of electric circuit breakers and like devices. Andrews.

12341. Sanitary attachments for telephones. Slocum. (Date applied for under International Convention, June 22, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-104 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2⅛-2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	87-89 xd
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1⅛
—— 4½ per cent. 1st Debenture Stock	100 ..	92-95
—— 4½ per cent. 2nd Debenture Stock	100 ..	77-80 xd
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5⅛-5¼
Crompton and Co.	3 ..	1⅞-2⅛
—— 5 per cent. Debentures	100 ..	96-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1⅛-1⅜
—— "A" Shares, 01-017,139	5 ..	2-2⅛
—— 5 per cent. Debentures	100 ..	89 94
—— 4 per cent. Deb. Stock, Red.	100 ..	83 88 xd
Electric Construction, Nos. 1 to 112,100	2 ..	⅛-¼
—— 7 per cent. Cumulative Pref.	2 ..	1⅜-1⅝
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	95 98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10 xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	11¼-12⅛
—— 4½ per cent. Preference	5 ..	5⅜-5⅝
—— 4½ per cent. Debentures	100 ..	109 111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15¼-16¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	31-33
—— 5 per cent. Bonds	100 ..	101-103 xd
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	11⅜-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11¼-12¼
—— 4½ per cent. Debenture Stock, Red	100 ..	106-108 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9-10
—— 7 per cent. Preference	5 ..	9-10
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9 9¼
—— Nos. 60,001-80,000	5 ..	8⅜ 9¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅛-13⅛
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	6¼-7⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5⅛-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	104-106
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5 xd
—— ditto (1903) 40,001-80,000	5 ..	4⅛-5 xd
Chelsea Electricity Supply	5 ..	5⅛-6⅛ xd
—— 4½ per cent. Debentures	100 ..	108-110 xd
City of London, Ordinary	10 ..	10¼-10¼
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-126 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	105 105 xd
County of London Electric Supply, Ordinary	10 ..	7¼-8⅛
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114 xd
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5⅛-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-109
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90 xd
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	101-104
Havana Electricity, 1-15,000	10 ..	9¼-10¼
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅜-8¼
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	3-3⅛
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	10¼-11½
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛
London Electric, Ordinary	3 ..	1¼-2½
—— 6 per cent. Pref.	5 ..	4¼-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 100,001-300,000	5 ..	9¼-9⅜
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113 xd
—— 4½ per cent. Cum. Pref.	5 ..	5⅜-5⅝ xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-100 xd
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	99-101 p.c. xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	98-101
—— Preference	4 ..	100-102
Notting Hill Electric Lighting	10 ..	14-15 xd
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6¼-7
—— 4 per cent. Debenture Stock	100 ..	99¼-101½
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	2⅝-3⅛
—— 4 per cent. Debenture Stock	100 ..	79-83
South London, Ordinary	5 ..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1 ..	⅜-½
—— 7 per cent. Cum. Pref.	1 ..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-108
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13-14
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-99 xd
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5⅛-5⅜
Westminster, Ordinary	5 ..	11¼-12⅛
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6⅛-6⅜ xd
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 ..	6-6¼ xd
—— Ord.	5 ..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	140-143
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	104-106 xd
Barcelona Tramways, Ord., 1-20,000	10 ..	13-14
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9¼-10¼ xd
—— 5 per cent. Deb., Red., 1-600	100 ..	99-102
—— 4½ per cent. Red. Deb. Stock	100 ..	96-100
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16xd
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1¼-1⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3⅜-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	92-96 xd
British Columbia Electric Railway Co., Ord. Def.	100 ..	105-108
—— Ord. Pref.	100 ..	98-101
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	104-107
—— 4 per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9¼-9⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¼-11⅜
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-124
—— 4½ per cent. 2nd Deb. Stock	100 ..	97-99
Buenos Ayres and Belgrano Trams.	5 ..	3-3⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 7/16-5 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	105-107 xd
—— Prov. Cert., all paid	100 ..	101-104 xd
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	96-98 xd
Calcutta Tramways, 1-102,268	5 ..	8⅛-9¼
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	106-108 xd
Cape Electric Tramways, Nos. 1-480,000	1 ..	1¼-1½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅞-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102-104
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14½
—— 6 per cent. Cum Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4, per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 ..	2¼-3¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88 xd
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9¼-10 xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	98-101 xd
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	101-103
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	9/32-11/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	104-106 xd
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	106-110
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum Pref.	10 ..	9¼-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106 xd
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,132 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 ..	90-92
—— 4 per cent. Pref.	100 ..	101-103
—— " " deferred	100 ..	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	39-41
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	120-123
—— ,, ,, ,, '85	100	118-122
—— ,, ,, ,, '01	100	115-118
Liverpool Overhead, 5 per cent Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700,	—	99-101
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	93-100
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111¼-112¼
—— Deferred Stock	100	104¼-105½
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	101¼-103½
Oriental Telephone and Electric Company	1	1¼-1¼
—— 6 per cent. Cum. Pref.	1	1 1/16-1 3/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 8	1,566	1,643	− 80	− 1624	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 1	277	357	+ 19	—	8	8	,, 15	14,328	3,316 380	353,945	1	9·71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 9	1,070	1,111	− 41	− 231	23·53	23½	March 31	55,025	11,145,551	1,309,903	1·18	10 08	2,338*b*	6·03
Birmingham Corporation	,, 1	339	347	− 8	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 5	935	997	− 37	+ 628	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 6	1,355	1,150	+ 205	+ 1,519	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	887	870	+ 17	− 112	16½	16½	Dec. 31	31,846	2,325,677	579,254	3·28	13·19	—	7·27
Bolton Corporation	,, 9	2,089	2,151	− 62	+ 867	40	38	March 31	96 765	20,215.196	2,161,133	1·13	10·63	2,394	6·11
Bournemouth Corporation	,, 5	1,470	1,052	+ 418	+ 1,429	16 83	16 83	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,225	7·19
Bradford Corporation	,, 8	4,828	4,979	− 151	− 1,857	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 9	1,180	1,183	− 8	+ 856*h*	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 7	5,551	5,433	+ 118	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 10	1,154	1,024	+ 130	—	10 60	10·60	March 3	—	—	—	—	—	—	—
Burton Corporation	,, 9	525	—	—	—	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,058	6·76
Cardiff Corporation	June 24	2,193	2,095	+ 98	—	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	July 8	270	213	+ 57	− 312	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 8	6,360	6,414	− 54	— *h*	6	6	,, 31	347,528	44,875,547	1,281,214	1 86	65 10	57,931	35·80
City and South London Railway	,, 9	2,300	2,336	− 36	— *h*	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 4	226	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	,, 6	630	610	+ 20	—	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 1	260	229	+ 31	+ 159	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	,, 31	11,250	2,853,200	281,343	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 7	131	160	− 29	— *h*	6½	6½	Dec. 3	6,358	402,511	110,738	3 79	13·78	942	7·33
Dublin U. T., electric cars	,, 7	4,255	4,188	+ 67	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·21	9 07	5,691	5·55
Dublin S. District, Electric	June 23	1,146	1,134	+ 12											
Dundee City Tramways	July 5	838	856	+ 32	—	22	21	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 8	930	773	+ 157	+ 921	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 8	16,088	13,734	—	— *h*	144¾	143	May 31	756,480	195,767,519	17,915,593	—	10·12	—	—
Gloucester Corporation	June 7	302	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 28	1,832	1,748	+ 84	+ 1,085	35½	33	March 31	74,019	17,819,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	July 8	1,450	1,408	+ 42	+ 946	35	35	,, 31	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 8	2,240	2,181	+ 59	+ 69	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 5	123	142	—	—	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 5	240	217	+ 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 8	7,014	6,130	+ 9.4	+ 4,441	89	89	March 25	298,233	64,223,676	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,223,507	1	9·79	—	4·82
Liverpool Corporation	,, 1	11,409	11,343	+ 66	+ 9,431	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 9	1,646	1,672	− 26	— *h*	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 1	16,184	13,329	+2,855	+39,107	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 6	149	—	—	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 8	13,887	13,216	+ 671	+ 6,860	149	131½	March 31	631,956	126,930,875	14,123,124	1·19	10 73	4,293	6·99
Nelson Corporation	,, 8	149	128	+ 21	+ 2·7	—	23	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 8	3,545	3,547	− 1	—	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10 98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 9	1 678	1,250	+ 427	+ 6,630	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	July 8	2,428	2,388	+ 40	− 229	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	June 29	670	647	+ 23	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	396,517	1·24	9·24	1,102	7·92
Rotherham Corporation	July 6	452	470	− 18	—	9½	7½	,, 31	23,569	5,251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	,, 10	4,546	4,451	+ 95	+ 3,440	70½	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	,, 8	237	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 9	5,187	4,923	+ 2·3	—	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 5	1,063	1,011	+ 51	− 251	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	,, 6	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 7	785	654	+ 131	+ 511	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 3	1,419	1,334	+ 85	+ 284	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 5	206	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 8	872	849	+ 22	+ 565	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	June 24	336	316	+ 20	+ 166	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6 33
West Ham Corporation	July 6	1,763	1,105	+ 675	+ 8,501	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 6	820	750	+ 89	—	—	7½	,, 31	—	—	—	—	—	—	—

† And 98 miles of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures.

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NOTES.

Wireless Telegraphy in France.—Whether *propter hoc* or only *post hoc* can only be conjectured, but M. de Branly's lecture in Paris on the wonders actual and possible of wireless telegraphy has been rapidly followed by remarkable results. Up to the present week the system had been steadily ignored by the Government. Now it is announced that the Minister of Commerce has decided to organise a service, and has requested his colleagues of War and Marine to establish with the least possible delay three coast stations, one at Toulon, one at Cherbourg, and one at Bizerta.

Water Power in India.—The Municipal Board of Mussoorie have in hand a large scheme by which electric energy will be obtained for lighting and use in connection with their waterworks. The three-phase plant needed will be driven by water power, and will in turn drive a certain number of pumps for the water-supply scheme. Complete specifications for the equipment have been drawn up by Mr. C. H. Shanan, A.M.I.C.E, and tenders are to be returned to Mussoorie by Oct. 23. They are to include the supply and erection of the water-power plant, the alternators, exciters, switchboards, transformers, motors, and the complete line equipment. The work will, we trust, be placed with an English firm.

Private Tramcars.—Considerable interest has been aroused in London by the fact that the Duchess of Northumberland recently engaged private electric tramcars to convey her guests to Sion House, Isleworth. It may be pointed out that "special tramcars" are not an innovation, and that one can be chartered to Hampton Court and back for three guineas. London is very far behind, however, in this respect. Private cars are common in other parts of the world. Even in Jamaica one can engage an electric "social" car for a whole evening. It has the run of the whole system, extending some eight miles out into the country, and only costs 10s. It is marked "private," and is often brilliantly lit up with coloured lights.

Wireless Telegraphy to Iceland.—The officers of two steamers which arrived at Leith from Iceland on Saturday report that about the 26th of last month the island was put into communication, partly at any rate, with the outer world by means of the Marconi system of wireless telegraphy. The communication is as yet only partial, as the apparatus at Reykjavik can only receive messages, but it is possible that a transmitting instrument will shortly be added to the equipment of the Reykjavik station. Should the experiment be satisfactory to those concerned, the wireless service may, for some considerable time at any rate, serve instead of the proposed submarine cable, the laying of which would be very expensive in proportion to the use that would be made of it. The wireless messages, the most of which come in the first instance from Denmark, are sent from one of the Marconi stations in the North of Scotland.

Decimal Weights and Measures.—Early this year Sir Edward Fithian, the secretary of the Association of Chambers of Commerce, sent a resolution of the association asking the Board of Trade to authorise weights of 20lb., 10lb., and 5lb. as aliquot parts of the cental, to which Lord Salisbury has replied as follows: "With reference to your letter of March 14 last, in which you suggest that new denominations of weights of 20lb., 10lb., and 5lb. should be legalised for use in trade, the Board of Trade have given careful consideration to the representations which have been made, and they are prepared to assent to the application. Steps will, therefore, be taken for the preparation of standards of the same octagonal form as the present 50lb. weight." The chambers consider that this concession will save time, labour, and expense, as the 50lb. weight as done already. It is amusing to find that the daily papers refer to this step as if it was part of the metric system of weights and measures.

Sir Humphry Davy Memorial.—There was an interesting ceremony at Clifton, Bristol, on Friday, when Signor Marconi unveiled a tablet which the Clifton Improvement Association proposes to place on 3, Rodney-place, Clifton, where Sir Humphry Davy, Dr. Thomas Beddoes, Thomas Lovell Beddoes, and his aunt, Maria Edgeworth, formerly lived. The ceremony, which attracted a large company, took place in the Grand Spa Pump-Room. Mr. Lewis Fry was in the chair, and welcomed Signor Marconi to Clifton, and afterwards gave some interesting details of the lives of Sir Humphry Davy, Dr. Thomas Beddoes, Thomas Lovell Beddoes, and Maria Edgeworth. In performing the unveiling ceremony, Signor Marconi said that the name of Sir Humphry Davy would ever live in the minds of men, for he was more than a genius. Few men had ever combined with such marked success the qualities of scientist and philosopher. It was appropriate that Clifton should, by means of the tablet, perpetuate the name of Humphry Davy, for it was here that he entered upon his public career.

London County Council Conduit System.—The conduit system of the London County Council has now had a fairly long trial. The results of experience with the first section laid down have pointed to improvements in details which are now to be embodied in the further lines to be converted. Under the several Tramway Acts the Council has to get the approval of the Board of Trade to the system employed, and each of the road authorities has also a voice in the matter. From a description laid before one of these authorities for approval we glean the following details as to the principal differences between the proposals of 1902 and 1905:

	1902.	1905.
Rails	102lb. per yard lineal.	105lb. per yard lineal.
Fishplates	54lb. per pair.	57lb. per pair.
Slot rails	⅝in. apart.	1in. apart.
Boxes for slot rails	2ft. 6in. long.	3ft. 6in. long.
Insulator boxes	1ft. square.	1ft. 4in. by 1ft.
Inspection boxes for drainage	19in. by 12in.	18in. square.

The increased width of the slot is the only objectionable alteration, but we believe this to be a necessity. The other changes give increased facilities for inspection and repairs or increased strength, and will be universally approved.

Telephone Agreement. — On Monday last the question of the future position of the staff employed on the telephone system as compared with that under which the company now employed them was discussed before a Select Committee of the House of Commons. Mr. Babington Smith, secretary to the Post Office, was recalled, and gave evidence with reference to claims put forward by the staff of the company. He said they were asking for continuity of employment when the transfer took place. At present their services could be dispensed with by the company at a month's notice, and he did not think there was much fear, having regard to the rapid growth of the service, that their prospect of continued employment would be worse under the Post Office than under the company. Assurances had been given by the Postmaster-General to deputations that the staff would be taken over *en bloc*, but that did not give a guarantee to individuals which would create a vested interest and enable them to claim compensation for loss of office. Those placed on the established staff (and they would be the large majority) would have a more secure tenure than under the

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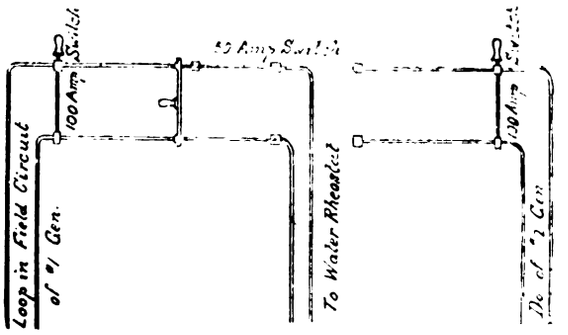
company, and those on the unestablished staff would be in no worse position than they were now.

The Manchester Mains Case.—In our issue for March 31 we reported the case of Midwood *v.* the Manchester Corporation. The judgment was given against the Manchester Corporation. The facts of the case are briefly as follows. A fault occurred on the Manchester mains, and this was burnt out electrically, as is the usual practice in most supply systems. Unfortunately, in burning out the fault the fire spread to the premises of the plaintiff, and damage estimated at £677 was caused. The Corporation appealed against the decision, but have again had the verdict given against them by the Court. The defence was that, as the Manchester Corporation had complied with the requirements of the Board of Trade, they should be relieved from the liability in question. Under the provisional order, however, it is provided that "nothing in this order shall exonerate the undertakers from any indictment, action, or other proceedings for nuisance in the event of any nuisance being caused by them." We commented on the case in our issue for March 31, and need only repeat here that the Manchester mains have been carefully designed and laid, and that, while justice has been done, it is adding insult to the damages when the mains are termed nuisance. It is only right that a municipal undertaking should be responsible for any damage it may do in the same way as other private undertakings are.

Tramway Speeds.—In the earlier days of electric traction the increased speed of electric tramcars over that of the horse cars which they replaced resulted in numerous accidents. There were in consequence a number of complaints that the speed of electric cars was excessive. As we pointed out then, the matter was rather one of educating the people to avoid crossing the roads without exercising ordinary care. The continued use of the tramways has been followed by a marked decrease in the number of accidents, and we are pleased to see that the restriction in maximum speed to eight miles per hour is being altered by the Board of Trade in many places. Amongst the most recent moves in this direction is one on the part of the Deptford Borough Council. The General Purposes Committee of this Council have instructed their mayor to represent to the Board of Trade that, in their opinion, the County Council tramcars should be allowed to travel at the highest rate of speed consistent with the safety of the general public. The Board of Trade have commissioned Lieut.-Colonel Yorke to inspect the various routes and to report to the Board, the County Council having urged that, in view of the fact that the cars are to be equipped with special brakes, and that the drivers have now acquired greater skill, a higher rate of speed should be allowed than was at first thought desirable. As in the case of motorcars, the safe maximum speed is determined by the braking facilities, and these, as pointed out, are very ample in modern tramway practice.

Heating of Enclosed Conductors.—This was one of the subjects brought before the Montreal convention of the Canadian Electrical Association last month. For the past three years McGill University has been the scene of some research work which is of great importance and interest to the electrical world, and which is revolutionary in its character. This is an investigation into the heating of enclosed conductors, and in the conclusions which are being reached it is being shown that the present information on the subject is far from complete, and existing tables are consequently quite incorrect. This work was to have been described to the convention by Prof. R. B. Owens, but in his absence Prof. L. A. Herdt discussed the subject. The paradox has been established that the thicker the insulation on a conductor the more current is required to cause a given rise in temperature. Though this seems absurd at first, it is explained by the fact that the thicker insulation has a greater radiating surface. If two small wires are placed in a small duct they can carry 30 per cent. more current than if they are in a large duct, for in the large duct there is no chance of radiation except where the wires touch the duct, and still air is one of the worst conductors of heat. Consequently, when laying out a system for 10deg. rise, it is necessary to place the wire with as thick insulation as possible, and in as small a conduit as possible. In experiments with bare wire in still air, the results tally very well with the tables given in the standard text-books, but as soon as wires are placed in conduits the old formulas do not apply at all. So far, these experiments have been conducted for rubber insulation only.

Paralleling Generators.—A method of obviating the disturbance in the exciter speed and voltage that ensues when one generator is thrown in parallel with another having the same source of exciting current, has been contributed to the "Wrinkles" department of the American National Electric Light Association by Mr. G. Hartman. Another objection that arises under the conditions mentioned is that the second generator, or generators, is subjected to the sudden switching on of a large percentage of the full load. The contrivance recommended by Mr. Hartman is illustrated in the accompanying diagram, which



we reproduce from the *Western Electrician* of Chicago. A water rheostat is connected to a double-throw switch, so that it may be inserted in the field circuit of either of the two generators or be short-circuited. This results in a very gradual rise in voltage from zero to normal, and a gradual decrease from normal to zero in starting up, or closing down, a second generator, line and transformer set. The disturbance is thus eliminated from the first generator, and there is a minimum strain on the second outfit.

Municipal Wiring in London.—The London County Council (General Powers) Bill this year again contained provisions which would, if passed, have authorised the municipal authorities within the Council's area to carry out wiring work. This clause was also inserted in the 1903 Bill, when it was strongly opposed by the Electrical Contractors' Association. In 1903 the clauses were struck out by the House of Commons. In spite of strenuous opposition by the above association the House of Commons passed the clause this year, but it has failed to get through the House of Lords. The chairman of the committee was the Duke of Northumberland. It was urged on behalf of those who supply fittings and general electrical installations to private consumers that they would suffer great loss and hardship if the clauses were accepted. The petitioners contended that the nature of municipal competition with private traders was grossly unjust and different in every respect from ordinary trade competition, and that it was unfair to use the ratepayers' money for the purpose of

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injuring other ratepayers by such trading. The Duke of Northumberland said it would not be necessary to call witnesses in support of the petition against the provisions, which would be struck out of the Bill. The Electrical Contractors' Association are to be congratulated on the success of their opposition, and we think the decision is one which is also in the interests of the electrical supply undertakings. Any such undertaking has everything to gain from the efforts of wiring contractors in the district to obtain work, and by competing with them it immediately reduces the number and activity of canvassers tending to increase supply business. The slight gains from municipal wiring in certain cases do not warrant the risk which any department of the kind must necessarily involve.

Heavy Electric Traction.—The engineering problem of converting steam railways over which a heavy traffic is carried over a considerable distance is one which, although treated of by many engineers, has yet to be finally solved. The many debates on the subject which have taken place before various engineering institutions in this country show that the financial question is the one to which most consideration has to be given. At the recent meeting of the American Institute at Asheville, Mr. Carl de Muralt contributed a paper on the subject. In this he dealt more particularly with a main-line system, taking as an example a line 175 miles long in one direction with a 49-mile extension for mineral traffic in another. He assumed that there were only 16 stations in the 175-mile length and four stations in the other. The traffic on the line was not as heavy as we are used to in this country, as it was assumed there were only eight trains per day in each direction. The question as to the most economical system to be used is then gone into most carefully. In each of the four systems on which information is given, high-tension transmission by either three-phase or single-phase alternating current is employed. The chief difference between them is in the matter of the equipment on the trains, and consequently in the sub-station machinery. In the first system the continuous-current series motor on the locomotive would be fed from sub-stations much in the same way as has been done in the most recent electrification of suburban lines in this country. The second system involves the use of three-phase induction motors on the locomotives; hence only static transformers are needed in the sub-stations. The third system would employ a single-phase alternating-current motor on the locomotive, and in the fourth a reversion is made to continuous-current motors fed from motor-generators carried on the locomotive. Actual figures are given for the first two systems, but the author confines himself to general conclusions when making comparisons between these figures and the results to be obtained by the latter two systems. We have not space at our disposal to follow his figures in detail, but his conclusions are all in favour of the three-phase alternating-current system. This he shows from his estimate to be cheaper to instal and to operate than the continuous-current system. He claims for the three-phase induction motor that it is at least equal in every respect to the continuous-current series motor and superior to the latter on a number of important points. The increased cost and inconvenience of having two overhead wires instead of one has still to be considered. The author states that in street railway systems the motor repairs cost anything from four to ten times as much as the repairs to the line. He concludes, therefore, that any slight increase in cost of supervision due to the two overhead wires would be small compared with the saving which would be effected by the use of three-phase motors. Where the line is through a hilly country stress is laid on the advantage of the three-phase motor as being able to return power to the overhead conductors when the trains are descending grades.

Double Trolley Wires in Cuba.—We understand that the General Electric Company of America has recently secured a large order for a complete network of inter-urban electric railway lines having Havana as their centre. The system will consist of a central power-house in Havana and eight outside sub-stations, together with line material for about 125 miles of track and rolling-stock for passenger and freight service over the entire system. The power-house in Havana will furnish 5,000 kw. of 19,000-volt, 25-cycle, three-phase current, generated by two 2,000 kw. generators and 1,000-kw. Curtis steam-turbine generators at 2,200 volts, and stepped up through air-blast transformers to the line voltage. The transmission lines will parallel the various lines of the railway to the sub-stations, where step-down transformers supply low voltage to rotary converters furnishing 600-volt direct current to trolley lines and feeders. From Havana one branch will run south-east to Rosario, a distance of about 40 miles. Sub-stations will be located at Cuatro Caminos, Lomas de Candela, and Providencia. A second line will run from Havana 17 miles south to Bejucal, with a sub-station on the line at Santiago de las Vegas. A third line, running south-west from Havana to Mariel, will have a length of 37 miles, and branch lines running north and south to El Carmelo, Santiago de las Vegas, and Tuira de Melena, amounting to about 30 miles in addition. Sub-stations on the line to Mariel will be placed at Marianao, Hoyo, Colorado, and Tuanajay, and at San Antonio Melena. The rolling-stock for passenger service will consist of 24 30-ton cars, seating 50 passengers and equipped with four motors geared for a maximum speed of 40 miles per hour. The freight service will be handled by 10 40-ton locomotives equipped with four motors geared for a speed of 17 miles per hour when hauling a 300-ton train. The entire system will have double overhead trolleys both in Havana and on the interurban lines. The high-potential transmission lines will be designed for a future potential of 30,000 volts to provide for extensions. The transformers in the Havana power-house and in the sub stations are also suitable for use on the increased potential. It is expected that the entire system will be in operation inside of 18 months, and that portions of it will be giving service before that time. As pointed out in the *Electrical World*, the novel feature in the equipment is the use of the two trolley wires in order to avoid the earth return. This system was at first proposed for the London United Tramway system in order to avoid disturbing the Kew Observatory. It was not installed, however, and the magnetic instruments were removed from Kew instead. In the States the system has been used at Cincinnati and one or two other places, but we understand that the tramway managers in these places would be glad to change over to the single trolley and track return if they were allowed to do so. The line voltage in Cuba is to be 600, and although a good deal of the ground may be swampy in character, we think that the single trolley and track return would have given successful results.

High-Potential Surges.—At the recent meeting of the American Institute of Electrical Engineers at Asheville, Dr. C. P. Steinmetz presented a paper on "High Power Surges in Electrical Distribution Systems of Great Magnitude," and Mr. P. H. Thomas followed with a paper on "The Rise of Potential on Commercial Transmission Lines due to Static Disturbances caused by Switching, Grounding, etc." In the course of the joint discussion, reported in the *Electrical World* of New York, Dr. Steinmetz stated that there existed undoubted evidence that the arc is self-rupturing—that is, it mends itself in the

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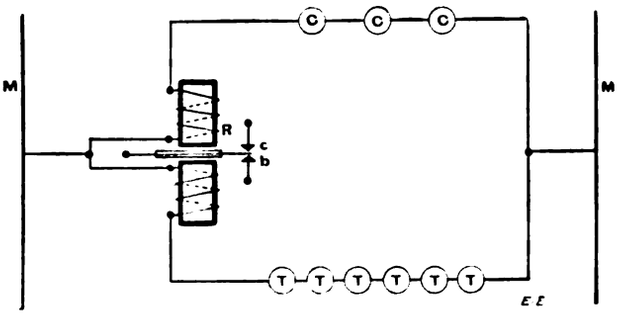
extreme suddenness, and the potential at mending may be greater than the striking voltage. After the arc mends itself it immediately ruptures again, and it then becomes an oscillating arc. The frequency of oscillation is determined by the capacity and the inductance, and not by the frequency of the E.M.F. If a condenser and an induction coil be placed in series with each other, by means of a spark gap an oscillating current may be produced in the system even when the supply E.M.F. is continuous. One of the conditions under which an arc becomes self-rupturing is that the voltage exceeds the striking distance of the arc, and that the flow of current in the arc causes the potential difference at the arc to drop practically to zero, and remain at zero a very short time after the arc has ruptured. Therefore, in experimenting with the arc in a circuit containing resistance in series and no capacity, the arc is not oscillating or self-rupturing, and cannot be made so, because simultaneous with the mending of the arc the voltage rises and so prevents the arc from rupturing. When high-frequency oscillations are produced by shunting the arc with capacity and inductance in series the length of time the arc exists is the time required by the charging current of the condenser to heat the air sufficiently to cause an explosion, and also to discharge the condenser and allow the voltage to drop to zero. The period of the zero current is the time required for the condenser to be recharged by the voltage from the inductance. The frequency of the oscillating arc can, therefore, be varied by varying the inductance, the capacity, or the length of the spark gap, all three elements entering into the determination of the frequency. The phenomena become more complicated where, instead of localised inductance and capacity, there are distributed inductance and capacity as in cables. In favour of the explanation of the oscillating arc here given may be stated the fact as observed by Mr. Stott, that short-circuits were always preceded by grounds on the lines and by static displays. If the explanation is correct, and if the E.M.F. reaches 100,000 volts, and the current is as large as 9,000 amperes, there is no possibility of insulating and protecting against these surges. The only course to pursue is that taken by Mr. Stott in avoiding the cause of the surge, and eliminating the continued occurrence of the spark discharge between the conductor and ground by disconnecting with the regular automatic circuit breaker that particular cable in which the spark first appears before the damage can spread farther and produce high-power low-frequency surges.

Potential Regulation of Carbon and Tantalum Lamps.—Messrs. A. E. Kennelly and S. E. Whiting describe in the *Electrical World* of New York an interesting device for regulating voltage based on the different behaviour of carbon and tantalum lamps under varying voltages. It is well known that the resistance of a carbon-filament incandescent lamp falls very markedly as the current through it increases. Thus, a 120-volt, 16-c.p. carbon lamp, which has a resistance of 600 ohms when cold, will have a resistance of about 300 ohms when at normal incandescent voltage. A 110-volt tantalum lamp, on the other hand, which has a resistance of 50 ohms when cold, may have a resistance of 300 ohms when at normal incandescent voltage. In each case the most rapid change of resistance takes place in the initial stages of voltage and current application. Between half voltage and full voltage the changes in resistance are relatively small. One device proposed by the authors is the use of a Wheatstone bridge with carbon lamps in one arm and tantalum lamps in another. In the place of the usual galvanometer a polarised relay or other magnetic mechanism would be employed to close a subsidiary circuit which would regulate the main voltage. An alternative plan is that shown in the illustration herewith, where a differentially polarised relay is used. In this arrangement the circuit from the mains, M M, splits through the coils of this relay, passing on one side through the carbon-filament lamps, C C C, and on the other side through the tantalum-filament lamps, T T T. The lamps are so chosen, or the resistances of their respective paths so adjusted, that the two branch currents have equal strength at normal voltage between the mains, thus leaving the relay in balanced condition—*i.e.*, with zero excitation. If now the main voltage should rise, the resistance of the carbon branch will diminish and that of the tantalum



branch will increase, thereby upsetting the balance in favour of the carbon branch current, and urging the tongue of the relay against the stop, *c*. On the contrary, if the main voltage should fall, the differential balance would be upset in the opposite direction and the tongue of the relay urged against the opposite stop. This action of the relay might likewise be invoked to control the main voltage through mechanism actuated by local circuits from the relay. From actual trials made with an apparatus of this kind over a relay of the Western Union type the authors found that an increase of 0·6 volts—*i e*, from 120·4 to 121—was quite sufficient to operate the relay. There was a time lag of about a second in the operation of the relay, which appears to be due to the thermal effects outside the lamps. The device is an interesting utilisation of the different characteristics of these two types of incandescent filaments.

Lightning Protection.—At the recent Denver Convention of the American National Electric Light Association, an interesting discussion, of which an abstract appears in the *Electrical World* of New York, ensued on "Present Methods of Protection from Lightning and Other Static Disturbances." Referring to the water jet arrester used in California, Mr. Alex Dow stated that this was merely a leg of high resistance and of no inductance, and that it consumed energy continuously. The water jet might be used to good purpose in many high-tension transmission lines as special protection during thunderstorms in much the same way as in certain railway plants the tank arrester is switched on during thunderstorms. In conjunction with choke coils it would furnish a thoroughly reliable means of protection, though its use involves a loss of energy from 3 kw. to 10 kw., depending upon the voltage. Owing to information received since the report was prepared, the recommendation of two ground wires should be withdrawn in favour of the use of a single ground wire, which will do the work as well as two wires and be as reliable. No reliable information could be obtained concerning the horn arrester, but it seemed that the tail-piece is dispensed with entirely in many European plants. Mr. Dow advised the appointment by the association of a reporter to gather information on the subject of lightning protection and to report same to the association. In reply to a question, Mr. Dow said that flashing across storage battery terminals to ground has happened, the discharge being across the surface of the tanks. Mr. R. F. Hayward stated that in Utah there are

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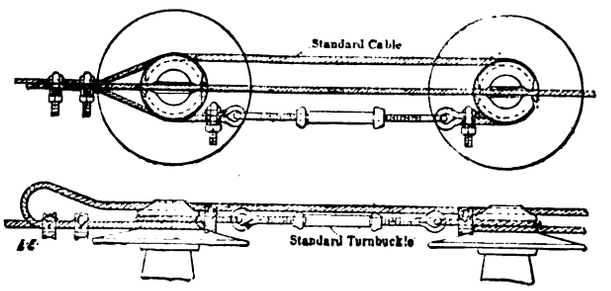
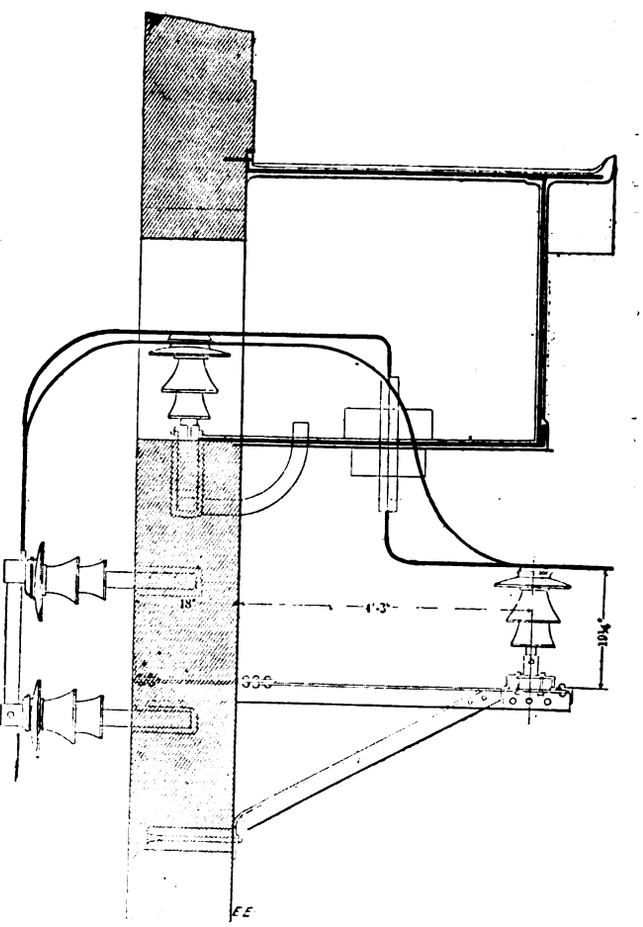
about 300 miles of 40,000-volt and 200 miles of 28,000-volt lines running in parallel, and scarcely any storm passed through the territory covered without striking something, either directly or inductively. He has come to the conclusion that the lightning protection should be spread all over the line in the form of lightning conductors. It is found that when a storm occurs it will generally strike the lines and split a number of poles, shattering all the insulators on one pole and puncturing a number of insulators on other poles. The effect is seldom found far from the point where the stroke comes, and if the stroke is near the power-house some apparatus is likely to be lost or terminals burned out. A number of transformers of the old air-blast type have been lost, but none of those with new windings which have replaced the old type, although in a recent storm some of the terminals were burned off. The arc will cross from terminal to terminal, jumping distances of five or six inches, and while this shuts down the plant for a moment, no other damage is done. Recent experience has shown that modern insulation, whether of the air-blast or oil type, is becoming very good and very high. Mr. Hayward considered that the ground wire should be placed on the line; if there is no ground wire on the line, one of the two circuits is grounded at each end of the line when a thunderstorm comes along. If a ground wire is above the other lines, it should be as far above as possible, for then the stroke will discharge to this wire and take the ground by a number of different paths, whereas if the ground is at the neutral point of the main circuit it is almost certain to cause an arc that will give a short-circuit, and these sudden short-circuits are the cause of setting up low-frequency waves which go into the power-house, pass through the choke coil, and are liable to break down the apparatus. Mr. E. P. Dillon stated that the Colorado Springs lines were particularly menaced by lightning. At present lightning arresters are liberally distributed at the various plants and sub-stations, but there are none on the line, since it is felt that the risk of having lightning arresters on the line was an offset to their advantage. He thought that a well-constructed ground wire would obviate some of the difficulties which have been met with. At three different times in the past two years the lines have burned out directly in the middle of a span, and not at the poles.

Niagara and Toronto Transmission.—In our last issue we gave some particulars of the new transmission lines which are being erected to convey energy from Niagara to Toronto. From further information appearing in the *Electrical World* we note the following details, which will interest those readers who have overhead line work to erect in this country. The three insulators carry the three conductors, for which circuits are placed at the corners of an equilateral triangle with 6ft. sides. The anchorage of the line wire at the terminal towers is carried out in the following way. Where the cables are secured before they pass into a terminal station, the three insulators for each cable are placed in a straight line with their centres 30in. apart. When a line cables reaches the first insulator of the three to which it is to be attached on one of these towers, it is passed round the neck of this insulator, and then secured on itself by means of two clamps that are tightened with bolts and nuts, as illustrated. The cable thus secured turns up and back over the tops of its three insulators, and goes to the terminal station. Around the neck of the insulator to which the line cable has been secured in the way just outlined, a short detached length of the regular copper cable with the parts of a turnbuckle at each end is passed, and this same piece of cable also passes round the neck of the next insulator in the series of three. By joining the ends of the turnbuckle and tightening it, a part of the strain of the line cable in question is transferred from the first to the second insulator of the series. In the same way a part of the strain of this same line cable is transferred from the second insulator of the series to the third or one nearest to the terminal station. From its insulators on a terminal tower each line cable passes to an insulator at the same level on a steel bracket outside of the terminal station. After leaving this insulator on the bracket, the



line cable turns up and goes through a bushing set in the bottom of a metal box or hood that is fixed on the outside of the terminal station above the steel bracket, as shown. Having reached the inside of this metal hood, the line cable makes another right-angle turn, and goes through the centre of a 40in. by 36in. opening in the brick wall of the terminal station. At the centre of this square opening the line cable is supported by one of the porcelain insu-



lators regularly used outside. The hood just mentioned is made of expanded metal covered with cement. From the line cable to the steel socket of the pin on the bucket the shortest distance through the air is about 17in., and this is also the distance from the cable to the metal hood. Between the line cable and the brick wall outside of the metal hood the distance is about 25in. At the upper outside edge of the hood there is a gutter that prevents the dripping of water on to the insulators and line cables below.

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ROYAL COMMISSION ON LONDON TRAFFIC.

The first volume of the report of this Commission was issued on Monday last, and is to be followed by seven other volumes, which will cover the whole subject. The Commission appointed in 1903 consisted of Sir David Miller Barbour, K.C.S.I., K.C.M.G. (chairman); the Right Hon. Earl Cawdor; the Right Hon. Viscount Cobham; the Right Hon. Lord Ribblesdale; the Right Hon. Sir Joseph Cockfield Dimsdale, Bart., K.C.V.O., M.P.; Sir John Poynder Dickson-Poynder, Bart., D.S.O., M.P.; Sir Robert Threshie Reid, G.C.M.G., K.C., M.P.; Sir John Wolfe Wolfe-Barry, K.C.B., F.R.S.; Sir Francis John Stephens Hopwood, K.C.B., C.M.G.; Sir George Christopher Trout Bartley, K.C.B., M.P.; Sir George Stegmann Gibb; Mr. Charles Stewart Murdoch, C.B.; Mr. Felix Schuster; Mr. Lynden Macassey, M.A., B.Sc., LL.D. (secretary).

The Commission were commanded to enquire into the means of locomotion and transport in London, and to report: (*a*) "As to the measures which they deem most effectual for the improvement of the same by the development and interconnection of railways and tramways on or below the surface; by increasing the facilities for other forms of mechanical locomotion; by better provision for the organisation and regulation of vehicular and pedestrian traffic, or otherwise. (*b*) As to the desirability of establishing some authority or tribunal to which all schemes of railway or tramway construction of a local character should be referred, and the powers which it would be advisable to confer upon such a body." The Commission not merely took evidence, but by a special arrangement obtained expert and technical advice from the Advisory Board of Engineers which they appointed. One of the members of the Commission, Sir John Wolfe-Barry, K.C.B., undertook, without remuneration, to act on and preside over the Advisory Board, and they state they were fortunate to obtain the services of Sir Benjamin Baker and Mr. William Barclay Parsons, M.I.C.E., chief engineer to the Board of Rapid Transit Railroad Commissioners of the City of New York, who was well acquainted with London. The full report of this Advisory Board will appear in vols. vii. and viii., yet to be published, but the Commission have not endorsed all the recommendations of this Board.

The Commission's report covers much ground that is beyond the scope of our journal, but the following abstracts will show the general trend of the recommendations. After showing the need for further facilities for locomotion and the failure of rehousing schemes in the central districts, it is pointed out that the only difficulty in the way of completely reorganising London for purposes of locomotion is the question of cost. The ideal scheme is the construction of railways in London for purposes of long-distance urban traffic, and of railways radiating to the suburbs for purposes of suburban traffic, the railways both in urban and suburban localities being connected with tramways for short-distance distribution, the connection of all main line terminal stations with urban tramways and railways, the widening of existing and provision of new streets for local urban traffic and the regulation of street traffic to prevent or reduce congestion, and the provision of complete facilities for passenger interchange. Under the headings, therefore, of "Streets," "Tramways," "Railways," and "Traffic Regulation" the Commission's principal recommendations are grouped.

Recommendations as to Street Improvements.—The narrowness and tortuousness of the London streets are "not a surprising fact when it is remembered how London grew without method or control." The Commission enumerate the various proposals made to them in regard to street improvements, which they remitted to the Advisory Board of Engineers for critical technical examination, and they set forth the proposals of the Board and their own opinion in relation thereto. The projects put forward by the Advisory Board are based upon the view that, as in the case of Paris from 1793, the future improvements of London should proceed on the lines of a carefully-thought-out plan, designed to meet the requirements of through and other traffic, and given effect to, subject to future modifications, in the light of experience, or owing to change of conditions, as time and money permit. With this conclusion the Commission are in emphatic agreement. Although the Advisory Board have not formulated any such complete plan, they advise, as the groundwork thereof, the execution, amongst others, of certain improvements mentioned in the report. The most important is a proposal for the construction of two main avenues through London, one 4¾ miles from west to east to connect Bayswater-road with Whitechapel, the other 4½ miles north to south to connect Holloway with the Elephant and Castle. Each avenue would be 140ft. in width, from house to house, with subways for water-mains; with four lines of tramway on the surface, and four lines of railway below the surface, for express and local stopping trains. The tramways on the main avenues are intended to connect with the tramway systems at both ends, and afford interchange of traffic with the various systems of tramways crossed on the route. The four lines of electrical railway in the sub-structure would be connected with the various railway systems. The Advisory Board of Engineers, it is stated, attach more importance to the west and east main avenue than to the one running north and south, mainly because statistics show the volume of traffic to the east and west is greater. The Commission entertain no doubt that both the main avenues would be of great value in relieving street congestion, and in providing much-needed facilities for central urban tramway and railway locomotion. At the same time they dwell upon the very heavy outlay involved; and on the fact that they are schemes each of which is complete in itself, and cannot be carried out piecemeal. The east and west avenue, with its subways, railways, and tramways, is estimated approximately to cost about £15,550,000, and the north and south avenue about £8,550,000 net. And supposing that a sum of 30 millions sterling would accomplish the work, it would probably require £1,100,000 to £1,200,000 a year to cover interest and sinking fund of the borrowed money. In return for the outlay, the municipality would own nine route and 36 track miles of tramway, and nine route and 36 track miles of underground railway, putting aside the immense advantages of two great thoroughfares. The tramways and railways would bring in a considerable profit. The Commission allude to New York, where an underground railway, with similar accommodation for express and local trains has been constructed at the expense of the municipality by a company under a contract for construction and for operation at an annual rent sufficient to defray interest and sinking fund on the municipal bonds issued for construction of the work. It must be understood, the Commission state, that the Advisory Board of Engineers do not themselves put forward their scheme of new avenues as a project for immediate accomplishment under existing conditions. They desire that its great utility should be realised, and that it should find a place in a general plan for the future development of London as means and opportunity offer. The Commission recognise its utility to the full, and agree that it should find a place in the general plan, if further careful study of the project, from all points of view, shows that it is financially practicable; but do not think that works of less magnitude, which may be within available resources, should be retarded in the expectation of its early accomplishment. The Commission, after consultation with the Advisory Board, recommend that new streets or widened streets should forthwith be laid out according to the following standard of width from house to house, depending upon their importance and the degree to which they are likely to attract traffic: main avenues, 140ft.; first-class arterial streets, 100ft.; second-class streets, 80ft.; third-class streets, 60ft.; fourth-class streets, 40ft. or 50ft.

Recommendations as to Tramways. — The Commission preface their statement of recommendations in regard to tramways by the enumeration of a number of fundamental propositions applicable to urban tramway operations in general, and to London conditions in particular, as follows: Wherever tramways can be laid on existing streets in London without widening, they can, when worked *commercially*, be made a direct source of profit. London in comparison with American and Continental and provincial English cities is conspicuously deficient in tramway

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facilities; there are extensive districts in the "West-end" and centre of London entirely unprovided for. There is, even where tramways exist, an entire absence of through communication between the various systems within, and between those within and those without the county of London, and every through passenger is obliged to change cars at the junctions, if any, of the various systems. "Accordingly, all the cars are obliged to discharge their passengers at dead-end terminals. At the six principal terminals (Westminster Bridge, Shepherd's Bush, Blackfriars Bridge, Aldgate, Moorgate, and Euston-road) nearly a quarter of a million of passengers alight from or join the cars every day in the streets. Apart from the great inconvenience caused to all or most of the passengers, the result is a very great congestion, both of tramcars and of ordinary vehicular and pedestrian traffic, at these terminal points, and the same congestion, though in a less degree, occurs at the other terminals in London. The Advisory Board of Engineers estimate that the carrying power of a tramway system may be diminished by about one-half by reason of the cross-shunting necessary at dead-end terminals. It will be seen that, from every point of view, tramway accommodation is glaringly defective. In a great area there is no tramway service at all. Where there is such a service, travellers do not obtain the full advantage which it ought to provide in cheapness, expedition, and convenience. An 'end-on' break in the course of a journey probably causes additional expense (for two independent fares usually cost more than a through fare), whilst the consequent delay and discomfort, especially in bad weather, and the uncertainty of transhipment are great drawbacks. Where the line abruptly terminates in the middle of crowded streets, even greater discomfort is caused, together with serious diminution of efficiency in the entire tramway service and an intolerable congestion in the streets. It is difficult to appreciate how such a state of things can have been tolerated so long. Whatever view may be held upon the expediency of extending tramways in London, it cannot be expedient to work those we have upon inefficient methods."

Functions of Street Tramways.—In smaller cities, tramways, the Commission state, supply a double want. They carry passengers from one part of the city to another, and also between the city and adjoining areas, to a distance of eight or ten miles. In London, it is probable that their usefulness will be more restricted. They will be chiefly used for short distances in urban and suburban districts. Experience shows that the metropolitan railways, even where no tramways compete, practically do not attract passengers for journeys of less than a mile. Railways and tramways can with advantage, it is stated, be worked in inter-connection. "Tubes" might be prolonged till they reach the surface at some point in the more open country, and then be continued on the surface as railways or tramways to or beyond the suburbs. Tramways on the streets in urban and suburban districts should, where possible, be laid out in interchange connection with main-line, "tube," and other railways by arrangement with the railway companies. The competitor of the tramway for short-distance traffic is the omnibus, and the horse omnibus, it is said, will always serve a useful purpose in London, unless superseded by the motor omnibus, in distributing passengers where tramways do not penetrate, but the Commission believe that on all the routes, where there is fair competition, the same thing will happen in London as happened in Liverpool between the years 1897 and 1903. Within a period of seven years all the omnibuses disappeared from the streets and gave place to electric tramcars, while the number of passengers carried was nearly trebled. These results, which have been repeated in other cities both at home and abroad, show, it is claimed, how eagerly the public avails itself of tramway facilities. Motor omnibuses will doubtless supersede horse omnibuses, and remove from the streets, greatly to the public advantage, a form of vehicle which, although it has been of great public utility, is now one of the principal causes of congestion in many streets. But the Commission think that, on routes suitable for tramways, where there is a large traffic, tramways will continue to be the most efficient and the cheapest means of street conveyance, and cannot recommend the postponement of tramway extension in London on the ground of any visible prospect of the supersession of tramways by motor omnibuses.

Widths of Streets for Tramways.—Is widening needed to admit of the construction of tramways? "That, indeed," the Commission state, "is the point upon which everything turns. Few would object to an extensive tramway system being laid down all over London but for the belief that it must involve an extensive system of street widening. This is the great difficulty. The opinion is widely held that the streets of London are too narrow for tramways on a great scale. No doubt many streets are too narrow. The real question is whether this disadvantage is so widespread as to necessitate the postponement of a great tramway extension until costly operations of widening have been carried through." In this connection the Commission state that the London County Council aim at a minimum width of 33ft. between the kerbs, but that the Commission think that a greater width than 33ft. is desirable as a rule for a double line of tramway, save that for short distances, or in less frequented thoroughfares, even a less width may be accepted. A single line might be laid in still narrower streets either for traffic in both directions, with passing places at intervals. or for traffic in one direction only. Such an arrangement is common abroad, and appears to work satisfactorily. "Judged by the above standards of width, the report proceeds, many of the main thoroughfares of London will admit of tramways. Of course, the decision must depend partly upon the extent to which the street is crowded, as well as upon its width. Certainly some street improvement is necessary in places from any point of view, and we have already recommended that preference should be given, as far as possible, to improvements which would widen roads intended for tramways, but we are persuaded that a great deal can be done in the way of tramway extension without any great expense of this kind."

Tramway Extensions.—No good purpose, the Commission state, could be served by their attempting to lay down a hard-and-fast scheme for the construction of tramways. The selection of proper routes would require minute examination. They describe and criticise the important proposals reported upon by the Advisory Board of Engineers, who, at their request, have indicated the various directions in London in which the construction and operation of tramways, after making the necessary street improvements, would be beneficial and useful. The routes in question are: across Hammersmith Bridge; Hammersmith to Knightsbridge; Knightsbridge to Aldgate in subway; Fulham and Brompton roads; Grosvenor-place and Hyde Park in subway; Edgware-road and Maida Vale; Harrow-road; Cambridge-avenue; Uxbridge and Bayswater roads; Westminster Bridge and Victoria-embankment; Waterloo Bridge and Blackfriars Bridge; Queen Victoria-street and Southwark Bridge; New Bridge-street and Farringdon-street; Holborn and Charterhouse-street; York-road, Stamford-street, and Southwark-street; Tower Subway; Tottenham Court-road and Whitehall; Moorgate, Liverpool-street, and Norton Folgate; Aldersgate-street to Post Office in subway; King's-road, Chelsea, and Buckingham Palace-road; Victoria-street, Westminster; Marylebone and Euston roads; Finchley-road. The advantages, the Commission state, of some of these proposals are obvious. If they were carried out, a tramway along the Euston and Marylebone roads and the Edgware-road would connect the existing eastern and western systems, passing quite close to five of the principal railway termini in London; north and south would be connected by two lines outside the City; four lines from the west would penetrate to the central area and thence be continued to the eastern districts; not least in importance, tramways would cross the Thames on two existing bridges (Westminster and Blackfriars), which would be united by a line along the Thames Embankment. Thus urgently needed through communication would be afforded. In short, the three isolated systems which we have described would be linked together, the central area, hitherto destitute of tramways, would be partially opened out, and the Thames would no longer interrupt communication between north and south. Some

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of these proposals of the Advisory Board of Engineers are undoubtedly open to criticism. They involve, in all, about seven miles (excluding the subways under the proposed main avenues) of tunnels or subways. There are parts of London, the Commission say, where the value of land is so great, notably in the City, that widening for tramway purposes is not to be thought of. In such places the only course is to construct subways. But that is not so everywhere, and, for the most part, if the choice lies between subways and widening, the Commission believe that it will be found nearly as cheap to widen the streets and lay tramways on the surface. In any case it must be a question of relative cost, with the additional consideration that travelling on the surface is always preferable and a wide street always an advantage. The Commission do not think that a case is made out in favour of a subway being constructed from Albert Gate along Piccadilly to the City, or for the tunnel beneath the Thames east of the Tower Bridge to unite existing terminals in Leman-street and Tower Bridge-road. As to the proposals within the city of London, some involve subways, others are for surface tramways. The Commission think that surface tramways should be laid down in the City where they can be shown to be reasonably practicable, and that subways should be made where surface tramways are not practicable. The Commission think the Grosvenor-place and Hyde Park subway, which would relieve the congestion at the crossings at Hyde Park-corner and Marble Arch, is so important that it should be taken in hand with as little delay as is possible. On the Euston and Marylebone roads, Bayswater-road, Hammersmith-road, Fulham-road, and King's-road, Chelsea, as well as on the other roads on which tramways are proposed, some street improvements will, at places, be required, and extensive improvements, in the way of widening streets, would be an advantage upon all the routes. In King's-road, particularly, considerable street improvements will be necessary; but if the construction of tramways were delayed until the full width recommended of 100, or even 80, feet could be everywhere secured, the introduction of tramways might be postponed indefinitely, owing to the great cost which such improvements would involve. The Commission believe that most of these routes could be laid out for tramways with only a moderate outlay for widening in particular places, and are so convinced of the urgent necessity for tramway accommodation in London, that they recommend that the work on the five routes in question should be taken in hand as soon as possible. The Commission think it unnecessary to indicate other routes with regard to which the same course might be followed. The illustrations already dealt with they think sufficient. If these works are executed, and the travelling public realise the advantages anticipated, further extensions, they say, will follow as a matter of course.

Tramway Operation.—Through communication—that is, the running of through cars over tramway systems, separately owned, without rebooking or transhipment of passengers—is of great importance in the interests of cheap, expeditious, and convenient locomotion, and the refusal of reasonable facilities for that purpose should not be allowed, but should be enforced, if necessary, by the grant of running powers. Where, however, through running of cars is impracticable, through bookings and an interchange of passengers, at convenient times and places, should be secured. Tramway systems within "Greater London" ought to be worked by one and the same authority, and that for this and other reasons. The Commission do not deal directly with the question of the municipal operation of tramways, as being outside the terms of their reference. They state, however, that they think it reasonable that some profit should be derived from the tramways for the benefit of the municipality, but that it does not follow that the best way of securing the largest profit will be that the municipality, even if it finds the money for construction, should undertake the task of operating. In other countries it is not unusual for municipalities to construct, purchase, or otherwise acquire the tramways, but in such cases the actual working is generally left to operating companies, with provision for proper rates and general control. It is claimed that such methods yield better financial results to the municipalities, and avoid difficulties which might arise from municipal authorities carrying on a business of this kind on a large scale. Abroad, the work of construction is also often facilitated by the same company that is afterwards to operate also undertaking the construction by contract with the municipal authorities, who are thereby saved from the risks and disadvantages attendant upon the making, as well as the working, of a line by a municipality. If the tramways are operated by the municipalities concerned, the Commission say they should be worked on sound financial principles, with ample provision for depreciation and repayment of capital or discharge of debt, and that any profit from tramways received by a municipality should, preferentially, be applied to necessary tramway developments, and to street improvements, and to meet expenditure which otherwise would fall on the rates.

Tramway Legislation.—The Commission strongly recommend the consolidation of tramway and light railway law. The Commission recommend the abolition of the "veto" of local and street authorities and of frontagers, and to provide that in "Greater London" the county councils and the Corporation of the city of London shall have a preferential right to construct any tramways within their districts if they are prepared to do so. Instead of a "veto," they recommend that local and road authorities should have a *locus standi* to appear before the Traffic Board and Parliament in opposition to any tramway scheme within their district, by whomsoever such tramway scheme might be promoted. In the same way, frontagers, who have at present a veto under the Tramways Act, 1870, should have a *locus standi* upon any tramway scheme affecting their property.

The recommendations of the Commission as to railways and the joint operation of railways and tramways in large systems we propose to leave to another issue, and also the proposed duties of the suggested Traffic Board. This, it is advised, should consist of three or five members, who should be capable men of business, energetic, impartial, and able to devote, if necessary, their whole time to the work of the Board.

THE GALBRAITH ELECTRIC FURNACE.

On Wednesday last the furnace above mentioned was shown in operation in an experimental form at the Brush Company's works at Loughborough. The furnace has been designed to deal specially with the iron sands which are found in very large quantities at Calliope Dock, Auckland, New Zealand, and elsewhere in that colony. We understand that all previous attempts to treat this sand have failed, in spite of the fact that it consists almost entirely of magnetite. The difficulty has been to reduce and smelt the sand, which chokes up all the types of blast furnaces which have been experimented with. Attempts which have been made to treat the sand after forming it into briquettes have also failed. The Galbraith furnace enables this sand to be treated continuously, and the inventor's figures give hope that the cost of treatment where cheap water power is available will be sufficiently low to make the process a commercial success. The furnace which we illustrate in Figs. 1, 2, and 3 is the earliest form which was experimented with in New Zealand. The drawings are incomplete, and show only the active portion of the furnace where the reduction of the iron sand and subsequent smelting was effected. It will be seen that a number of rods, marked A A in the drawings, pass through from one side of the furnace to the other. These are made of graphite, and are maintained in an incandescent state by the passage of electricity through them. The side linings of the furnace, marked B B, can also be of graphite when parallel connections are used for heating the incandescent bars. The end lining, C C, is made of a refractory material which is also an insulator. The iron sand is then fed into the top of the furnace, and it trickles down over the incandescent bars, being first reduced and afterwards melted. In the furnace which we saw working at Loughborough on Wednesday the form of the incandescent bars was very

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different to that shown in the drawing. Each line of bars was moulded out of graphite in the form of a grid, the section of each bar being diamond-shaped, with its long axis horizontal. The space between two adjacent bars was small compared to the width of the same, and the alternate grids were staggered, so that these openings in one set came immediately over the centres of the bars in the next set. In the Loughborough furnace the voltage applied to the bars was about 18 volts alternating, which was obtained from a 100-kw. oil-cooled transformer. The iron sand can either be reduced in the furnace itself—in which case a certain amount of powdered carbon has to be introduced with it—or it can be reduced beforehand by a preliminary roasting, as was the case in the experiment we witnessed. The sand is then fed into the top of the furnace, and is gradually melted as it passes down over the incandescent carbon bars. It falls into a receptacle at the bottom, which in practical work would be heated, and from which the steel obtained could be drawn out for further treatment, so as to obtain a uniform product. As collected in an uncooled receptacle the product has subsequently to be melted again, and there were on view a number of small ingots which had been prepared in this way. It will be seen, therefore, that the furnace is simply used to reduce the iron sand into metallic iron or steel, and that the removal of any impurities in the sand or the decarbonisation of the steel has to be carried out as a subsequent operation, which can be, however, effected

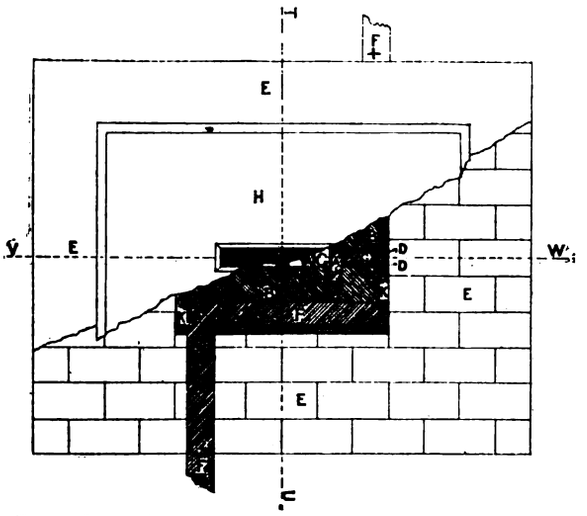

FIG. 1.—Plan of Galbraith Experimental Furnace for Treatment of Iron Sand.

without a complete remelting of the product from the electric furnace. The electrical details for conveying current to the graphite bars have yet to be perfected, and the cost of upkeep will depend on such details and on the life of the blocks in question. The inside of the furnace is always filled with carbon dioxide, so that the wasting away of the bars should not be rapid. The bottom of the furnace into which the molten metal drops is kept closed and sealed, so that no air passes into it. The upper end of the furnace as shown at Loughborough was closed by the box through which the reduced iron sand was fed in. The result was that there was a slightly higher pressure inside the furnace than out, which caused lighted gases to issue from the joints between the graphite blocks and the furnace walls. We were also shown a number of these blocks which had been used for a considerable run, and which showed no signs of being reduced. There was no attempt in the experimental furnace to keep in the heat, and consequently the radiation losses were large and the temperature round the furnace unpleasant. It is obvious, however, that this radiation can be cut down to a very large extent by some such construction as is shown in the illustrations herewith. Any figures as to output and cost which have been obtained at present are bound to be high, owing to the experimental nature of the trials. Mr. W. Steuart, who as an electrical engineer has taken up the development of the furnace with the inventor, succeeded in reducing steel at the rate of 38lb. per hour with the furnace illustrated. In this experiment the sand was both reduced and melted in the furnace, and the consumption of energy was 1·1 units for this amount. In considering this furnace it must be borne in mind that it is designed for a special object and for the treatment of material which, though exceedingly

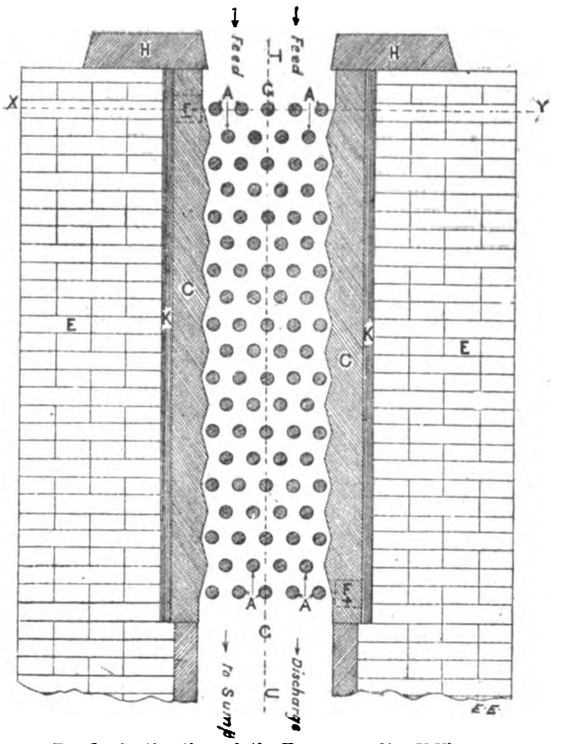

FIG. 2.—Section through the Furnace on Line V W.

rich in iron, has hitherto defied all efforts of the metallurgist. From this material the Galbraith furnace has produced steel with a consumption of energy for a given weight which would be warranted if cheap power is available. It seems that in New Zealand there are two large waterfalls—*i.e.*,

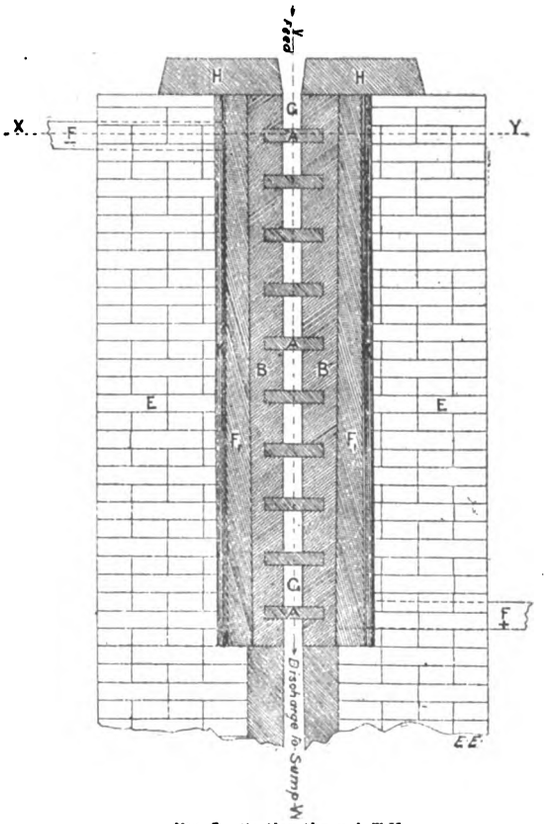

FIG. 3.—Section through T U.

those at Huka and Ainwhaniwha—from which energy could easily be transmitted to these iron sand deposits. At each of these falls 10,000 h.p. could be obtained at a very small cost per horse-power per annum. Mr. Steuart's estimate of this cost is in the neighbourhood of

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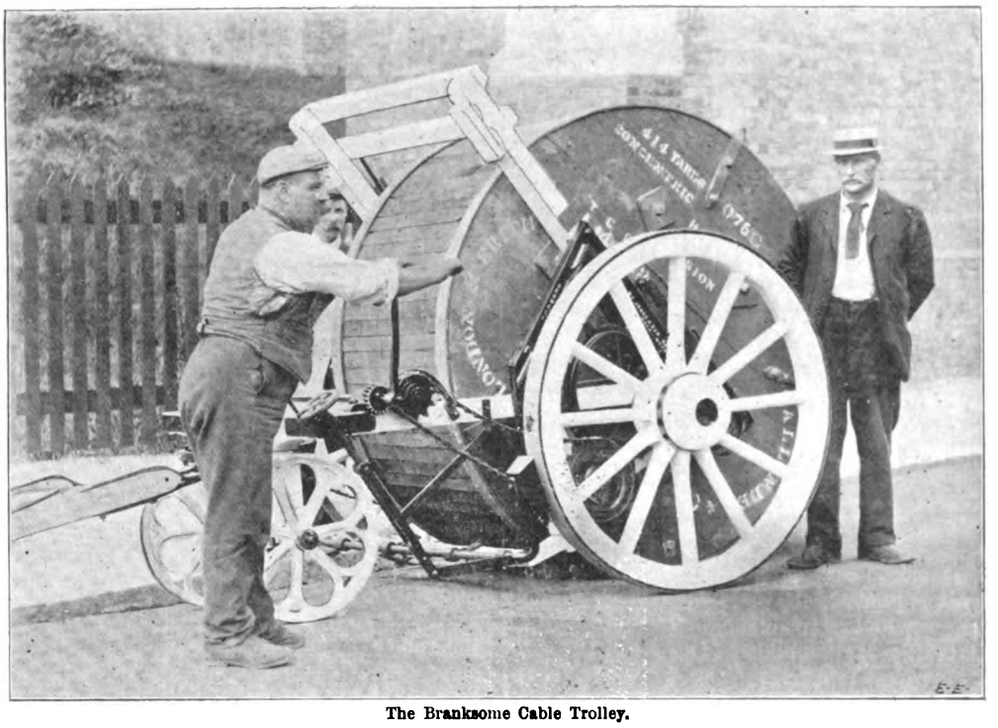
30s. per horse-power per annum. Such a low figure brings the cost of electrically heating a furnace down to a point at which it can compete with a furnace using fuel. In this respect it must be remembered that in the electric furnace acting on the reduced sand, only the heat required to melt the iron has to be provided. In the fuel-fed furnace, the materials which pass through include fuel, slag, and the necessary air for combustion purposes. It is known, for instance, that the actual weight of the gases leaving a blast furnace is about seven times more than the iron produced. The heating up of material other than iron, therefore, is responsible for quite a large proportion of the fuel required. The Galbraith furnace has special advantages for the special work contemplated, and we trust that by its aid the iron sand deposits, not only in New Zealand, but also in Canada and elsewhere, will be added to our other sources of commercial iron and steel. The Galbraith Iron and Steel Company, Limited, are developing this furnace, and has at present London offices at Cannon-street Hotel, E.C.

ELECTRIC TRAMWAY AND RAILWAY EXHIBITION.

(Continued from page 53.)

THE BRANKSOME CARRIAGE AND MOTOR WORKS, of Poole-road, Bournemouth West, showed a cable-drum trolley which is worthy of note. The details of this trolley can be seen in the accompanying illustration. It has for its object the reduction of labour in the handling of cables for underground mains, and is so constructed that one man can load up drums of cable weighing as much as five tons. It will be seen from the photograph that the upper part of the trolley is hinged. To load up a drum of cable, this is first tilted up. The carriage is then backed over the drum, and the usual axle bar is secured to the upper side of this hinged portion. By means of a pinion driven by the handle shown and gearing into a tooth rack the upper part of carriage is then moved back, which raises the drum off the ground. The details of this cable trolley are substantial throughout. We understand that it has done good service at Bournemouth for the Bournemouth and Poole Electricity Supply Company.



The Branksome Cable Trolley.

THE ST. HELENS CABLE COMPANY, LIMITED, were showing a representative selection of their numerous manufactures and raw materials used. Perhaps the principal attraction was a solid piece of Para rubber. This is the largest single piece ever imported, the weight being 1,100lb., and its value, roughly, at the present market rate, £300. Another interesting item was a machine designed to show that the company's dialite cable is not subject to trouble from low temperatures, such as the cracking of the dielectric when bent. To demonstrate the advantages of dialite in cases of low temperature, they showed a piece of dialite cable being continually bent backwards and forwards by this machine, at a temperature of 30deg. F., the cable being under an electrical pressure of 2,500 volts during the whole of the time. That this cable gives equally satisfactory results under conditions of extreme heat, has been demonstrated on former occasions. The exhibit included many samples of different forms of cable made by the company and coils of copper wire drawn by them; also a pyramid of drums loaded with trolley wire, of which they manufacture a very large amount, electrical lift rope, and steel span wire. The remainder of the exhibit consisted of fireproof cables, rubber cables, indiarubber gloves tested to 5,000 volts, insulating and waterproof tapes, mats, matting, motor 'bus tyres, packings, insertions, tubing, and various other mechanical rubber goods. We noticed particularly some rubber-lined leather gloves, the leather giving effective mechanical protection to the insulating material. Reference may also be made to the high quality of the insulating mats shown. The whole made an exhibit well calculated to enhance the reputation of the company for reliability of goods supplied.

MESSRS. EVERETT, EDGCUMBE, AND CO., LIMITED, had a good display of instruments on their stand. These included a direct-reading "watt-photometer." This instrument is so arranged (see the accompanying diagram) that a single adjustment enables the following quantities to be read off direct: (1) candle-power; (2) watt consumption; (3) efficiency in watts per candle-power. The apparatus consists of a polished mahogany case, which when open forms a direct-reading photometer having a Trotter pattern head. The arrangement is such that any variation in the voltage either up or down from the normal does not in the least affect the accuracy of the candle-power measurements. A wattmeter is also fitted in the case, and on pressing a key the pointer indicates the watt consumption of the lamp. A further key is provided, on pressing which the instrument indicates the watts per candle-power direct. This is accomplished by causing the photometer carriage, as it is moved backwards and forwards according to the candle-power of the lamp, to vary the resistance in series with the volt coil of the wattmeter in such a way that the instrument reads "watts/candle-power" instead of "watts." By means of this instrument the candle-power and efficiency of a whole batch of lamps can be determined in a few minutes, and this in broad daylight and without any precautions being taken as regards the adjustment of the voltage. All measurements are made direct, no calculation

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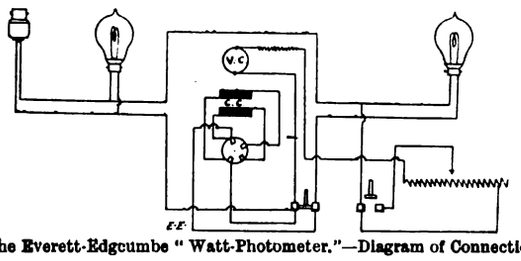
whatever being necessary. Reference may also be made to the company's leakage indicators for direct and three-phase currents designed to comply with the new regulations for the use of electricity in coal mines. Rule 6 of the regulations in question states that the leakage current—that is to say, the current passing from one main to the other through the earth—shall not exceed one-thousandth part of the maximum supply current; and Rule 7 states that in every completely insulated system leakage indicators are to be connected up to show immediately the occurrence of any fault, and that daily readings on these instruments are to be entered up in a book kept for the purpose. In the case of the direct-current instrument, when the switch is in the normal position a deflection to the right or to the left indicates a fault on the positive or negative main, as the case may be. The other two points on the switch connect the instrument through a resistance between each main and the earth. It has been sometimes stated that the readings on these two stops give the actual leakage current as demanded by the Home Office. This is, of course, not so. A table, however, accompanies the instrument, from which not only the actual leakage current, but also the insulation of the positive and negative mains, can be at once read off. It may, perhaps, be stated that these results do not depend for their accuracy on the assumption that the insulation of the main to which the instrument is connected is perfect, but are equally accurate however faulty either or both mains may be. In the case of three-phase systems three resistances are joined to form an artificial neutral point, and a sensitive milliampere-meter is connected between this and the earth.



The Everett-Edgcumbe "Watt-Photometer."—Diagram of Connections.

Normally, no deflection will be obtained. If, however, the insulation of any one of the mains should be faulty, the deflection will be at once observed. Further readings can be taken by connecting the instrument between each of the three mains and the earth, from which a very good idea of the state of the system is obtainable.

The Everett-Edgcumbe Inkler synchroniser recorder is another instrument well worthy of notice. The chief trouble met with in the design of a satisfactory recorder is, firstly, to overcome the friction between the pen and the paper; secondly, to cause the instrument to read correctly whether the pen is full of ink or nearly empty; to prevent spilling of the ink and consequent blotting of the records, and to provide a satisfactory arrangement for working forward the paper chart. In the recorder under review the pen is replaced by a hardened steel point, which does not press on the paper, and thus is quite free to take up its correct position. At equal intervals of time—usually every five seconds—a tapping device causes the steel point mentioned above to press through an inked typewriter ribbon on to the paper chart. The result is that a round dot is produced on the latter, the position of which corresponds accurately to the voltage or current, or to whatever is being measured. The intermittent tapping is produced by means of an electrical clock, which closes a circuit every five seconds, and thus actuates an electromagnet in the recorder itself. A second electromagnet in the recorder at the same time drives the paper chart forward through a definite amount. It may, at first sight, be thought that an electric contact introduces a complication into the system, but it has been found, after many years' experience, that such electric clocks work without any attention whatever for years at a time, and are, moreover, more accurate timekeepers than the ordinary clock. A single timing mechanism can be employed to actuate a number of recorders, either a battery being employed as a source of current, or, where available, the supply mains. Also, in series with these recorders, can be connected any number of clock dials, which not only serve as clocks, but also show at once that the paper charts of all the recorders are timing correctly. The construction, as above described, is such that a much smaller electrical instrument can be used for measuring purposes. For direct current, a moving-coil instrument is employed, while for alternating currents either the dynamometer type as in the case of recording wattmeters or recording power-factor indicators, or the moving-iron type for ammeters and voltmeters. For high-tension circuits, the instruments are worked through series or current transformers. The paper chart is usually supplied in the form of long rolls, lasting a month at 1in. per hour (which speed can, of course, be varied as required) and, as the paper is passed through the instrument, it is automatically wound up on a drum until required. The electric clocks used in connection with these instruments are constructed on the "Hope-Jones Synchronome" principle and are absolutely self-winding, so that no attention is required by the recorder, except to change the charts once a month. The currents working the system only flow for such very short periods that the energy absorbed is negligibly small, amounting, perhaps, to some 10 ampere-hours per annum per recorder, at a voltage of four or six volts. The indicating ribbons are in the form of continuous bands, and only require changing at rare intervals. For alternating-current instruments a special astatic moving-iron system is employed, which consists of two "Universal" ammeter coils wound in opposite directions, and each acting on a separate soft-iron disc. By this means any stray field which may exist in the neighbourhood of the instrument strengthens one coil by the same amount that it weakens the other, so that the effect on the reading is nil. In the case of switchboard instruments the whole is enclosed in a cast-iron case, which forms a further protection, so that the recorders are absolutely unaffected by stray fields, whether the movement be of the moving-iron or the moving-coil type. The controlling clocks are of two forms, and work either with a pendulum or balance-wheel escapement, according to the use to which they are to be put. From what has been said it will be seen that practically the same accuracy is attainable with these recorders as with an ordinary central-station instrument.

A notice of this interesting exhibit would be incomplete without mention of a portable street photometer which has been designed as the result of numerous experiments, and embodies the following important points: (1) a portable electric standard is employed, which can be readily checked at any time, and which is worked off a portable accumulator; (2) lights of various colours can be readily compared, the photometer being constructed on the "flicker" principle; (3) the scale reading has merely to be multiplied by the candle-power of the lamp employed in order to give the actual illumination on the photometer; (4) the candle-power of the source of light under test is at once obtainable by means of a table from this figure, as is also the illumination on a horizontal plane should this be required. The flicker arrangement is a modification of that employed in the "Everett-Edgcumbe laboratory photometer" for arc lamp testing, and it is especially designed to get over the errors usually found when comparing incandescent electric lamps with arc lamps or incandescent gas. The instrument is as portable as it can be made, and no previous experience whatever is required in order to use it.

On their stand MESSRS. NALDER BROS. AND THOMPSON had a large assortment of electrical measuring instruments for all purposes, both direct reading and recording, several typical switchboard panels being shown with instruments, switchboard, and circuit breakers complete. There was a new type of circuit breaker, consisting of the overload and reverse current variety, fitted with carbon brakes and magnetic blow-out. This instrument has the spread-brush form of contact, and possesses the advantage that if the short circuit remains on it is impossible to replace the switch. The switch is fitted with a free handle, and represents the most up-to-date and complete form of circuit breaker. We noticed some moving-coil switchboard instruments in new sizes, such as the very small edgewise type, as also a very large station voltmeter of the illuminated dial type; also a new type of soft-iron instrument in an iron case, known as

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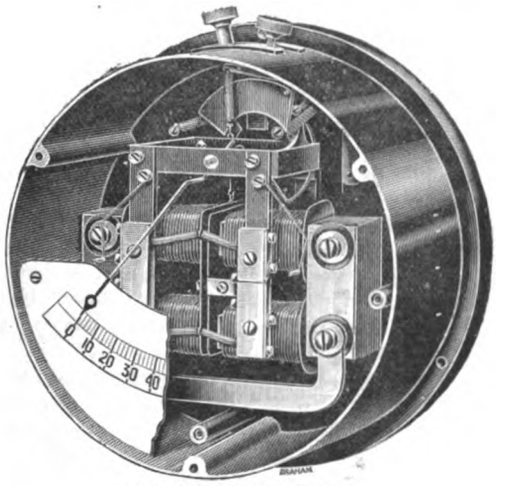
the O.K. type. This instrument is either for direct or alternating currents, and is screened so as to render it unaffected by external fields, and fitted with an improved form of air damping.

A new form of wattmeter was also exhibited. This instrument was invented and patented by Dr. C. V. Drysdale, D.Sc., and presents many points of novelty. The accompanying illustration shows its working parts with the cover removed. The instrument consists essentially of four fixed current coils, wound on soft-iron cores; these cores are arranged to give a very intense field with a very small air-gap. Between the poles of the magnets are two flat coils wound with fine wire, which constitute the pressure coils.



The Drysdale Wattmeter.

These are wound in opposite directions, and as each is arranged to have an equal number of turns, the self-induction of the pressure circuit is practically nil, consequently the correction which would have to be applied due to this factor is eliminated. Of these two pressure coils, the thickness of which is only $\frac{1}{60}$in., one is fixed and the other allowed to move vertically in the field produced by the current coils. This vertical motion is transformed into a rotary one by means of a fine wire attached to the coil, which passes over an arbor to which the pointer is attached. To the pointer axis is attached an improved form of air damping, which makes the instrument dead beat. The advantages of this instrument are many. Firstly, owing to the extremely little space taken by the pressure coils the magnet air-gap is very short in length, consequently a very strong field is produced, which gives large force in the instrument, and at the same time renders the instrument unaffected by external fields. Secondly, the coefficient of the self-induction of the pressure circuit being negligible, the errors at low factors are very small—in fact, careful testing on this form of instrument shows that it can be guaranteed to within 1 per cent. with power factors as low as one-tenth. These results, we believe, are the best that have been attained so far in alternating-current wattmeters. The instrument is mounted in an iron case, and is provided with two adjustable screws, one for clamping the moving coil when the instrument is in transit and the other for setting the zero. A large number of these instruments have, we understand, been supplied to various power stations in the kingdom for use in connection with transformers.

THE LANCASHIRE DYNAMO AND MOTOR COMPANY, LIMITED, Trafford Park, Manchester, were exhibiting, among other machines, one of their automatic reversible booster sets (Turnbull and McLeod patents). This, indeed, was the principal feature of their display, and although similar sets have already been supplied to several central stations, it merits more than passing notice here. These boosters, it may be explained, are chiefly used for working on traction systems with a battery in parallel with the generators, the object being to keep the load on the dynamos practically constant, the battery discharging at times of heavy load and charging at times of light load. They are also of use in works where the motors are large and started and stopped frequently, or in any other place where the load is of a varying character. Taking into account the large variations in the voltage of a battery (not only with varying current, but with the same current at different times), it is evident that the first requisite is an exciting coil which shall always make the sum of the battery and booster voltages practically equal at all times to the 'bus-bar voltage. This is accomplished by putting on a coil, A (see the accompanying diagram), excited by the difference between the battery and 'bus-bar voltage. If the booster is worked on the straight part of the characteristic, it will be seen that the coil can be made to give a voltage on the booster armature always equal to the difference between the battery and dynamo voltage, so that, no matter what the state of the battery, the booster always brings the battery up or down to the 'bus-bar voltage. If, now, another coil is added a very small current in this will cause a very large difference in the booster voltage. For instance, a shunt coil, B, across the 'bus bars would increase the voltage on the booster, which would again increase the strength of coil A, and the battery would heavily charge. If, on the other hand, instead of B a coil is put on wound in the opposite way, the voltage of the booster would be altered so as to produce a heavy discharge. The last coil is a series coil, C, arranged to carry the whole or part of the dynamo current, and is arranged so as to oppose coil B; then, any increase in the ampere-turns of B above C will cause the booster to build up so as to heavily charge, and any decrease of B below C will cause the battery to discharge. A few series turns are usually added in the battery or feeder circuit to make up for the armature reaction, and C R drop of the booster itself. To take the case of the booster on a traction system; if the dynamo tries to take an overload the coil, C, would over-

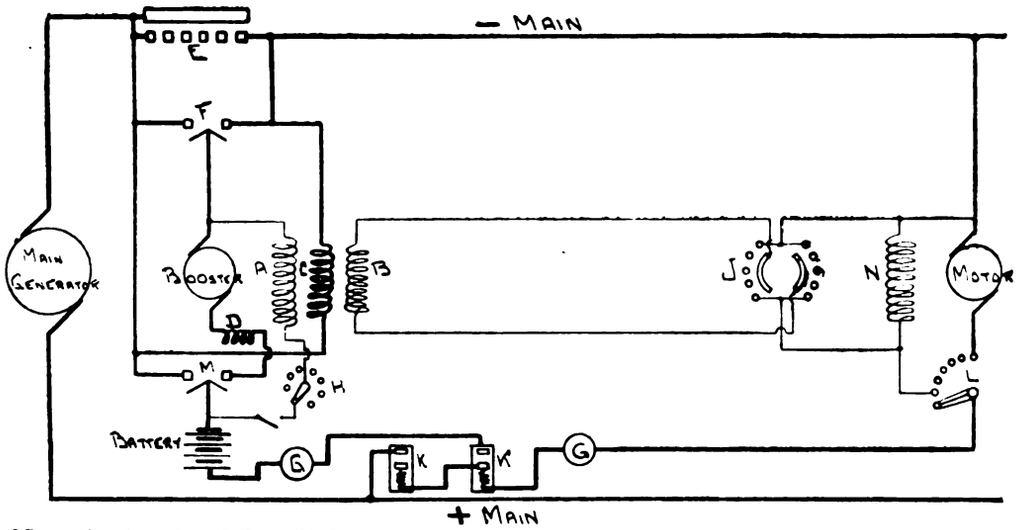


Diagram of Connections for Automatic Reversible Booster.—A, B, C, and D, Booster Field Coils; E, Series Regulator; F, S.P. Change Over Switch; G, Ammeters; H, Shunt Regulator; J, Potentiometer Shunt Regulator; K, Circuit Breaker: L, Motor Starter; M, S.P. Change Over Switch; N, Motor Field.

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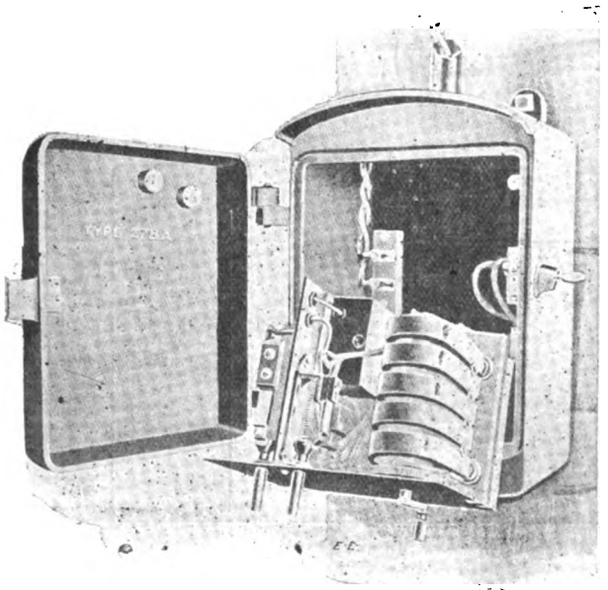
power B and the battery discharge until equilibrium was restored; on the other hand, if the dynamo current tries to reduce on light load, B overpowers C and the battery charges until they are balanced. As the booster depends for its control on the dynamo current, and not on any balancing of voltage, depending on the dynamo characteristic, compound machines may be used as well as shunt, and all trouble from hunting and kindred causes is avoided. Most boosters which do not depend on the falling characteristic of a shunt dynamo rely on the drop in volts on the battery and booster in discharging, which is balanced by a series coil in the feeder. If this coil is not exactly of the right strength, the battery discharges too much or too little, usually varying with the state of the battery. The particularly valuable property of a coil in the dynamo circuit consists in the fact that it can be made as strong as desired, and always balanced by a regulator on the shunt coil to fix the dynamo current on anything required; and if the current should vary, acts with very great force to bring it back to the normal again, thus making the booster very stable and greatly facilitating paralleling. If it is desired to use the battery and the booster on the line without the generators, coil A is disconnected and coil C connected to help B giving the battery a constant voltage with varying load.

Of the various apparatus shown by the WESTERN ELECTRIC COMPANY, special reference may be made to



Western Electric Co.'s Traction Telephone Set.

their patent traction telephone set. In connection with street railways and electric tramways the need has arisen for means of communication between drivers or motormen and the generating station and engineers. In cases of breakdowns, accidents, or flooding of the permanent way, it is essential that the facts shall be promptly communicated to the responsible officer, so that he may take the necessary steps for preventing a complete interruption of the service. It has been kept in view in designing the telephone under notice that a traction set must be eminently reliable under all atmospheric conditions; it must be strong and able to withstand a considerable amount of rough usage. The operation of the set must be simple and as nearly automatic as possible, so that even under the greatest excitement there will be no difficulty in establishing communication instantaneously. The parts of the set must be easily accessible for inspection and repair, and, the most essential point of all, the operator at either end of the line must be efficiently protected from danger should the telephone lines become crossed with a high-voltage traction circuit. The whole should, of course, be enclosed in a mechanically strong weather-proof case. The outer case consists of a cast-iron box, with ample flanges to ensure protection from damp weather, and is fitted with a reliable lock. It is in a form suitable for mounting on the side of a feeder pillar or trolley pole. The set is also made up in cases without lugs, suitable for mounting on the top of cast-iron pillars in the same manner as the well-known fire-alarm sets. To communicate with generating station the motorman turns the generator crank a few times, and then by means of the combined transmitter and receiver, of the form commonly known as a microtelephone, converses with the engineer at the station. At the upper part of the set there are two projecting rods; these engage with the anvils cast in the front of the outer door and operate switches which respectively open the transmitter circuit and cut the apparatus entirely clear from the line when the door is closed. This is a very important part of the set, for the automatic opening of the battery circuit prevents waste of the current, and the opening of the line circuit serves the double purpose of preventing damage to the set in the event of a cross of the telephone line with the traction circuit, and permits an unlimited number of these sets to be placed in "bridge" across one pair of lines, which may thus serve for a whole route, or in small systems for the whole network, and thus save the expense of providing switching apparatus at the generating station. The accompanying illustration shows the inner case of the set opened for inspection or repair. It will be seen that all the apparatus is mounted on a sliding base which runs in guides cast in the side of the set, this arrangement enabling the whole to be removed into a convenient position as shown for inspection. The shelf is locked into position by a locking lever having an ear adapted to serve as a handle by which the lever may be rotated and the shelf unlocked so that it may be moved forward. It is prevented from being completely removed or from falling when drawn forward for inspection by lugs which engage with stops in the guides, but can be entirely removed for repair by simply drawing it forward until the lugs are opposite the openings in the guides and then lifting the shelf vertically. This is of considerable advantage, for should the apparatus become deranged so that removal to a distant point is necessary, the linesman simply removes the shelf and replaces it temporarily by a spare one. The sliding out of the shelf serves to automatically disconnect the apparatus from the line with which it is associated. Included in the circuit of the apparatus are line fuses so arranged that if abnormal currents are present on the line the fuses blow while the door is being opened, thus constituting a signal whereby the person desiring to use the instrument is apprised of the abnormal and dangerous condition of the lines. The fuses entirely disconnect the apparatus before the person has time to grasp the handle of the generator or microtelephone. In addition to this, a lightning or high-voltage protector of the open space carbon cut-out type is provided, which serves to effectively earth the line in the event of connection with a circuit of over 300 volts potential difference. This will cause the fuses previously mentioned to be operated and isolate the apparatus. Further protection is obtained by interposing a repeating coil between the telephone apparatus and the line. This repeating coil or transformer is wound with double silk-insulated copper wire, enclosed in an earthed metal case filled with special insulating compound, and allows telephone currents to pass by induction from the set to the lines without there being any metallic connection between them. A very important feature of this set is that the protective apparatus and the telephone apparatus are arranged in separate groups with an earthed metallic shield between them, so that any dangerous high-potential condition that may exist in the compartment wherein the protective devices are mounted may not be communicated to the telephone apparatus, but may instead be diverted through to earthed shield interposed between the two groups. All portions of the set accessible to the person making the communication are earthed upon the feeder pillar or trolley pole. Another feature which will be greatly appreciated by users of this set is that all parts are standard apparatus and readily interchangeable, and can be supplied from stock should it be necessary to change or replace any of them. Included in the exhibit were samples of the company's "Electrose" insulators for overhead line work. The tests to which this material has been subjected show its mechanical strength and insulating qualities to be exceptionally satisfactory. Nor has twelve months' exposure to weather on the Niagara Falls Power Company's

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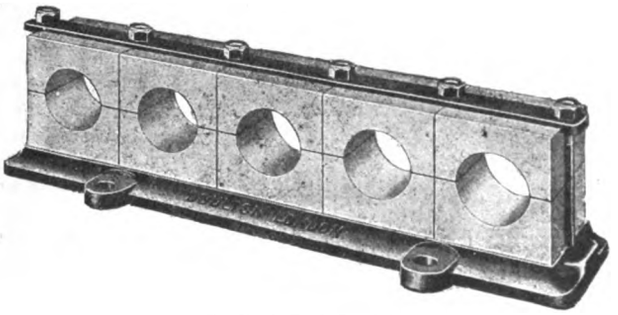
high-tension transmission line to Buffalo had an appreciable effect on the surface of the material, we understand. Switchgears, ventilating fans, small motors, cables—the latter including a sample of the Liége telephone cable—and other specialities too numerous to mention in detail completed a representative exhibit of the firm's high-class manufactures.

MESSRS. DOULTON AND CO., Lambeth, exhibited a fine selection of their specialities for electrical work. Prominence was given to conductor rail insulators, more particularly those of the "Pedestal" type, for particulars of which we would refer the reader back to an illustrated notice in our issue for Sept. 9, 1904, p. 383. We noticed samples of platform copings, such as the company have supplied for the District Railway and tube lines of London, also a large variety of fuse bases, fuse handles, fuse-box insulators, etc., besides many standard patterns of insulators in both stoneware and high-grade white porcelain for telegraph, telephone, traction, transmission, and other purposes. Needless to say, ducts for underground cables and Doulton's very useful bridge insulators for "solid system" laying were included. The rack insulator illustrated herewith comprises a base of cast iron supporting a set of cleats. Each cleat consists of a pair of grooved insulators in cream glazed vitrified stoneware. The cleats are made with grooves of different sizes to take cables up to 2¾in. diameter, but they are of uniform external dimensions, and, therefore, interchangeable. The parts are held firmly in position by bolts, the upper ends of which pass through an iron or fibre strip lying in a recess in the cleats. The rack may be built up to take several tiers of cables. Reference may be made in conclusion to some specimens of plumbago



Doulton's Rack Insulator.

crucibles and chemical-resisting ware, which completed the exhibit. The whole served incidentally to show to what a high degree of perfection Messrs. Doulton and Co., Limited, have developed this branch of their business.

ELECTRIC WINDING MACHINES.*

BY PROF. PAUL HABETS, OF BRUSSELS.

The ever-increasing application of electricity to mining machinery, and the economy resulting from centralising the generation of energy required for working large undertakings, has not been kept back for want of finding means for working winding machinery electrically. When it is a question of underground mechanical haulage, the electric transmission offers enormous advantages over all other systems (steam, compressed air) with regard to economy and facility of installation. But the exaggerated fear of introducing electric plant into explosive mines, the cheapness of machines by compressed air and also the possible utilisation of existing compressed-air plants, have retarded the great development of electric haulage in underground workings. Even in the case of the main winding machines, which can be placed close to the steam-engines, electric driving has been introduced during the last years with the object of reducing the consumption of steam. This economy is, however, doubtful. The losses due to the transformation of electric energy may, in fact, equal the unfavourable conditions under which a steam winding engine is working if the latter be an economical condensing engine. The economy is certain, however, when the winding machine must be placed further away from the steam-engine, or when the use of electric transmission permits of doing away with boilers. In designing a steam winding engine it was generally considered sufficient to determine the resultant statical moment of the rope-roll. The use of electric driving has necessitated a study of the dynamic conditions of the problem, which is not without importance also in designing steam winding engines, if it be desired to work the engine under the most economical conditions. The author brought to notice at the exhibition of electric winding engines at Düsseldorf, 1902, the study of the dynamic conditions of haulage for machines with ropes and perfectly balanced, winding machines with cylindrical drums and with counterbalancing ropes, and machines with Koepe's pulley. The latter was at that time the only machine to which direct driving by electric motors had been applied. At present the application has been extended to machines with variable rope-roll, notably to the machine installed at the coal mines of Grand Hornu. It seems, therefore, desirable to investigate the question more closely.

DYNAMIC INVESTIGATION OF HAULAGE.

Statical Moments.—The law governing the relation between the statical moments and the number of revolutions made by the shaft which carries the winding gear of the ropes may be determined by calculation or by a graphical method shown by M. H. Dechamps. As an example, the author has selected the electric winding engine installed at the coal mines of Grand Hornu. The following data have been furnished by M. E. Trousart: depth, 1,000m. (3,300ft.); useful load, six wagons, 2,600 kos. (2½ tons); dead load, six wagons, 1,260 kos. (1¼ tons); dead load, one cage, 2,000 kos. (two tons). The flat aloes rope is taper and of the following dimensions:

TABLE I.

Length. M.	Length. Feet.	Thickness. Mm.	Thickness. Inches.	Weight per Metre	Weight per Foot
				Kgs.	Lbs.
0 to 120	0 to 394	50 to 48	1·97 to 1·89	14·65	9·84
120 ,, 220	394 ,, 722	48 ,, 46	1·89 ,, 1·81	13·75	9·24
220 ,, 320	722 ,, 1,050	46 ,, 44	1·81 ,, 1·73	12·50	8·40
320 ,, 420	1,050 ,, 1,378	44 ,, 42	1·73 ,, 1·65	10·90	7·32
420 ,, 520	1,378 ,, 1,706	42 ,, 39·5	1·65 ,, 1·56	9·25	6·21
520 ,, 620	1,706 ,, 2,034	39·5 ,, 36·75	1·56 ,, 1·45	8·90	5·97
620 ,, 720	2,034 ,, 2,362	36·75 ,, 35·25	1·45 ,, 1·39	8·40	5·64
720 ,, 820	2,362 ,, 2,690	35·25 ,, 33	1·39 ,, 1·30	8·25	5·54
820 ,, 920	2,690 ,, 3,018	33 ,, 33	1·30 ,, 1·30	8·12	5·45
920 ,, 1,020	3,018 ,, 3,347	33 ,, 32·9	1·30 ,, 1·29	7·68	5·15
1,020 ,, 1,120	3,347 ,, 3,675	32·9 ,, 32·7	1·29 ,, 1·28	7·10	4·77

The diameter of the bare drum is 1·40m. (4ft. 7⅛in.), the initial radius is 1·20m. (3ft. 11½in.), and the final radius 3·73m. (12ft. 2⅞in.). The number of revolutions for one haul is 64. To draw 56 tonnes (55 tons) per hour it will be required to make 25 hauls per hour; it takes 144 seconds to make one ascension, and reckoning 38 seconds for manipulating the machine, there remain 106 seconds for the actual ascension. To prevent the speed from exceeding 15m. (49ft. 2½in.) per second in the pits, a constant angular acceleration is allowed for 15 seconds to reach the rated speed of 42 revolutions per minute in 77 seconds. The stopping is effected in 14 seconds by a constant retardation. The moment of inertia of the two drums, including the brake drum, is 5,606·5 kg.-m.² (133,000 lb.-feet²). The moment of inertia of the motor is 2,548·4 kg.m.² (60,460 lb.-feet²), and that of a head-gear 407·7 kg.-m.² (9,675 lb.-feet²). By the aid of these data the conditions for manipulating the winding machine can be found. The curves (Figs. 1 to 5) may now be drawn according to M. Dechamp's method for flat tapered ropes winding on drums: (1) Curve $A_0 A_{10}$ representing the weight of the rope per metre run as a function of the depth; (2) $B_0 B_5 B_{10}$ representing the weight of the unrolled part of the rope as a function of the depth; (3) $B_0 B'_5 B_{10}$ representing the weight of the unrolled part of the rope as a function of the number of revolutions of the machine; (4) the curve of statical moments $x_0 x_{10}$ of the ascending loads referred to axis C C'; (5) the curve of statical moments $x'_0 x'_{10}$ of the descending loads referred to axis H H'; (6) the invert $x''_0 x''_{10}$ of $x'_0 x'_{10}$ referred to axis C C'; (7) the curve $X_0 X_{10}$ of the resultant statical moments.

* Paper read before the Institution of Mechanical Engineers (translated from the French).

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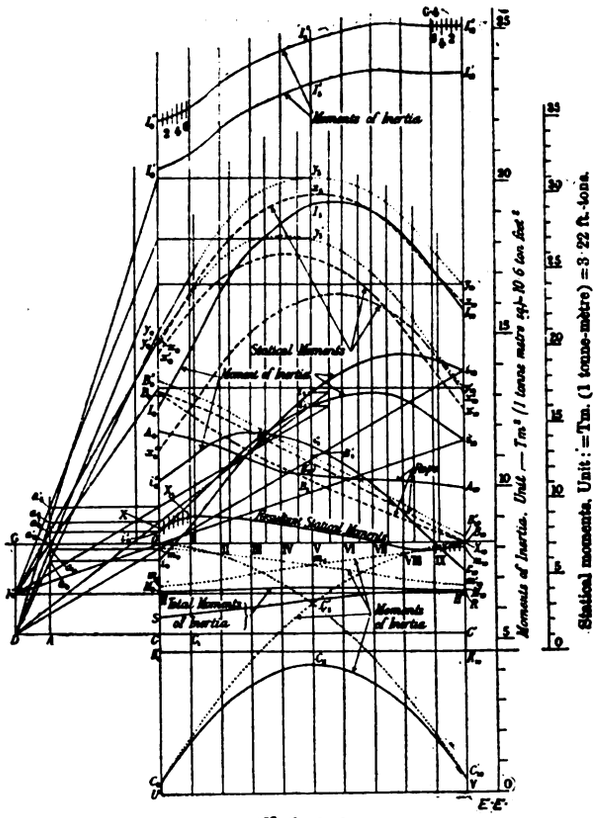
Resistances (Figs. 1 and 4).—Besides the statical moments the motor has also to overcome the resistance of the air to the motion of the cages, the frictions in the pit and at the bearings of the head-gears and of the shaft of the machine, and, finally, the resistance of the rope to bending. These various factors may be assimilated to a load suspended at the ascending rope, and whose moment be added to the statical moment. This load has been found to be 15 per cent. of the useful load in the trials made on the electric winding machine at Preussen II. In the absence of exact data, and also for the sake of simplicity, we may take the moment of resistances as constant during the whole hauling, and give it a value equal to 15 per cent. of the maximum statical moment of the loads. The value of the statical moment, including resistances, is measured by the ordinate of the curve $X_0 X_{10}$ by lowering the axis of abscissæ an amount $C K_0$ equal to 15 per cent. of the maximum moment, $C_1 X_1$. To the statical moments must further be added the moments of the accelerating forces required for the moving masses. These masses are fixed to the shaft of the motor and participate in its rotation. The moment of the accelerating forces may be deduced from the moment



Abscissæ Scale.
1 Div. = 100 m. (328 ft.) or 6·4 Revs.

FIG. 1.

of inertia (I) of the moving masses referred to the shaft of the motor, and from the law of rotation of the shaft, as will be shown further on. For the purpose of determining the moments of inertia of the masses, it will be convenient to consider the following: (1) the masses of the loads suspended on the rope; (2) the masses of the rope-rolls; (3) the masses of the head gears; (4) the mass of the drums and pulleys.

Moments of Inertia of the Suspended Loads (Figs. 1 and 4). The suspended loads, P, may be considered as concentrated at the end of the instantaneous radius, ρ, of the rope-roll, which is, therefore, also their radius of gyration. The moment of inertia is then

$$I = \frac{P}{g} \rho^2 = P \rho \frac{\rho}{g},$$

$P \rho$ is the statical moment of the suspended load; it will, therefore, be sufficient to multiply the statical moment by $\frac{\rho}{g}$. The moments of inertia may be found graphically from the values of the statical moments of the ascending and descending loads. It may be noticed that in determining the statical moments, we neglected the lengths of rope between the winding gear and the pit's mouth, which are in equilibrium. But as these lengths are 40m. to 50m. (131ft. to 164ft.), they cannot be neglected in making determination of the moment of inertia. New curves of moments, $P \rho$, must be determined by adding to the curve $B_0 B_5 B_{10}$ the weight of 50m. (164ft.) of rope; we thus obtain $B''_0 B''_{10}$, which serves to determine the curves of moments $y_0 y_5 y_{10}$ and $y'_0 y'_5 y'_{10}$. The latter should be inverted and referred to axis C C'. This operation may be done on the curve of moments of inertia. We proceed as follows: On the ordinate through C, we project the ordinates of the curves $y_0 y_5 y_{10}$ and $y'_0 y'_5 y'_{10}$, and through the projections thus obtained we draw lines to pole D in case of

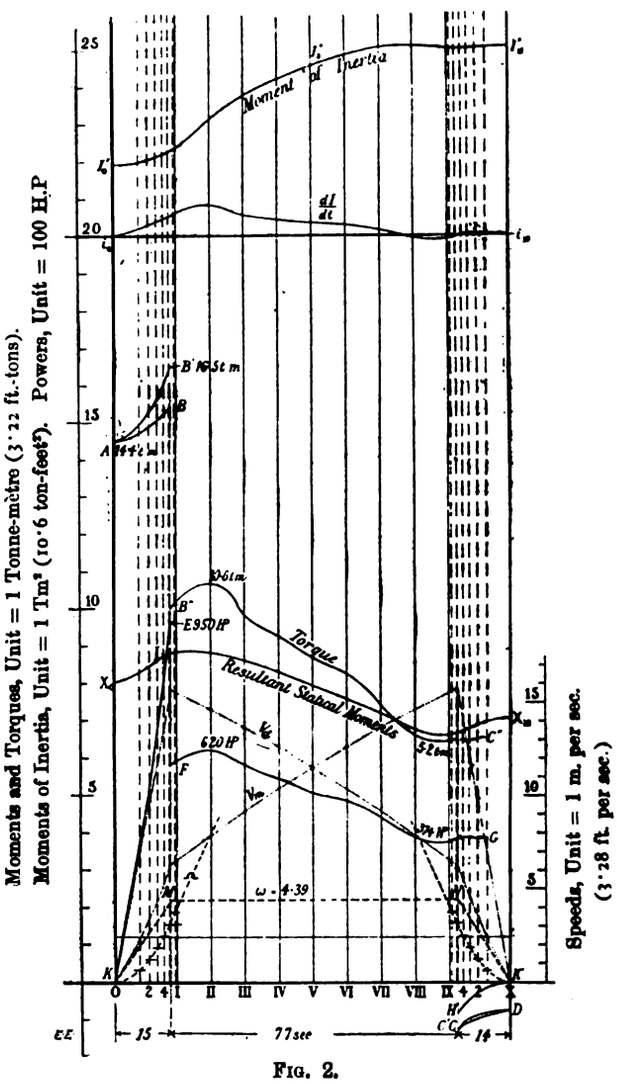


FIG. 2.

curve $y_0 y_5 y_{10}$ and to pole F in the case of $y'_0 y'_5 y'_{10}$. We next calculate one of the moments of inertia that is easy to obtain; for instance, the moment corresponding to the small radius of the rope-roll. We take $\frac{P}{g} r^2$ for the ascending load, its value is $C i_0$; a horizontal line drawn through i_0 intersects the pole-ray D y_0 in a_0; a vertical through a_0 intersects the pole-rays in points a_5 a_{10} a'_0 a'_5 and a'_{10}, these points are then projected on the ordinate through C, and through the projections thus obtained we draw pole-rays emanating from poles D or F as the case may be. To obtain the moments of inertia, $i_0 i_5 i_{10}$ and $i'_0 i'_5 i'_{10}$, of the ascending and descending loads, we produce the pole-rays until they intersect the corresponding radius of the rope-roll. In fact, we have

$$A a_0 = C i_0 = C y_0 \frac{r}{g}; \quad A a_5 = V y_5 \frac{r}{g}; \quad V i_5 = A a_5 \frac{\rho}{r} = V y_5 \frac{\rho}{g}$$

and so on. Curve $i'_0 i'_{10}$ of the moments of inertia of the descending loads referred to axis H H' must be inversed and referred to the same axis, C C', as the moments of inertia of the ascending loads. Curve $i''_0 i''_{10}$ is thus obtained. The moments of inertia of the ascending and descending

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loads are now added by adding the ordinates of their respective curves. Curve $I_0\ I_5\ I_{10}$ is thus produced.

Moment of Inertia of the Rope-Roll (Figs. 1 and 4).—The weight, P', of the rope-roll may be determined by taking the differences between the weight of rope, O B''_0, and the weight of the unrolled rope represented by curve $B''_0\ B''_5\ B''_{10}$. The moment of inertia depends on the radius of gyration. In the case of winding on constant radius, the radius of gyration is the same as that of the rope-roll, and it is not necessary to consider the different parts of the rope separately. We simply multiply the useful load of the cages and the ropes by $\frac{r^2}{g}$. In the case of conical and spiral drums, the variation of the radius of gyration must be

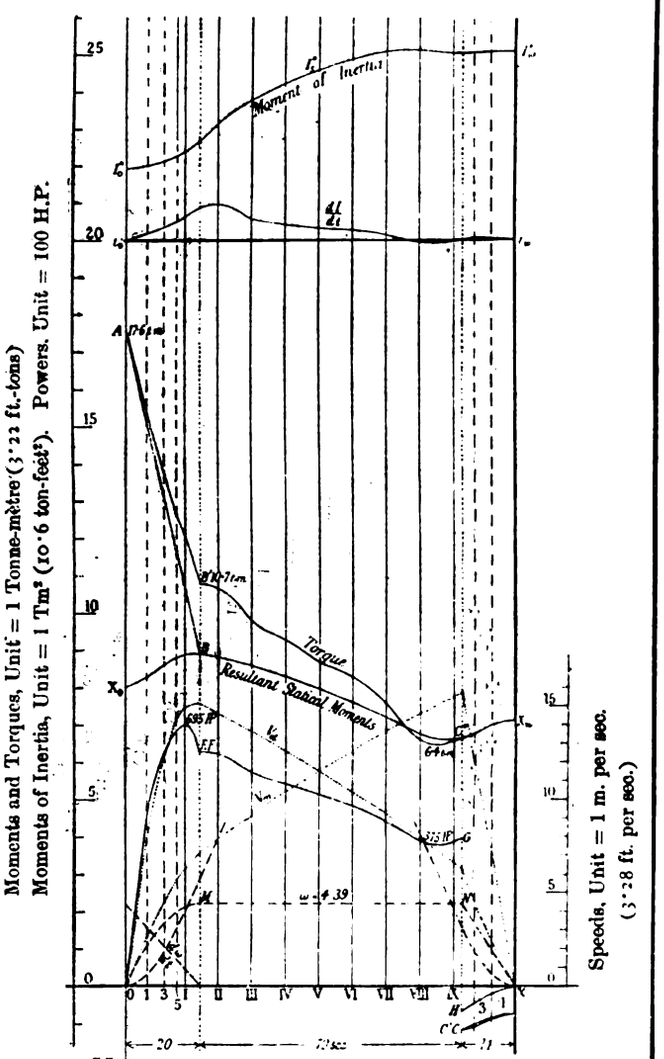

FIG. 3.

taken into account. When the rope is not taper, the radius of gyration of the rope-roll (radius ρ) is $\frac{r^2+\rho^2}{2}$,* where r is the smallest radius of the rope-roll. If the rope is taper, the error committed by not taking into account the decreasing thickness of the rope is negligible. The moment of inertia is determined by multiplying $\frac{r^2+\rho^2}{2}$ by the mass $\frac{P'}{g}$ of the rope-roll. The curves $C_0\ C'_5$ X and O $C'_5\ C'_{10}$, referred to axis O X, represent the moments of inertia of the two ropes. The two curves are identical, but inverted with regard to each other; the sum of their ordinates will give us the total moment of inertia ($C_0\ C_5\ C'_{10}$) of the rope-rolls. The latter moment should be added to the moments of inertia ($I_0\ I_5\ I_{10}$) of the loads, thus determining the total moments, $I'_0\ I'_5\ I'_{10}$ (Fig. 1).

Moment of Inertia of the Head Gears.—The moment of inertia (I_m) of the head-gears may be determined from the drawings. I_m must, however, be multiplied by $\frac{\rho^2}{R_m^2}$, ρ and R m being the radius of the rope-roll and head-wheel rim respectively; the two sets of reduced moments of inertia are represented by the ordinates to curves $m_0\ m_5\ m_{10}$ and $m'_0\ m_5\ m'_{10}$ (referred to O X). These curves are identical, but inverted with regard to each other; by adding their ordinates, the total moments of inertia ($M_0\ M_{10}$) of the head-gears are found. The ordinates to curve $I''_0\ I''_5\ I''_{10}$ (Figs. 1 to 5) are equal to the sum of the ordinates to curves $M_0\ M_{10}$ and $I'_0\ I'_5\ I'_{10}$.

Moment of Inertia of the Winding Gears and of the Motors (Figs. 1 and 4).—The moment of inertia of the drums, brake drum, and gearing may be determined by referring to the drawings. In the case of electric driving, the moments of the motors must be added. The moment of inertia of the winding machinery is constant, and must be added to the moment determined above. This may be done by setting its value C U off from C C' downwards; the ordinates of curve $I''_0\ I''_5\ I''_{10}$, referred to U V as axis

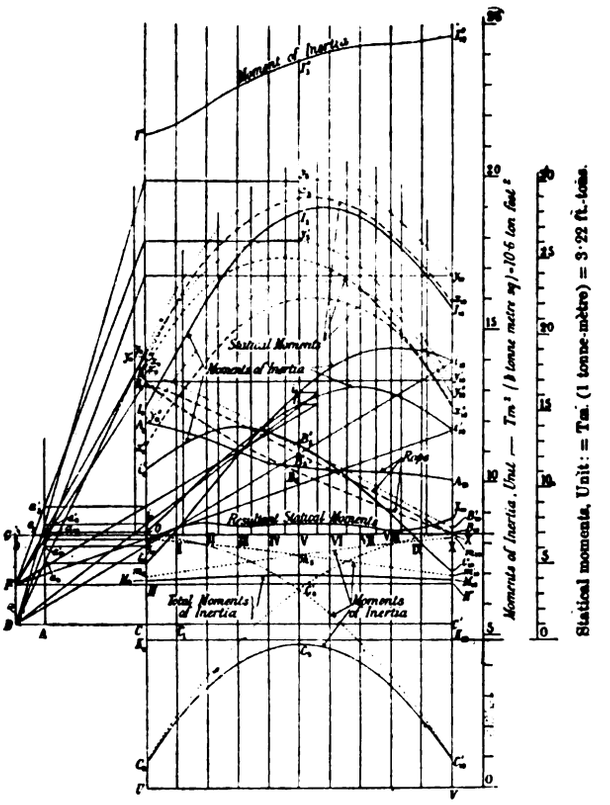

FIG. 4.

of abscissæ, will then be a measure of the total moment of inertia. The curve $I''_0\ I''_5\ I''_{10}$ may be called the "characteristic of inertia" of the winding engine.

Speed of Rotation of Machine Shaft.—The moments of the accelerating forces may be determined by the total moment of inertia and by the speed of rotation of the motor shaft. For this purpose curve $I''_0\ I''_5\ I''_{10}$ must be referred to abscissæ representing time. The abscissæ of $I''_0\ I''_5\ I''_{10}$ are proportional to the number of revolutions made by the motor shaft, and the total number of revolutions of this shaft during each draw is 64, so that each division of the axis of abscissæ will represent 6·4 revolutions. We must also know the time required for each revolution, if the relation between speed and time is to be determined. This depends, however, on the manner in which the machine is manipulated by the driver. There are two simple cases: (1) starting with a uniformly accelerated angular velocity, which implies a constant angular acceleration; (2) starting with a uniformly decreasing angular acceleration. Analogous laws may be adopted during the period of retardation. The first case has been adopted in connection with the data supplied by M, Troussart, by allowing a

* The moment of inertia of that part of the rope which is never unrolled is constant, and may be added to the moment of inertia of the winding gear.

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time of 15 seconds to get up a speed of 42 r.p.m, which is an angular velocity, $\omega = \frac{2\pi \times 42}{60} = 4{\cdot}39$ radians per second; the constant angular acceleration is thus $\frac{4{\cdot}39}{15} = 0{\cdot}292$; the rate velocity is maintained 77 seconds, and the stopping is effected in 14 seconds with a constant negative acceleration $\frac{4{\cdot}39}{14} = 0{\cdot}313$. Curve O, M N X (Figs. 2, 3, and 5) represents the variation of the angular velocity. The integral of O, M N X for a given abscissæ, t, represents the total angle, Ω, through which the motor shaft has turned since starting, and by dividing Ω by 2π we obtain the total number of revolutions made by the shaft during time t. The curves which represent the relation between the statical moments (X_0 X_{10}, Figs. 1 to 5) and time, and also between the moments of inertia (I''_0 I''_{10}) and time, can now be drawn, by taking the ordinates of these curves (Fig. 1), which correspond to each revolution.

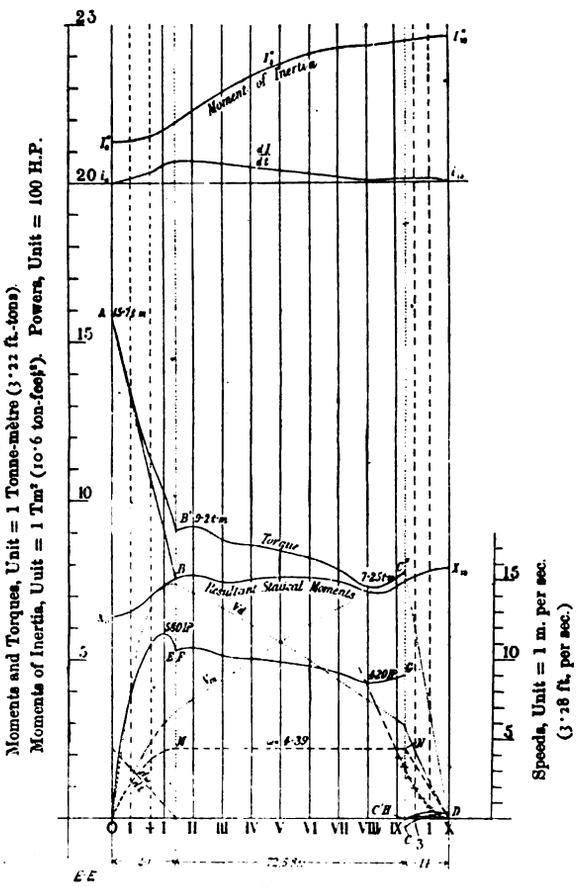

FIG. 5.

Moments of the Accelerating Forces.—The energy exerted by the accelerating forces during time t is $\frac{\omega^2}{2} I$, where ω is the angular velocity at the end of time t and I the moment of inertia (I''_0 I_{10}''). If M be the moments of the accelerating forces, then the energy exerted by these forces during time t may also be expressed by $\int_0^t M\,\omega\,dt$; hence

$$\int_0^t M\,\omega\,dt = \frac{\omega^2}{2} I.$$

As M, ω, and I are functions of t, we obtain by differentiation

$$M\,\omega = I\,\omega\,\frac{d\omega}{dt} + \frac{\omega^2}{2}\frac{dI}{dt},$$

or,

$$M = I\,\frac{d\omega}{dt} + \frac{\omega}{2}\,\frac{dI}{dt}.$$

$\frac{d\omega}{dt}$ is constant during the period of acceleration and retardation, and is zero during the period of constant speed. Multiplying the ordinates of curve I''_0 I''_{10} by the corresponding values of $\frac{d\omega}{dt}$, and then adding the results (algebraically) to the ordinates of X_0 X_{10}, we obtain the portions A B and C D (Fig. 2). For the purpose of calculating $\frac{\omega}{2}\frac{dI}{dt}$, we construct the derived curve of I''_0 I''_{10} graphically. The ordinates of this new curve (i_0 i_5 i_{10}), estimated from the line through i_0 as axis of abscissæ, are now multiplied by the corresponding values of $\frac{\omega}{2}$ taken from O, M N X, and the results are added (algebraically) to the ordinates of A B X_1 X_9 C D. In this manner we obtain the total torque (A B′ B″ C″ C′ D, Fig. 2) which must be exerted by the motor at any instant. It will be seen that the torque varies considerably. It attains a maximum of 16,500 kg.-m. (119,345 ft.-lb.) at the end of the period of acceleration, and then suddenly drops to 10,000 kg.-m. (72,330 ft.-lb.) at the beginning of the constant speed period; during this period the maximum value is 10,600 kg.-m. (76,670 ft.-lb.), and the minimum 5,200 kg.-m. (37,612 ft.-lb.). The torque is negative during the period of retardation.

Power and Expenditure of Energy.—The torque of the motor multiplied by the corresponding value of ω is the power which must be developed at each moment. This power is represented by curve O, E F G H X (Figs. 2, 3, and 5), the integral of the latter is the energy spent during each draw. At the end of the acceleration period the power attains a value of 950 h.p., whilst during the constant speed period it varies between 620 h.p. and 370 h.p.; the latter figures differ from those found by M. Troussart, which have undoubtedly been found by a less exact method than the one adopted by us. The case of uniformly decreasing acceleration has also been treated; the results are indicated by the curves Fig. 3, which are marked with the same letters as the corresponding curves in Fig. 2. It may be noticed that the curve O M, which represents the variation of the angular velocity. ω, during the acceleration period, is the integral curve of the straight line which represents the variation of the acceleration $\frac{d\omega}{dt}$. It will be seen that although a rather greater torque is required during the acceleration period, which is not difficult to obtain with an electric motor, the power required varies much less. It would, therefore, be advantageous to start the machine with a decreasing acceleration. It might be asked whether the power would not be less variable if the radii of the rope-roll were chosen so as to make the statical moments less regular. We have treated the machine at Grand Hornu with regard to this question, for $r = 1{\cdot}10$m. (43·4in.) instead of 1·20m. (47·24in.). The results are shown in Figs. 4 and 5, the same letters as on Figs. 1 and 2 being used all through. It will be seen that the power diagram is much more regular. The ordinates of the power diagrams which we have determined should be divided by the efficiency of the motor so as to obtain the total power spent; the integral of the latter curve would give us the total energy required. The useful work divided by this energy is the efficiency of the winding machinery. The efficiency of electrical motors differs with the kind of motors and their starting devices.

(To be continued.)

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LONDON TRAFFIC.

The event of the week is the issue of the first volume of the report of the Royal Commission on London Street Traffic, though, on the other hand, some may think the rejection of the London County Council Bill by the House of Lords more important. It may, however, be found that the two events are more or less interconnected. Whatever may be the opinions held by other men, nothing is more certain than that the Commission's majority report is definite and drastic. A minority report, which is far more consonant with our views, is presented by Sir G. C. T. Bartley, while Sir G. S. Gibb, who signs the majority report, does so with an explanatory note. A quarter of a century and more ago the present writer suggested a careful examination of this subject and the formulation of a unified scheme, so that extensions in every direction should relieve, and not add to, the congestion of traffic. Since that time the population has increased from about four and a half millions in Greater London to about six and a half millions. Had a scheme of main roads and streets been at that time designed and made compulsory, we should hear very little about congestion now; but things went on as they were, and it needs little foresight to know will continue to go on in the same happy-go-lucky way in future, this report notwithstanding. We fear, indeed, that this report will have the effect of increasing congestion rather than the contrary, in that, supporting as it does large ideas of tramway extension, these extensions will to some extent take place where the conditions are really not favourable to tramway work. By all means extend tramways where the conditions are favourable, but do not accept the views that they are satisfactory under all conditions. The rejection of the London County Council Bill brings about a condition of affairs little short of a crisis. Congestion of traffic during certain periods of the day at the dead end of the lines south of the bridges, and the danger to life and limb occasioned by the rush to and from the cars and from other traffic, has reached the final stage. This position of affairs was foreseen, and whether the public agrees or not to passage across the river, that passage must come about, or the usefulness and extension of the tramway lines cease. We think the London County Council has been very wrongly advised in some of its extensions, but that does not help matters. But to the more important topic—the report. The gist of the report is summed up in the phrase: hitherto divided counsels and control, in future a central authority. Much as the creation of new spending departments may be disliked, there can be no two opinions as to this suggestion of the report. Traffic to be dealt with properly must be dealt with as a whole, and this means one supreme authority for the area of Greater London. Unfortunately, the report suggests a board that should be consultative and advisory only, though its decision would be final, and the veto of existing authorities would be subject to such decision. The arguments relating to working-men housing and such like things in this report if given in a Shaksperian play would be reckoned farcical. It is astounding to what length politicians and place seekers will go when dealing with the working classes, and the whole means fishing for votes. Economical laws are lacking, or are summed up in the phrase: it is expedient to make friends with the voting *oi polloi*. Take as a sample the implication that a workman must not work more hours than a maximum; he may waste two hours a day, more or less, in a train or tram, he may spend fourpence a day for his ride, and he cannot pay more than a certain amount for his rooms. Of course not; but, taking

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the extreme, shorten his hours of work, take him a longer ride further out to a less expensive room at a greater cost per ride, and will that help the workman? In other times the argument was get the workman to live as near as possible to his work; now it is get him to live away—it will be good for the tramway and for the workman. It is assumed that the economics of the factory are elastic, and, in fact, that factories can be established anywhere. The craze of the workmen's advocate says the man first—the factory after. The economic law says the man is only a factor in the factory economy, and other factors being all right there will be no difficulty about the man. All that is good in this report is easily summarised — thus a useful lot of information and the dealing with natural areas by one authority. There is no doubt the most valuable suggestion is the supreme board, and it is in this direction, if anywhere, that good will result from the labours and expenditure of this Commission, but such board must be given power to initiate as well as to advise.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL WIRING.

SIR,—I should esteem it a favour if you would allow me, through the columns of your valuable journal, to thank those gentlemen who so kindly volunteered to come forward and give evidence on behalf of the contractors against the London County Council General Powers Bill.

Thanks to the solicitors engaged, our case was presented in such a manner before the House of Lords that the committee decided to strike out Part 12 of the Bill entirely—that is, the whole of the clauses relating to municipalities carrying on the wiring work themselves.

You may remember that in 1903 similar clauses were introduced into a Bill by the London County Council, and that we were then successful in getting the House of Commons to move an instruction that they should be cut out. This year we were unsuccessful in the House of Commons, but successful in the House of Lords, and our success is in a great measure due to the opposition we were able to make owing to the good evidence volunteered and to the money subscribed by members of the electrical profession generally outside of our association.—Yours, etc., LEONARD G. TATE,

Hon. Secretary, Electrical Contractors' Association.
20, Bucklersbury, E.C., July 17, 1905.

LONDON TELEPHONE DIRECTORY, 1905-6.

SIR,—We beg to state that through a mistake on the part of the National Telephone Company our name and telephone number were not inserted in the above. In order to overcome this difficulty we have had small labels with gummed backs arranged for easily pasting into the space that is available for our name, in such a way as not to interfere with any of the other names in the telephone directory. We shall be pleased to send these immediately on receipt of an inquiry by telephone or otherwise.—Yours, etc, UNION ELECTRIC COMPANY, LIMITED

151, Queen Victoria-street, E.C., July 18.

RAWORTH REGENERATIVE CONTROL.

A demonstration of this system of tramcar control was made in the Birmingham district last week on the Station-street-to-Yardley route. The distance of four miles has gradients varying from 1 in 16 to 1 in 20 for 3½ furlongs, and the whole route is hilly. Thus it showed the full advantages to be derived from the system. A full description of the Raworth control will be found in our issue for July 29, 1904. We propose here to confine our remarks to the improvements made since that date, and to the records obtained on the Birmingham tramways. There the Raworth control has been in use since March, and has reduced the energy required per car mile from 1·3 units with series motor to 0·97. The brake blocks repairs averaged ·005d. per car mile, as against ·063d. with the previous equipments. The average temperature of the motor windings after 18 hours' service is about 140deg. F. with the shunt motors, as against 120deg. F. for the series motor. As to the repairs to motors and controllers, the period of trial has not been long enough to give any comparative figures.

The feature of the demonstration was a car on which the series-parallel control has been introduced with shunt motors for the first time. The electrical details of this equipment have been designed by Mr. Raworth's son, and particulars as to the same were not available. The trial showed, however, that the changes from series to parallel, and *vice versâ*, were made without any sudden acceleration on braking of the car, and without sparking at the brushes on the motors.

At Yardley those attending the demonstration were shown the generating station equipped with four Diesel engines, each of 160 h.p., coupled to direct-current dynamos. At a lunch which followed Mr. Raworth explained the advantages of the system of control, and the great saving which it effected over the older methods of driving cars electrically.

NOTES ON THE INDUCTION MOTOR AS GENERATOR.*

BY T. P. E. BUTT.

It has been known almost from the initial invention of the asynchronous alternating motor, generally known as induction motor, that, if connected to its supply mains and driven at a slightly higher speed than synchronism, it reverses its usual function and becomes a generator. This knowledge, however, does not appear to have been put to any extensive use, at least not in a commercial sense†, and even in cases where applied, very few details are obtainable to allow one to form an opinion of the actual value of such machines.

There is another point in such machines equally interesting, and perhaps more useful, demonstrated by Danielson, and published in the *Elektrotechnische Zeitschrift* about two years ago. He described a method of converting an alternating-current motor from asynchronous to synchronous, by suitably exciting the rotor with continuous current. This is a point for which much use should be found, for such machines, in addition to possessing the inherent qualities of the synchronous motor, are self-starting. In order to effect this the motor is started up as an induction motor on light load, so that its speed approximates synchronism. At the right moment the rotor lines are switched over from the resistance to a suitable source of continuous current, which pulls the rotor into synchronism, and maintains it at this speed. Such machines should be of use on inductive systems to raise the power factor, where such an inflexible arrangement as the ordinary synchronous motor may not find favour.‡ Circumstances having placed the writer in a position to test the above principle, he assumed that the converse would hold good—that is, if power were applied to the rotor shaft, and its windings supplied with continuous current, the outcome would be a successful generator. The results are given in this paper, and, although not obtained under favourable conditions, are of interest.

About two years ago, when it was decided to augment the lighting supply of Johannesburg from the electrical plant of the Robinson Deep G.M. Company, it was found necessary to obtain an additional generator to provide a reserve for the existing plant, in case of accidents and to

* Paper read before the South African Association of Engineers on May 6, 1905.

† Induction motors are used for electric traction on mountain lines. When descending a hill electricity is forced back into the trolley wires, and a braking effect is produced, the machine acting as a generator.

‡ This method might be noted in connection with the electrical driving of stamp batteries.

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allow for general repairs. The management did not at first fall in with this idea, and the project temporarily fell through. It happened, however, that a 300-h.p. 2,000-volt induction motor, originally intended for operating a hoist, had been laying dismantled on the property for several years, and the suggestion of the writer to convert this into a generator was entertained and adopted. It should be explained here that the generating plant consisted of two direct-coupled three-phase 250 kw. machines working at 2,100 volts 60 cycles, and the power demand was such as to require one generator constantly running, the second assisting on the peak of the load for several hours during the day, whilst from 4.30 p.m. till midnight this second generator was loaded and often overloaded for the municipal supply, and although in case of accident to either generator the mine requirements would have had first consideration, the town supply was sufficiently remunerative to warrant the installation of another machine. Owing to the difficulty in getting at short notice an engine suitable for driving this machine, it was arranged to operate it from one of the mill engines, a 500-h.p. single-crank compound engine having at that time a surplus of about 300 h.p. A friction clutch and pulley were attached to an extension of the line shafting and rope drive provided. This necessitated the location of the generator in a wing at the extreme end of the power-house, in a position invisible from the main switchboard.

To use the generator asynchronously involved very little alteration to the existing apparatus. The windings, of course, remained the same, but it was necessary to make provision for a variable speed for this machine, which, unlike the ordinary generator, requires a slight increase of speed to take an increased load. To get a variable speed from the mill engine was out of the question, and recourse had to be made to other means—viz., magnetic slip. This demanded the installation of the huge rheostat which originally formed the controller. This method would not be an efficient one if constantly used, but this was not intended, its use being restricted, as a rule, to the short period of time required in putting in or taking out of parallel with another generator to regulate the transfer of load. This arrangement demanded a permanent increase of speed above that of synchronism, and an increase of 5 per cent. was allowed, which was as much as possible, taking independent working into account. The controller was located near the generator, and operated by motor from switchboard, the position of its axle being indicated by luminous signals. The arrangements for asynchronous running were practically complete, but for independent working an exciter was required suited to the rotor winding, and for this purpose a disused plating dynamo was found having a capacity of 600 amperes at 30 volts. A low-tension panel was located near the generator, and the rotor windings brought to it, provision being made for rapidly connecting them to either the exciter or controlling rheostat.

It may be opportune at this point to give a short non-mathematical explanation of the action of asynchronous generators, which differs in some points from that of the regular generator, and is not generally understood by practical men. Taking the ordinary polyphase induction motor, here we have a shifting magnetic field in the stator, as a resultant of the combined action of the primary currents. The torque on the secondary (usually the rotor) due to currents generated in its conductors by cutting this flux, is proportional up to a certain limit to the difference in the relative speeds of the primary flux and the revolving element, and is practically proportional to the load. Beyond this limit the torque starts to fall off, owing to magnetic leakage caused by the heavy currents in rotor and stator, and if the load is not reduced the rotor comes to rest. If such a motor is now connected to the supply mains on no load, it will attain a speed practically equal to that of the primary field, the slight difference being necessary to allow sufficient cutting of flux to generate currents in the rotor of the magnitude required to overcome windage and friction. These currents will be in a direction tending to diminish the relative motion of primary field and rotor. If power is now applied to accelerate the rotor shaft, then, as it approaches synchronism, the current will diminish, until at synchronous speed the working component nearly vanishes, leaving a wattless current, and we have practically an unloaded transformer, the bigger magnetising current being due to the air-gap and the disposition of the winding, this current being just sufficient to magnetise the core to the extent required by the back E.M.F. Now, still keeping the primary connected to the mains, increase the rotor speed, its conductors again cut the primary flux, but in an opposite direction. The currents now generated, instead of utilising their energy in wiping out the primary magnetism, the source of the back E.M.F., are reversed and reinforce it, thus tending to raise the stator back E.M.F. above the forward, and force current back into the line. If the rotor speed is still further increased more currents are induced, the stator back E.M.F. tends still further to rise, and more load will be taken; and if the capacity of this machine is sufficient and has the necessary power behind it, the load on the system will be transferred to it, and steam can be shut off the regular generator or generators supplying the system, upon which they will continue to run as motors, and supply the magnetising current.

Now, compare some of the characteristics of this machine with that of the ordinary synchronous generator. The expression (pairs of poles by revolutions per second) will not give the correct frequency, but higher, the difference being due to the relative motion of the secondary conductors with reference to the primary field, which must occur to produce the rotor currents, or in other words, this is the negative slip; and the amount of this slip to assume a certain load will depend on the rotor resistance. The frequency will be determined solely by the currents supplied it by the synchronous machine regardless of its own speed. The speed, however, must not rise above a certain critical value, or the power required from the prime mover will fall off rapidly, due to magnetic leakage, as in the case of the motor. Provision then must be made for this in governing the engine, or should this point be exceeded the engine might run away.

Another point, the power factor. This will be dependent on the amount of load supplied to the system, but independent of the nature of such load, so that any currents demanded by apparatus employed on the system not in phase with the working current must be supplied by the synchronous machine. Paralleling is, of course, a simple matter, there being no need for synchronising; it is always better, though, to get the speeds as near as possible to avoid disturbance to the system, if the machine is of large relative capacity. The possibility of running such machines for boosting purposes, as suggested by M. Le Blanc, will not be touched on here, but is mentioned as another addition to its area of usefulness.

Now, turning to another function of this machine. The synchronous part of the operation requires little or no explanation; the rotor is simply transformed into a field magnet with a continuous iron surface, instead of the usual definite polar projections. Anticipation of serious magnetic leakage in this method can be referred to results. The first trial took place under asynchronous conditions; the machine, it should be stated, has a distributed winding, three slots per phase per pole in stator and four in rotor, the number of poles being 24, so that the permanent speed was 315 revolutions, or 5 per cent. above synchronism at 60 cycles. At this speed or near it, and with the rotor resistance all in circuit, the switch was closed on the 'bus bars, thus paralleling it with a synchronous generator which at the time was delivering 90 kw. A current equivalent to 30 per cent. of the non-inductive full load current was taken, and under these conditions the disc movement of a sensitive watt-hour meter in circuit was scarcely perceptible; the resistance was then cut out, until the whole load was taken, and steam was then shut off the synchronous machine, which continued running as a motor. After this steam was again admitted and the load increased and distributed by means of the rheostat on the two machines until a combined load of 362 kw. was carried, out of which the induction machine supplied 170 kw. This was the limit attained and was determined by the speed of the mill engine, which was not well governed, and at this point became unstable, thus causing sudden transfers of load between the generators, and big voltage variations. A

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higher limit would have been obtained with a more favourable load—that is, motors of relatively small capacity or lights—but nothing less than 50-h.p. motors were available, and the switching on of such at this stage would cause a marked fall in speed of the mill engine, upon which heavy surgings of current would take place, knocking the voltage beyond control and dislocating the service.

The machine was next tried as an independent generator. More interest was attached to this test, as if the operation proved successful, this method of working would have considerable commercial valve. Two methods of exciting the rotor were available, either by cutting out one branch of the winding altogether, and connecting the other two in series to form the path for the current, or by connecting two branches in parallel and putting the combination in series with the third. This latter method was found to be more economical in exciting current. The trials under these conditions and with an induction motor load resulted in attaining an output of 180 kw. before the engine governing gave trouble. The excitation at this load was 7 kw. On a lighting load the results were extremely satisfactory, the output limit being largely increased—in fact, on certain occasions of big demand at the municipal lighting station, loads up to 315 kw. have been delivered with an excitation of 330 amperes at 25·5 volts. The engine under this load had got beyond governor control and fallen 4 per cent. in speed, but beyond this showed no signs of distress. This load, however, was abnormal, the maximum seldom exceeding 260 kw. The excitation required at no load was 138 amperes at 9·5 volts, or 1,311 watts as against 27 amperes at 133 volts (3,591 watts) for the regular generator. At loads of 180 kw. on similar power factors of approximately ·75 the excitations were 6·4 kw. and 5·2 kw. respectively; here the longer air gap of the regular generator tells to advantage. On similar loads (lighting) of 220 kw. the order is reversed, the regular generator requiring 5·2 kw. against 4·5 kw. of the converted machine.

The results on the whole must be considered good. With a constant speed at the prime mover, higher limits would have been reached on motor loads; part of this was due to the governing, but large steam pressure fluctuations played no inconsiderable part, and this was in a measure unavoidable, owing to the fact that two large winding engines were supplied from the same battery of boilers. The excellent results obtainable on non-inductive loads, neglecting the part due to less armature reaction, were attributable to the gradual assumption of the load, under lighting conditions, as distinguished from the sudden changes caused by switching on motors of large relative capacity, when on inductive loads. The temporary pulling up of the prime mover under the latter conditions was, of course, noticeable on lighting loads when heavy banks of lamps were thrown on; but this occurred very seldom, and it is obvious that, although inconvenient in such cases, it had not the dangerous factor which such occurrences might mean to motor loads. This machine offers another field of usefulness as a motor, and with its present connections can be used in case of emergency to drive half the mill (100 stamps), no change at all being necessary beyond disconnecting the mill engine.

To sum up, then, it must be admitted that under the disadvantageous conditions prevailing, good results have been obtained as far as the object in view was concerned. With more power at our disposal, and under our own undivided control, still better results could have been looked for on inductive loads. Asynchronous working increased either generator capacity by about 45 per cent., and was sufficient to tide over the peak of the day load. The heavy wattless current is a serious trouble, and reduces to a great extent the advantage obtained in other directions. It could be neutralised by the use of a static condenser, but condensers of the size necessary here (capacity 35 microfarads) can scarcely be called commercial apparatus, and would be expensive and difficult to obtain here.* Independent working was certainly a success, and up to the time of the writer leaving the company it was nearly always used as such. The short air-gap and low flux density in the rotor, although favourable as a motor, allowed a big armature reaction when generating on inductive loads, but the effects of this would not have been so noticeable with automatic voltage regulation, such as, say, the Tirrell system. As to the use of such machines in mining districts, such as the Witwatersrand, it depends entirely on circumstances. No doubt in the near future isolated electric generating plants will disappear, and be replaced by central supply stations, operating over suitable areas. When such a system is actually in sight, any immediate addition to the generating plants of mines likely to be affected by the change could be provided for by a machine such as described, which, on conversion of the systems, could at once resume its original *rôle* as a motor.

* Mr. Alexander Russell informs me that he has condensers for 500 volts working (four in series for 2 000 volts, costing £1 per three microfarads) at Faraday House, London, supplied to him by the Stanley Manufacturing Company, of America.

A LIGHTNING ARRESTER RELAY.

The small spark gaps required in lightning arresters protecting comparatively low voltage (under 5,000 volts) circuits has always been a source of unreliability in their action. This is partly due to the bridging of the small gaps by dust, insects, etc., and partly to the fact that, at least in the horn type of arrester, the current at which the arc runs up the horns and extinguishes itself increases as the gap is reduced, so that with very small gaps—such as a 1mm. gap, corresponding to a sparking voltage of about 3,400—the large current is sufficient to melt the edges of the horns partially, and so interfere with the exact setting of the gap. One of the simplest ways of increasing the gap depends on the influence of ultra-violet rays on

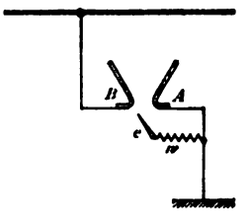

Fig. 1.

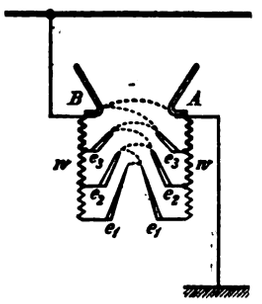

Fig. 2.

the sparking distance in air. Usually the ultra-violet rays are produced by a small auxiliary spark gap placed quite close to the main gap, and preferably arranged so that one pole of the main gap also forms one pole of the auxiliary gap (Fig. 1), whilst the other pole of the auxiliary gap is connected to the other pole of the main gap through a high resistance. Sometimes two or more auxiliary gaps are employed, each longer than the last, and arranged so that the sparks start across the shortest gap and then jumps across each of the other gaps in turn, and finally bridges across the main gap (Fig. 2). In this way the sensitiveness to dust, etc., of the main gap is reduced, but the auxiliary gap is now liable to these troubles. There is, however, a certain advantage in the arrangement, for whereas the poles of the main gap cannot safely be given a sharp or pointed form owing to the large arc rapidly burning them away, the auxiliary spark, owing to the small currents dealt with, can take place between pointed electrodes, and this, as is well known, leads to a marked increase in the permissible gap for a given voltage.

Various other solutions have been suggested, but without any very definite success. Recently a piece of apparatus, based on a new principle, has been devised for the same purpose by the Siemens-Schuckert Company.* It is known as a "lightning arrester relay," and would seem to get over most of the difficulties. The action depends on the artificial production of a higher voltage than that against which protection is sought, this higher voltage being made to break down the resistance of the main gap. The connections for this arrangement are shown diagrammatically

* See A. Dina in *Elektrotechnische Zeitschrift*, May 25, 1905.

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in Fig. 3, where W is a damping resistance connected to earth through the main spark gap, B, A, and also through an auxiliary resonant circuit in parallel with the main spark gap. The auxiliary circuit contains a small air-gap, F, which is readily bridged by the voltage rise in the line, whether this voltage is of a rapidly fluctuating nature such as is produced by a lightning stroke, or increases slowly as in the case of the gradual accumulation of a static charge on the line. As soon as the spark across F takes place rapid electrical oscillations are set up in the auxiliary circuit consisting of the spark gap, F, the two condensers, C and C_1, and the primary coil, P, of the Tesla transformer, of which S forms the secondary. These oscillations produce a high voltage in S, which is connected at one end direct to the main spark gap, and at the other end to the other pole of this gap through the condensers, etc., and this voltage breaks down the resistance of the gap and so permits the line to discharge to earth, in spite of the fact that the voltage difference between line and earth is too low in itself to span the main gap. At the same time the high voltage set up in S is quite harmless to the installation, because it occurs between earth and one horn of the arrester, and becomes neutralised in the auxiliary circuits containing the condensers without affecting the potential of the line. Even if this were not the case, the capacity of the line to earth would practically act as a short-circuit towards the very high-frequency currents and small amounts of energy dealt with in the Tesla transformer.

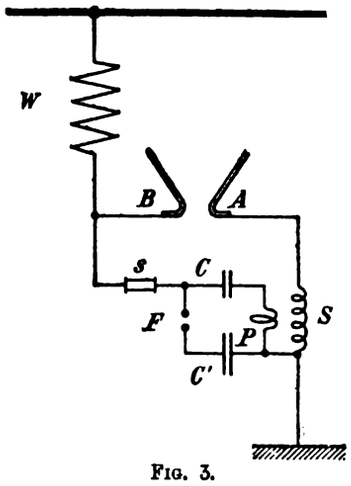

FIG. 3.

Under these conditions the main gap can be set at a reliable length of 3mm. or 4mm., and the auxiliary gap, F, though small, can be made quite reliable and free from outside disturbance by completely enclosing it in a tube, for there is no longer any need for the auxiliary gap and the main gap to have a common pole, or even for them to be situated close together.

As actually constructed, the condenser C, which is permanently subjected to the circuit voltage, is given a capacity of about ·005 microfarad, and for a 3,000-volt circuit is arranged to withstand a breakdown pressure of at least 12,000 volts. Condenser C_1 is only under pressure during a discharge, and so is arranged for a somewhat lower breakdown voltage, and is given a capacity of about ·01 microfarad. The secondary, S, of the Tesla coil consists of 20 turns wound into an 8cm diameter spiral, and has a low self-induction coefficient of only about 25×10^{-6} henrys. It is placed inside a porcelain tube, and the primary, P, which consists of only one turn, is placed outside this tube.

In order to avoid any risk of damage due to the breaking down of a condenser, a fuse is placed at *s* which cuts out the auxiliary circuit, but not the main spark gap, in the event of such an occurrence.

THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

(*Continued from page 60.*)

We chronicled last week the opening day's proceedings before the Select Committee of the House of Commons, consisting of Sir James Kitson, Sir Herbert E. Maxwell, Mr. Frank Edwards, and Mr. John Rutherford.

When on Friday last Mr. Honoratus Lloyd, K.C., commenced to resume the examination of Mr C. H. Merz, counsel for the London County Council, the City Corporation, and some of the local authorities applied for particulars of the purchase clause which the promoters were prepared to offer, as no information had been furnished as to period, proposed assignees, or terms

Mr. LLOYD replied that he imagined this would be a question for the committee to settle.

Counsel for the opponents insisting upon their application, the committee held a brief conference, after which the Chairman announced that it would be necessary for the promoters to outline their proposal as early as possible.

Mr. MERZ's examination was then resumed. He stated that a scheme of this magnitude needed to be specially designed; the comparatively small capacity, and the geographical situation of the existing undertakers' generating stations, rendered them quite inadequate for such a purpose. With the plant proposed by the promoters a high diversity of power load would be practicable. In the existing stations the capital charges accounted for 50 per cent. of the total cost of generation. What was a bad load factor with them would become a good one taken in the aggregate. He repeated his evidence before the Lords' Committee to the effect that a station with a capacity of 90,000 kw. could be installed at the rate of £8. 4s. per kilowatt, against an average of £50. 5s. for the existing stations. There would also be a saving on management expenses and wages, and on coal, oil, and stores. One-third to one-quarter of the existing stations were non-condensing, while another third could only condense by the aid of cooling towers. The comparisons in regard to coal took into account varying calorific values, 11,000 British thermal units per ton being allowed for Tyne coal and 15,000 for Welsh. The tables under this head were based upon the average prices of the last 15 years, and a margin of 30 per cent. was added for a possible rise. Steam-turbines of 20,000 h.p. capacity would be used as prime movers, and up to this size their efficiency increased with the size. There was an economy in space, wages, and maintenance. It was proposed to have the first section of the scheme (90,000 kw.) completed by 1910, and the whole four or five years after. The promoters estimated that in the industrial area they would be able to supply two-ninths of the total energy generated by them as follows: one-ninth to existing undertakers, and one-ninth to power users direct. They did not propose to lay a triplicate system of mains in the non-industrial area at once. He repeated the figures as to costs of operation and as to income given before the Lords' Committee, of which we gave particulars at the time.

Cross-examined by Mr. Lewis Coward, K.C., on behalf of the London County Council, he stated that he did not consider the fact of the Council having a vested interest in the municipal electric lighting undertakings to the extent of some three millions constituted a reason why the measure should not pass, as he regarded this as a comparatively small consideration in relation to the great industrial interests at stake. He did not agree that the decision of Lord Cross's Committee when considering the early Power Bills was hostile to the purposes of the present Bill. He denied that the County of Durham Electric Power Company had absorbed municipal undertakings. What the company did was to enter into arrangements whereby districts hitherto unprovided obtained a supply of current, the undertakers having, with the exception of Gateshead, failed to furnish a supply, although powers had been obtained. When asked whether he was aware that the London County Council presented a Bill for co-ordinating the existing undertakings, Mr. Merz became the examiner, and inquired whether this included the companies, to which Mr. Coward replied in the affirmative. Asked on what ground the promoters based their application for exemption from the London Building Act, Mr. Merz replied that both economy and security would be effected thereby. The promoters, in preparing their estimates, had assumed that the tramway undertakers in the Metropolis would not take power from the

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company for their present requirements, but they might for future extensions, and substantial custom was expected from the railways as they electrified their suburban lines. He assumed that the existing electric light undertakers, as business men, would in a large measure take energy from the promoters because it would be cheaper. He could not quote a precedent for laying down a generating plant at the rate of £8. 4s. per kilowatt, for the simple reason that the present scheme was without a parallel in this country. If exemption from the Building Act were not secured, it would add from £1 to £2 per kilowatt to the price. He was briefly examined as to carrying the mains under the Blackwall and Millwall tunnels, which have special protective Acts in their favour, but it was understood that this matter would be gone into fully on the examination of Sir Alexander Binnie.

The committee then adjourned.

On Monday, July 18, the cross-examination of Mr. C. H. MERZ was continued by the various counsel representing the opponents to the Bill. The fact that the city of London was in the non-industrial area, and that it contained no tramway, railway, or docks that could not be supplied from outside, was urged as a reason for striking the area out of the Bill. Mr. Merz could not agree to this, as some cable route through the City might be found advantageous. He considered that the clauses of the Bill prevented undue competition with existing undertakers. This company had power to buy up an undertaker. If this were done in a district where there were two competing companies now, he considered that the Board of Trade could still protect the remaining undertaker. Mr. Baggallay was cross-examining on this point on behalf of the Charing Cross and City Company, when

Mr. BALFOUR-BROWNE stated that negotiations were going on between the County of London Electric Company and the promoters of this Bill, which he hoped might result in an understanding. He, therefore, reserved the right to defer his cross-examination until the negotiations were completed or dropped.

Mr. BAGGALLAY then asked if negotiations with the City of London Company were also in progress.

Mr. MERZ said a letter had passed as to why the Bill was opposed, but that this letter had not been answered. The Electric Power Development Company were the promoters of the Bill, and they had powers to buy shares in other companies. They might acquire control of any other company in that way. In that case the energy supplied for lighting would not be taken into account when making the average price for dividend purposes. Neither would the revenue from stand-by charges other than for power actually supplied.

In the course of the hearing the following draft of the promised purchase clause was handed in:

Clause 79a, p. 43.

In the event of any public authority or body of trustees (hereinafter called the "purchasing authority") being authorised to acquire the undertaking at the expiration of a period of 50 years from the passing of this Act, and of subsequent periods of 10 years thereafter, the following provisions shall apply and have effect—that is to say:

1. Twelve months' notice in writing shall be given to the company by the purchasing authority intimating their intention to acquire the undertaking.

2. The price to be paid by the purchasing authority to the company shall be a sum equal to the amount standing in the books of the company at the date of the purchase as representing the capital expenditure of the company as audited in the manner hereinafter provided, and without any allowance to the company for compulsory purchase or for the goodwill or prospective value of their undertaking.

3. For the purposes of the immediately preceding sub-section the accounts of the company shall be annually audited by an auditor to be appointed by the Board of Trade, and a copy of the accounts as audited shall be filed with the Board of Trade.

4. The purchasing authority shall also pay to the company for the materials and stores on hand at the date of purchase a price to be agreed on, or, in case of difference, to be determined by an arbitrator to be appointed by the Board of Trade, and in addition the value of the debts due to the company, and the company shall discharge all debts due by the company at the date of purchase and all liabilities with respect to any debenture stock or mortgage debt of the company.

5. The expression "undertaking" shall for the purposes of this section include all rights of generating, purchasing, using, transmitting, transforming, distributing, supplying, and utilising energy and all other rights, powers, authorities, and privileges of the company, and all such property real and personal, and all other interests and rights in, to, and out of the property real and personal, and obligations and things in action as may be in the possession of the company or belong to them immediately before the date of purchase, and all books, accounts, and documents relating thereto, but subject to all liabilities and obligations of the company other than the debts due by the company, and the liabilities with respect to the debenture stock and mortgage debt of the company.

6. As from the date of purchase the undertaking shall be transferred to and vested in the purchasing authority, and such authority shall have and may exercise all the rights, powers, authorities, and privileges of the company, and shall to the exclusion of the company be subject to all the duties, obligations, agreements, and liabilities of the company in like manner as if they were the company, except the debts due by the company at the date of purchase, and the liabilities with respect to the debenture stock and mortgage debt of the company.

The clauses embodying the agreements with the municipal undertakers of Stepney, Bexley, and Barking, referred to in our last issue, were also handed in, as was the agreement with the Kent Power Company. The arrangement with the Stepney Metropolitan Council is contained in Clause 85A, which has 18 sub-sections. The agreement is for 50 years, subject to option to terminate at the end of 25 years with compensation for the unredeemed portion of the plant and mains of the company less than 25 years old appropriated exclusively to the supply of energy to the Council. The sub-sections read as follows:

1. The company shall not supply energy within or for use within the metropolitan borough of Stepney except to the Council and to any railway company for the purposes of their railway.

2. Subject as hereinafter provided, the Council shall purchase in bulk from the company all the electricity which the Council may require beyond that which their present existing generating station is capable of furnishing within the dimensions of the present building.

3. The Council may maintain in efficient working order and make improvements and additions to the plant installed or to be hereafter installed at their present generating station and works and as regards auxiliary plant whether inside the existing building or not, and they may use the said plant to its full capacity before being required to take a bulk supply from the company as aforesaid, but the Council shall not increase their generating plant beyond that which their generating station as now constructed is capable of accommodating.

4. The Council shall not be required to guarantee to take any fixed amount of energy from the company.

5. Provides for a supply being given by the company within 18 months from the passing of the Act.

6. Says that if within 12 months the company cannot prove that they will be ready to supply, the special provisions of the Act as regards Stepney shall cease to have effect.

7. The said supply of energy shall be delivered by the company at such points within the said borough as the Council may require, provided that the number of points shall not exceed two until the extent of the demand from each point reaches 2,000 kw., after which the Council may increase the number of points by one for every additional 2,000 kw., or fraction of 2,000 kw., which the Council may demand from the company, provided, nevertheless, that the company may vary the location of the point of supply to any other point within the radius of a circle described from the point required by the Council, such circle having a diameter of three furlongs.

8. The said supply shall be delivered converted to the form and transformed to the pressure reasonably required by the Council.

9. Provides that in the event of a breakdown or failure of supply by the company the Council may make temporary arrangements for supply at the company's expense.

10. Puts damages for failure of supply on to the company.

11. The charge to be made by the company in respect of bulk supply shall not at any time exceed a fixed sum of £3 per annum per kilowatt of the maximum demand and a running charge of ·33d. per unit, and the Council shall have the right at the expiration of every period of five years from the passing of this Act to appeal to an arbitrator to be appointed by the Board of Trade for a reduction of the above-mentioned running

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charge, such arbitrator to have regard to the company's actual cost per maximum kilowatt demanded on all their stations and their production cost per unit.

12. The price charged by the Council to power consumers shall not exceed by more than £1. 10s. per annum per kilowatt demanded the price charged by the company for the bulk supply.

13. The Council shall lay down such additional distributing mains as may reasonably be required to deal with the increase or extension of business. In the event of the Council making default therein to such an extent that another company is allowed by Parliament to supply in Stepney, the company shall themselves be entitled to lay such new mains as the extension of business and competition with the new company may require.

The remaining five sub-sections deal with the purchase of a sub-station site, of certain three-phase cables, and to the settlement of disputes by arbitration.

Clause 85*d* deals with the Bexley Urban District Council, whose generating station is to be taken over. The purchase is to take place within two years from March 31, 1906, on the following terms:

2. The company shall as consideration for and subsequent to the taking over of the said generating station pay to the Council from time to time as and when payments fall due from the Council sums equal to the sums payable by the Council for interest, repayment of instalments, and charges on or in respect of the loans raised by the Council on account of the capital expenditure on the said generating station as hereinbefore defined, but subject to any necessary apportionment to be made, provided that in ascertaining the amount of the sums aforesaid no part of any revenue of the Council shall be taken into account in relief of the company. Provided also that the company may at any time at their option, and if the lenders or any one or more of them agree to receive back the loans earlier than the Council are entitled to repay the same, pay to the Council the amount required by such lenders to pay off the loans in lieu of continuing to pay future interest instalments and charges thereon. All stores not paid for out of capital shall be taken over by the company at a valuation.

3. The company shall supply and the Council shall take all current required for the electrical undertaking and tramways of the Council at a flat rate which shall not exceed 1·35d. per unit, provided that if the company call upon them to do so the Council shall supply all power users in the Council's area with current at a lower rate than the above, on condition that the company compensate the Council for any loss resulting from such supply, including loss of profit to the Council, such loss of profit to be agreed between the respective engineers of the Council and the company, or, failing agreement, to be determined by an umpire to be appointed by such engineers. Such umpire shall have regard to the whole circumstances of the case, and his decision shall be final.

Sub-sections Nos. 4 and 5 provide for the working of the switchboard and the control of public lighting, and the revision by the Board of Trade of the prices charged every five years.

6. Fixes the points at where the current shall be metered both for the tramways and general supply.

7. The current shall be supplied at the pressures and on the systems and with such regularity as may be reasonably required by the Council.

8. The company may at any time after the passing of this Act, and after the erection of a permanent generating station of their own and the connection therewith of the Council's cable system, so as to give a satisfactory supply of current discontinue the use of the said generating station taken over from the Council and dispose of the same and the plant and machinery therein, provided that the company shall not effect such disposals until they have given to the Council a satisfactory guarantee for the repayment of the said outstanding loans and interest thereon.

9. The company may use for the supply to other districts the existing generating station and plant taken over from the Council, provided that such use shall in no way interfere with the efficiency or the reliability of the supply given to the Council.

10. The company shall be at liberty to sell current direct otherwise than through the Council's mains to all power and traction users, but the company shall not otherwise compete with the Council.

Sub-section 11 fixes the expiration of the bulk supply to the Council in 42 years, subject to one year's notice and to compensation for the unredeemed portion of special plant and mains installed in Bexley within 25 years of that time.

12. Binds the Council to take their public lighting and tramway supply from the company, and to insert a similar clause in any lease of the tramways.

The usual arbitration and other clauses as to failure of supply follow.

The Barking Urban District Council's agreement is somewhat similar to the above, but it covers the purchase of the complete undertaking by taking over the present loans and paying also the loss from working. The following clauses are of special interest:

6. The average prices to be charged by the company for electrical energy within the Council's area shall not exceed the following:

Energy for power purposes	1d.	per unit.
,, traction purposes.....	1d.	,,
,, public lighting	1·5d.	,,
,, private lighting	4d.	,,

14. The company shall supply the Council with energy for the whole of their existing and any future sewage pumping system at an average price not exceeding ¾d. per unit.

16. The company shall either take over the staff which the Council now employ in their electrical undertaking at the date of the transfer thereof or, at the option of the company, shall compensate any member of the said staff for loss of office. All increase of salaries and wages made by the Council after the passing of the said Bill into law shall be subject to the reasonable approval of the company.

The agreement with the Kent Electric Power Company is to ensure mutual co-operation. This is shown by the clauses which follow:

2. The London Company are to give to the Kent Company and the Kent Company are to take from the London Company all energy required for supply to the customers of either company within or for use or distribution within the common area and the control and management of the distribution of energy therein shall, subject to the terms of this agreement, be in the hands of the Kent Company.

3. All energy to be supplied by the London Company in the common area shall be distributed by the Kent Company upon the terms of this agreement.

4. The London Company shall not erect or operate or be interested in a generating station in the area of the Kent Company outside the common area. No main feeders or distributing apparatus shall be laid or erected by the London Company in the area of the Kent Company without the consent of the Kent Company.

6. The Kent Company shall pay to the London Company for all energy so supplied by the London Company to the Kent Company the gross amount received by the Kent Company for the current distributed by them to the customers less the following deductions: (*a*) A sum equal to 10 per cent. per annum upon the capital cost to the Kent Company of all mains, feeders, and distributing apparatus in the common area, which amount of 10 per cent. is intended to cover 3 per cent. for depreciation and 7 per cent. for interest on capital. In the event of the said 3 per cent. proving insufficient or excessive for the purpose, the amount shall be subject to revision from time to time between the parties. (*b*) The amount of the actual cost to the Kent Company of all their working expenses and all annual payments attributable to revenue account in the common area. (*c*) A fair proportion of the administrative expenses of the Kent Company attributable to the common area. Any differences under this clause shall be referred to arbitration. The steps to be taken for the development of business and the price or prices of supply in the common area are to be settled from time to time between the parties by agreement in consultation, and in case of dispute are to be stttled by arbitration.

9. The London Company shall not supply energy within the common area for use without such area within the county of Kent.

On Tuesday the cross-examination of Mr. Merz was continued in the morning, but was subsequently interrupted to allow two other witnesses to be heard. One of these was the Hon. C. PARSONS, who repeated the evidence given before the House of Lords Committee as to the possibility and advantages of having very large generating units. The cost per horse-power of electrical machinery decreased as the size of the turbines increased, and the larger the generating station the more cheaply it could be equipped. London was so great that if its equipment were appropriate it could be supplied with electricity at a cheaper rate than was possible in any other city in the world. At present all its electric generating stations combined did not possess machinery as powerful as that of the two latest Cunard steamships, which had turbine-engines capable together of producing 140,000 h.p.

Mr. C. E. L. BROWN gave similar evidence, and also

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figures showing that large steam-turbines were finding favour on the Continent.

On Tuesday night in the House of Commons Mr. BONAR LAW, in answer to a question, said the Bill as at present drawn provides that no agreement for the sale of an undertaking shall be of force until it had received the approval of the Board of Trade, but until the Bill had received Royal assent no case can be submitted to or considered by the Board of Trade. Thus the agreements, which we abstract above, have yet to be considered by the Board of Trade should the Bill pass.

In reply to Mr. Lough, Mr. BALFOUR said he understood this measure was not uncontroversial, and, if so, there was little hope of its passing this session.

On Wednesday the cross-examination of Mr. Merz was again continued on lines similar to that followed before the House of Lords Committee. Evidence was then given by representatives of the Great Northern and Great Eastern Railway Companies in favour of the Bill.

Mr. BALFOUR BROWNE, K.C., for the County of London Electric Supply Company, informed the committee that a bargain had been arrived at between the two companies. The arrangement, which he claimed to be in the interest of the companies and public alike, was that when the promoters of the Bill had got their system into proper working order, three years being allowed for the purpose, the County of London Company agreed to take from them current for any additional requirements beyond that which could be met by their present plant, upon arbitration terms (failing agreement), on the basis of a substantial reduction below what it cost the County of London Company to manufacture electricity. They undertook to adopt the same price as that in the Administrative Company's schedule throughout the industrial area, so that the consumer would at once get the benefit of cheap power.

Mr. FITZGERALD, K.C., confirmed this statement, and submitted a clause for carrying out the agreement, which is not unlike that for the Stepney supply as regards general conditions.

PERSONAL.

Mr. F. Schofield, traffic superintendent of the Bradford city tramways, has been appointed general manager of the Leyton tramways at a salary of £300 a year.

The Poplar Borough Council have appointed Mr. W. Innes, St. Andrew's Cross Electricity Works, Glasgow, assistant electrical engineer, at a salary of £200 per annum, rising by annual increments of £10 to a maximum of £300 a year.

The Brighton Corporation Tramways Committee recommend that Mr. William Marsh be appointed tramways engineer and manager at a salary of £300 per annum, increasing by annual increments of £50 to a maximum of £400.

We regret to learn that Mr. W. A. Thompson, assistant mains superintendent to the Tynemouth Corporation, lost his life at Tynemouth on the 14th inst. while assisting another bather who had been caught by the current, and before it was possible to get a boat out both were drowned. Mr. Thompson was a hard-working and promising man who was greatly esteemed by all in the works.

The King's Lynn Town Council have increased the salary of their electrical engineer from £200 to £220, with a further increase of £10 at the end of each following period of 12 months until a maximum of £250 is reached.

Mr. J. B. Hamilton, general manager of the Leeds tramways, has been elected president of the Municipal Tramways Association.

TRADE NOTICES AND NOVELTIES.

Controllers.

Messrs. Dick, Kerr, and Co., Limited, London, have recently issued an illustrated pamphlet descriptive of their metallic shield blow-out controller for electric tramways, railways, cranes, etc. In regard to the evolution of the solenoid blow-out, which constitutes such an important part of this controller, each development has been the result, we are told, of careful observation under widely varying conditions. The chief improvement arises in the method of protecting the solenoid. As shown in Fig. 1 herewith, present practice is to place it in a metallic shield. The coil is enclosed in a casing of copper or other non-magnetic material, and it can be then brought directly into the sweep of the arc. The external magnetic field created round the shield of non-magnetic metal attracts the arc to the shield and divides it in two, one arc going from the contact finger to the shield and the other from the shield to the contact segment. These two arcs travel rapidly in opposite directions on the copper shield, and finally become united again in the air, but around the coil and shield; the arc at this stage has become attenuated to such an extent as to rupture, and may be, in fact, ruptured long before it has actually encircled the blow-out device. In Fig. 2 is shown the action of the arc. At A the arc is

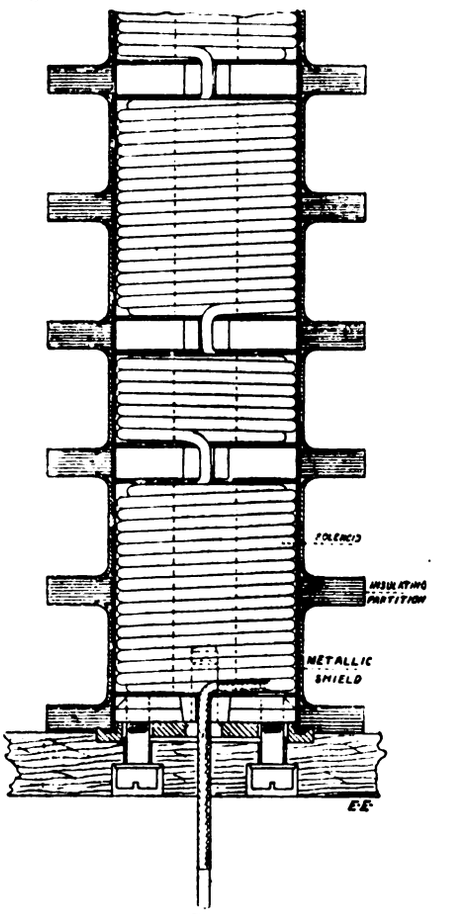

FIG. 1.

just started between the electrodes, and a deflection of the arc towards the shield is visible. At B the arc has struck the shield, and is commencing to encircle the section; at C the shield is partially enclosed; and at D the arc has united in the air and has left the shield.

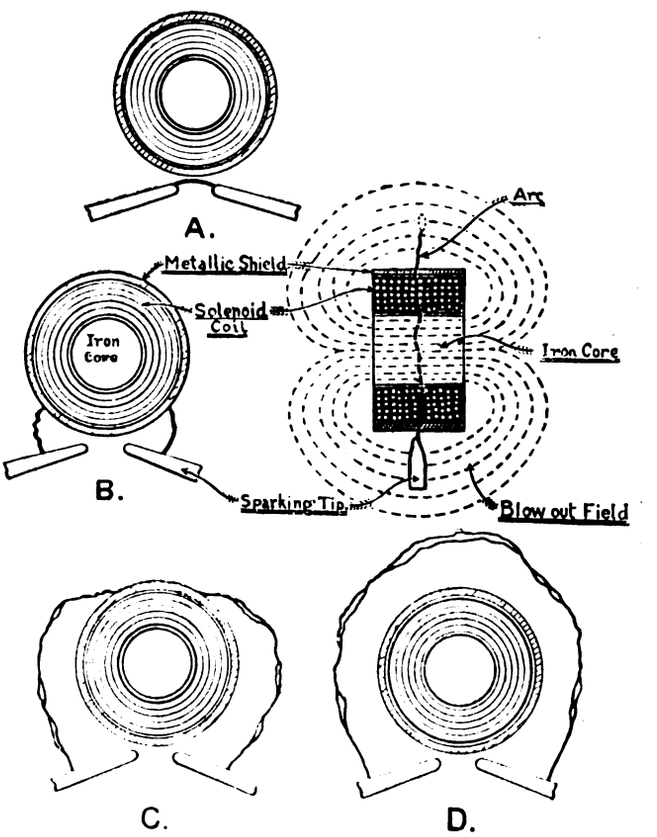

FIG. 2.

Generally speaking, the arc is literally swept over the shield with great rapidity, and does not affect the metal in the slightest degree. It is interesting to note the tendency of the arc to travel on the centre of the copper shield, and this is of great advantage, as the

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insulating partitions are not subject to injury. That the copper ring suffers to no extent from the discharge may be gathered from the fact that on examination after two years' continual use no material depreciation could be detected either on the metal ring or on the partitions. The blow-out is hinged on the pivots, and can be swung back and lifted out for inspection and cleaning. In swinging it back the trolley connection is broken, and, therefore, the current can be applied only when the blow-out is closed. It has been demonstrated on an ordinary service controller that 60 or more amperes on an inductive load may be broken time after time by slowly separating the finger and contact by barely $\frac{1}{16}$in. without the slightest trouble. Other novel features are combined in the controller, but for particulars of these we must refer the reader to the pamphlet under review.

MANCHESTER ELECTRICITY ACCOUNTS.

The accounts of the Manchester Corporation electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £2,199,689. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc, are given below.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	70,197	10	2
Distribution of electricity	35 504	18	9
Rents, rates, and taxes	19,910	16	8
Management expenses, salaries, etc.	8,311	7	2
Law and parliamentary charges	225	9	9
Special charges, insurances, etc.	1,483	18	6
Amount written off for bad debts	358	1	1
Special renewals	13,327	17	4
Renewals suspense account	25,000	0	0
Balance carried to net revenue account	127,379	16	6
	£302,199	15	11

Cr. Income.	£	s.	d.
By sale of current by meter	300,150	1	9
Public lighting	675	5	4
Rental of meters	383	1	8
Rental of motors	942	1	10
Cottage rental, less repairs, etc.	49	5	4
	£302,199	15	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgage debt—loans as per capital account	1,978,235	9	4
Sundry creditors	90,060	10	1
Total liabilities	2,068,295	19	5
Amount at credit of renewals suspense account	50,000	0	0
Amount at credit of reserve fund	20,386	14	1
Sinking fund	210,363	5	4
Instalment of loan repaid	23,862	5	4
	£2,372,908	4	2

Cr. Outlay and Assets.	£	s.	d.
Expended on land, buildings, plant, etc.	2,199,689	11	7
Stores on hand	36,785	18	3
Cash at bankers and in hand	36,894	0	2
Reserve fund investment	20,386	14	1
Cash in hands of treasurer	1,912	6	1
Sundry debtors for current supplied, etc.	76,534	13	7
Balance owing for street-lighting	705	0	5
	£2,372,908	4	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			47,170,721
Quantity sold: Private consumers	14,679,373		
Quantity sold: Public lamps	81,032		
Quantity sold: Traction	18,926,305		33,686,710
Quantity used on works			3,292,842
Total quantity accounted for			35,979,552
Quantity not accounted for			10,191,169
Number of public lamps			53
Total maximum supply demanded (kilowatts)			20,023

COVENTRY ELECTRICITY ACCOUNTS.

Herewith we give abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., for the year ended March 31, 1905, of the Coventry electricity department. The total expenditure on capital account to that date is £134,503.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	3,334	1	9
Distribution of electricity	254	16	8
Attending and repairs to public lamps	147	0	0
Rents, rates, and taxes	322	1	4
Management expenses, salaries, etc.	865	8	5
Special charges, insurance, etc.	107	12	9
Total expenditure	5,031	0	11
Amount carried to net revenue account	8,216	15	3
	£13,247	16	2

Cr. Income.	£	s.	d.
Sale of current per meter	12,460	12	10
Rental of meters and other apparatus	787	3	4
	£13,247	16	2

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	151 650	14	8
Sundry creditors	3,487	1	2
Amount received for deposits	13	0	0
Balance at credit of net revenue account	1,396	12	9
Sinking fund account	12,032	6	1
	£168,579	14	8

Cr. Assets.	£	s.	d.
Capital account—amounted expended for works	134,503	11	3
Stores on hand	265	19	4
Sundry debtors for current supplied	4,535	3	11
Other debtors	300	1	1
Securities held (cost price)	12 019	2	0
Cash in hands of treasurer	16,956	17	1
	£168,579	14	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,576,150
Quantity sold: Private consumers by meter	1,314,267		
Quantity sold: Public lamps	61,468		1,375 735
Quantity used on works			58,921
Quantity used in magnetising, etc.			141,494
Number of public lamps			40
Total maximum supply demanded (kilowatts)			970

BATH ELECTRICITY ACCOUNTS.

The accounts of the Bath electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £146,310. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5.114	4	0
Distribution of electricity	1,012	14	4
Attending and repairs to public lamps	379	16	2
Rents, rates, and taxes	726	6	6
Management, expenses, salaries, etc.	1,841	11	3
Special charges, insurances, etc.	163	0	9
	9,237	13	0
Amount carried to net revenue account	8,145	9	0
	£17,383	2	0

Cr. Income.	£	s.	d.
By sale of current per meter	16,552	10	2
Rental of meters and other apparatus	481	8	10
Sale of lamps and other apparatus	111	1	2
Income tax repaid and discounts	238	1	10
	£17,383	2	0

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	140 075	0	0
Sundry creditors	6,279	5	1
Balance at credit of net revenue account	937	0	5
Reserve fund account	813	12	2
Bank overdraft	5,256	0	2
	£153,360	17	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	146,310	16	4
Stores on hand	870	15	10
Sundry debtors for current supplied	4,923	1	7
Other debtors	178	0	9
Cash in hand	1,078	3	4
	£153,360	17	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,429,002
Quantity sold: Private consumers by meter	613,402		
Quantity sold: Public lamps	376,005		989,407
Quantity used on works			68,042
Total quantity accounted for			1,057,449
Quantity not accounted for			371,553
Number of public lamps			183
Total maximum supply demanded (kilowatts)			916

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LEGAL INTELLIGENCE.

MIDWOOD AND CO. v. MANCHESTER CORPORATION.

On the 13th inst. the Court of Appeal dismissed this case, in which the defendants appealed against a verdict and judgment for the plaintiffs for £677 for damage to stock arising from a fire caused by the fusing of one of the Corporation's electric mains. The action was tried by Mr. Justice Lawrence and a special jury.

Their Lordships came to the conclusion that the leakage in the mains causing the explosion was clearly a nuisance, and there was nothing in the Electric Lighting Acts which authorised a leakage of that kind. They also held that there was ample evidence of negligence on the part of the defendants to go to the jury, and therefore dismissed the appeal with costs.

BIDEFORD AND WESTWARD HO! LIGHT RAILWAY.

On the 11th inst. Mr. Justice Walton resumed the hearing of the case of the British Electric Traction Co. and the Bideford, Westward Ho! and Appledore Railway Co. *v.* Charles Chadwell, contractor, of Blackburn. The claim was for money expended by plaintiffs in completing certain works undertaken. Plaintiffs alleged that it was agreed that in the event of defendant wilfully making default in proceeding with the execution of the works, which consisted of certain electric tramway construction, plaintiffs might complete them and recover any extra expense which they might incur. Plaintiffs claimed £12,000, but that was reduced to £8,690, after allowances had been made to defendant as to the value of materials left by him on the ground, and fees due to him as engineer in the construction of another tramway at Devonport, etc.

Mr. A. S. CHAPMAN, formerly engineer in Mr. Chadwell's employ on the Bideford tramway contract until the plaintiffs took it over, called on behalf of the defendant, said for a time he remained on the job, and had with him a cashier, leading carpenter, and several men. If necessary he could have got more men and carried the work on, instead of things being allowed to stand still for a long time. One of the lines was nearly completed; had he been allowed he could have finished it within a fortnight. The value of the plant and materials on the works at the time was nearly £3,900, and all that ought to have been allowed to defendant by the plaintiffs. He was ordered to stop the work by the engineer of the company, by the town clerk, and by Mr. Chadwell.

Mr. ASHTON, for defendant, submitted that the fact of stopping the work, pending an amicable arrangement with the authorities, did not constitute wilful default, and, therefore, defendant ought to succeed in this action and receive damages.

Mr. LLEWELLYN DAVIS, for the company, stated that the delay was not the fault of plaintiffs, but was caused through the friction between the defendant and the authorities.

Judgment was entered for plaintiffs for £7,500, with costs.

ATTORNEY-GENERAL v. MANCHESTER CORPORATION.

On Saturday, in the Chancery Division of the High Court, Mr. Justice Swinfen Eady heard a summons in an action brought by the Attorney-General at the relation of Sutton and Co., carriers, of Manchester, to restrain the Corporation carrying on business in alleged opposition to them, and from applying the funds of the Corporation for that purpose. The summons asked for an affidavit of documents and for leave to deliver to the defendants some very lengthy interrogatories. The defendants objected to Sutton's as trade rivals looking at their books. The statement of claim sets out that the Corporation are not entitled to use the city rate for the purpose of an undertaking for carrying parcels, and that they are burdening the tramway to an extent they are not entitled to by applying the revenue to other purposes.

It was arranged that the plaintiffs should prepare a notice to admit facts as speedily as possible, and the summons should stand over generally, but to be mentioned again some time during the present month.

WAKEFIELD, LEEDS, AND DEWSBURY LIGHT RAILWAY.

On Thursday week Mr. Justice Swinfen Eady, in the Chancery Division of the High Court, heard an application on behalf of the Electric Construction and Maintenance Company, and now under liquidation, against their solicitors, Messrs. Harrison, Beaumont, and Smith, for an order that they should deliver bills of costs and of their work done for the company, and also for an order that those bills should be taxed.

His Lordship held that it would be oppressive to order the solicitors to deliver bills of costs nearly two years after the company had gone into liquidation, and dismissed the summons, with costs.

POST OFFICE TELEPHONE RENTS.

In the Peterhead Small Debt Court on Friday Lord Stanley, the Postmaster-General, sued three subscribers to the Post Office telephone service for payment of £4. 10s. each, the annual subscription for telephone exchange line from their premises to the post office at Peterhead, with right of communication, in terms of agreement entered into in 1903, and fees for transmission of messages for one year. The defendants each lodged a counter-claim of £10 for loss and damage through default or failure of the telephone service to implement the agreement.

After hearing a mass of evidence, which took three hours, the SHERIFF said they had the statement of one man against a whole host of witnesses for the defence. He must prefer the evidence of the host, and he found in each case for the defendants, assessing a counter-claim at £4. 10s. (the sum claimed by plaintiff), and costs.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

An extraordinary general meeting of the shareholders was held on Monday last for the purpose of authorising the Company to raise £75,000 by the creation and issue of second preference stock at 5 per cent., a sum of £300,000 by second preference stock of additional capital authorised by the Metropolitan Railway Act of 1897, and a sum of £100,000 by debenture stock at 4 per cent. under the Metropolitan Railway Act of 1905. Mr. R. W. Perks, M.P., presided, and the statutory resolutions were carried.

The CHAIRMAN said the directors had agreed to sell the whole of this issue at a price of 65, that being the same price as the second preference stock of the Company. They had concluded a satisfactory arrangement with the Brompton and Piccadilly Company for running over a portion of the wider line. The total expenditure up to the present moment on the electrification of their railway had been £1,373,766, and further expenditure would bring that sum up to £1 623,766. Except £515,000, the amount provided by debenture stock, the whole of the money had been raised by ordinary and preference stock. In reply to a shareholder who wanted to know when the directors expected their line fully electrified, he said they hoped to be putting forward and maintaining a different service in a few weeks.

ELECTRIC CONSTRUCTION.

Mr. J. W. Barclay presided over the ordinary meeting on July 14. Particulars of the report appeared in our issue of July 7, and it was adopted.

The CHAIRMAN said that the profit was only sufficient to justify payment of the dividend on the preference shares, but they carried forward £3,319. The Electric Power Storage Company, in which the Company had a large interest, continued to do very well in spite of the general depression, and its previous dividend of 6 per cent. had been maintained. The directors, while satisfied with the investment, were, however, of opinion that part of the funds invested in this accumulator business might be more advantageously employed in their own, and probably part of their holding in that company would be offered to the shareholders within the next few months. The general expenses had been reduced by £870. During last year competition had been intensified, and prices further reduced, not by their former German and American competitors, but by the great extension of factories for making electrical plant in this country, where the capacity for producing electrical plant had doubled in the last few years. The accounts showed that the Company were in a stronger financial position than ever before. They got a fair share of what orders were going, and the results of the business in the past year were not worse than the experience of others similarly situated.

ELECTRICAL POWER STORAGE.

Mr. J. IRVING COURTENAY, who presided on July 14 at the annual meeting, in moving the adoption of the report (published in our issue of July 7), said that during the year the Company, in addition to the smaller class of business, had obtained a full share of the large central-station contracts throughout the country, and had completed 16 central-station batteries, six of which were in the metropolitan area. The Company's works were fully employed, and had work in hand for several months ahead, though there were signs that the business in accumulators was not so brisk as it was 12 months ago, in addition to which the cutting of prices, which had now become general, rendered it possible to make only the smallest profit on each individual transaction.

A dividend at the rate of 6 per cent. on the ordinary shares was adopted.

DIRECT UNITED STATES CABLE.

The report for the six months ended June 30, 1905, shows an increase of £6,348 in the revenue, which totalled £48,469. The expenses, including provision for pension fund, endowment assurance, and income tax, but exclusive of cost of cable maintenance, amounted to £22,571, leaving a balance of £26,897 as the net profit, making, with £2,876 brought forward from the previous half-year, a total of £29,774. Three quarterly interim dividends of 3s. each per share, amounting to £27,319, have been declared and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making, with three interim dividends, 3¼ per cent. for the year, being a total distribution of £39,461. The reserve fund has been debited with £3,946 for cost of cable maintenance, and after being credited with interest on investments, profit on sale of securities, and amount transferred from revenue, the balance now amounts to £482,947, taking the investments at cost price.

GERMAN-DUTCH TELEGRAPH.

The report of the first year's working states that a joint subsidy of £95,000 per annum has been granted to the Company for 20 years. Of this amount £76,250 is payable by the German Government and £18,750 by the Dutch Government; 90 per cent. of the cable receipts will be reckoned towards the subsidy during the 20 years. The Company is now laying submarine cables from Menado in the Celebes *via*

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Jap in the Carolines to the United States island of Guam, where a connection is being formed with the American-Pacific cable; and from Jap to Shanghai, where a junction will be effected with the German cables between Shanghai, Tsingtau, and Chifu, and thence with the network of the Great Northern Telegraph Co., whose lines run over Siberia to Europe. Forty years' cable-laying rights have been granted for Jap and Menado, while similar privileges have been secured from the Chinese Government for Shanghai and from the United States Government for Guam, where the Commercial Pacific Cable Co. will work the cables by virtue of an agreement with the German-Dutch Co. An agreement has been concluded with the Great Northern Telegraph Co. to maintain and repair the cables during the first 10 years' working for a fixed amount.

THOMAS PARKER, LIMITED.

In their report for the past year the directors regret to have to report that the severe competition and reduced prices, combined with trade depression, still continue in the electrical industry. After deducting general charges, maintenance, and interest on debentures, the accounts show an adverse balance, which it is proposed to meet by transferring £6,000 from the reserve fund, carrying forward £153. 19s. 1d. to next year's account. The directors have thought it advisable to transfer £1,500 from the reserve fund to a suspense account to meet a possible loss that may be made in connection with foreign agencies. The buildings and plant have been well maintained, and in view of the large amount written off for depreciation in former years and the sums spent out of revenue for maintenance of plant and machinery, the directors have not considered it necessary to draw on the reserve fund for the depreciation account, as the average over the 11 years during which the Company has been working is well above the usual figures for similar manufacturing companies. The directors have decided to forego one half of their fees for the year. The directors attribute the unsatisfactory results entirely to lack of orders during the year, as although the works were full at the beginning of the year's working it became advisable later to stop all night work and reduce the number of hands employed and eventually to resort to short time rather than attempt to keep the works full of orders at prices which would not pay the cost of production. During the last few months it is satisfactory to note that the works are again working full time. The works staff has been kept in a fully efficient state, and the directors are satisfied that no opportunities have been lost to secure work at remunerative prices, or to improve designs and reduce cost of production to meet the adverse conditions.

GENERAL ELECTRIC.

The report of the directors for the year ended March 31, 1905, states that the net trading profits and income from investments, etc., amount to £73,822. 16s. 9d.; after deducting depreciation and debenture interest amounting to £25,919. 15s. 11d., there remains a balance of £47,903. 2s. 10d., out of which the dividend on the preference shares at the rate of 5 per cent. for the year ended March 31, 1905, has been paid, absorbing £12,500, leaving an available balance of £35,403. 2s. 10d., which the directors recommend should be appropriated as follows: payment of managing directors' and employés' bonus, £3,540. 6s. 6d.; payment of dividend on ordinary shares at the rate of 5 per cent. for the year ended March 31, 1905, £15,875; reserve account, £15,987. 16s. 4d. The reserve account stands in the accounts at £80,255. 7s. 2d., being the amount of undivided profits as at March 31, 1904; the proposed appropriation of the undivided profit of the year ended March 31, 1905, amounts to £15,987. 16s. 4d; giving a total of reserve account of £96,253. 3s. 6d. The trading profits have suffered under the continued depression of trade. The Witton engineering shops and foundry have been fully occupied during the last 12 months, and the results have been satisfactory. The carbon works have throughout the year been working at their full capacity, and produced a uniformly high standard of quality. The directors hope that the unprecedented cutting of prices by foreign competitors may soon end, and allow the Company to reap the commercial benefit of this important enterprise. The Manchester, Birmingham, and London factories continue in their normal progress. During the year further 1,570 ordinary shares have been allotted to the directors of the Company and members of the staff at par.

CROMPTON AND CO.

The report of the directors for the year ended March 31 last states that, although the volume of business done by the Company is as large as in previous years, prices still rule very low. The results of the contracts carried out by the Company during the year have proved satisfactory, but the profits realised in this direction have been adversely affected by the low prices obtained for goods manufactured at the works. With a view to greater economy in the future, the directors have entirely reorganised the staff at Chelmsford. The net profits for the year amount to £9,128. 10s. 7d., which compares unfavourably with the profit of £14 584. 5s. 4d. in the preceding year. After providing debenture interest and other items, there remains with the sum brought forward from last year, a balance of £2,713. 2s. 1d. Considering that in prosperous years, instead of distributing large dividends, the directors placed substantial sums to a reserve fund, they are of opinion that the present occasion is one which justifies the application of part of such undivided profits to assist in paying a dividend. They therefore propose to take £4,000 from the reserve fund, to pay a dividend at the rate of 2½ per cent. per annum for the year, and to carry forward a balance of £656. The loans and other advances owing to the Company by the Chelmsford Electric Lighting Co. have been repaid by the Electric Supply Corporation, partly by debentures, and the costs of realising the debentures, as well as a small discount on the shares held in the new company, have been charged to the contingency fund. The balance of the contingency fund, £2,058. 12s., has been added to the provision for doubtful debts. Important contracts for constructing and equipping electric lighting and tramway undertakings, both in the United Kingdom and abroad, have been secured on terms which should undoubtedly result in satisfactory profits for the current year, so that the prospects of the Company for the future are more encouraging. Amongst others, large contracts have been secured from the Electric Supply Corporation, and in order to assist in obtaining capital for that company it has been considered advisable to guarantee its earnings for four years, and for this purpose an investment in the shares of a guaranteeing company has been made. An insurance has been effected to cover part of this risk. Should any money be paid under the guarantee, it has to be returned out of future profits of the Electric Supply Corporation, with interest.

ELECTRIC SUPPLY CORPORATION.

The report of the directors for the year ended Dec. 31, 1904, states that the negotiations referred to in the last report were duly completed, and as a result the capital was increased by an issue of 11,092 shares. The Company has acquired at par the whole of the share capital of the Chelmsford Electric Lighting Co. by an issue of 7,000 fully-paid shares in this Company. The Chelmsford undertaking is a prosperous one, the net profits of that undertaking for last year amounting to £3,869. By the issue of the above 7,000 shares the total share capital alloted to Dec. 31, 1904, was 21,492 shares of £5 each. The directors have made an issue of £50,000 of 4½ per cent. debenture stock, which amount has been secured by a deed of trust. Since Dec. 31 last the stations at Exmouth and St. Andrews have been erected and equipped, the mains have been laid, and the supply has commenced. The Company has, therefore, the following stations at work: Dalkeith, Chelmsford, Dollar, Totnes, Jedburgh, Exmouth, Melrose, St. Andrews. The capital expenditure during the year, as set out under the headings of the several towns in the capital account, has amounted to £43,677. 6s. 8d. In order to carry out the operations of the Company as described in the original prospectus, further capital was required, and since the closing of the accounts for 1904 negotiations have been brought to a successful issue for the placing of an additional 20,000 shares. In consequence, the undertakings at Hendon, Hitchin, Falmouth, and Dumbarton (in the latter case including the tramways) are being pushed forward as quickly as possible. Owing chiefly to the dividend on the Chelmsford undertaking, a small balance, £216, has been carried forward.

LISBON ELECTRIC TRAMWAYS.

The report for the year 1904 shows a net available balance of £42,730 after deducting interest and amortisation due on the debentures of "Companhia Carris de Ferro de Lisboa," and after payment of debenture interest and other charges, together with London office expenses and directors' remuneration, and providing reserve for depreciation, insurance reserve account, and exchange reserve account. The usual preference dividend of 6 per cent. for the year 1904, amounting to £25,533, has been paid, leaving £17,197 to be carried forward.

NEW COMPANIES REGISTERED.

Portable Accumulators, Limited.—Capital, £25,000. Object: to acquire the business and the sole right of manufacture and sale in the United Kingdom of electrical portable accumulators, which heretofore formed part of the business carried on at various addresses by the Tudor Accumulator Co. Registered office: King Edward's Mansions, 210, Shaftesbury-avenue, W.C.

Auto Claw Co., Limited.—Capital, £15,000. Object: to carry on the business of electricians, electrical engineers, etc. Registered office: 38, Beech-street, Barbican, E.C.

James C. Kay and Co., Limited.—Capital, £10,000. Objects: to acquire the business carried on at the Phœnix Foundry, Brook-street, Bury, as James C. Kay and Co., and to carry on the business of iron and brass founders, engineers, electrical engineers, etc. Registered office: Phœnix Foundry, Heap Bridge, Bury.

Liens Registered.

London United Tramways (1901), Limited.—Acknowledgments of indebtedness, dated June 13, 1905, registered June 23, creating £258,000 and £42,000 further debenture stock, making a total of £1,331,000, and being supplemental to a trust deed dated Feb. 26, 1902, and indenture of acknowledgement of indebtedness dated July 22, 1903, for securing £1,031,000. Trustees: Lord Revelstoke and Sir George White, Bart. Charged on various freehold and leasehold properties, the undertakings, and all property, including the unpaid capital, whether called or not.

Telegraph Printing Co., Limited, Manchester. — £950 debenture, dated July 6, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Phillips's Commutator Grinder Co., Limited, London E.C.—Lien registered July 11, for £50 5 per cent. debentures, part of £5,000. Amount previously issued, £600. No trustees. Charged on all the property, present and future, including the uncalled capital.

Oriental Telephone and Electric Co., Limited.—A trust deed, dated June 28, 1905, to secure £100,000 debenture stock, has been

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registered. Property charged: the company's undertaking and property, present and future. Trustees: Sir Auckland Colvin, Earl Soham, Framlingham, Suffolk; and G. F. Braithwaite, Kendal, Westmoreland.

Amazon Telegraph Co., Limited.—A Board resolution under seal, dated June 20, 1905, creating £35,900 further debentures, has been registered. Property charged: A subvention of £17,125 per annum and all other moneys payable by the Government of Brazil under Clause 10 of a concession dated April 29, 1895. Trustees under deed mentioned below; Sir William C. Quilter, Bart., King's Arms-yard, E.C., and Sir John D. Pender, K.C.M.G., Electra House, Finsbury-pavement, E.C. The present issue ranks *pari passu* with £119,700 like debentures issued in 1897. Both issues are covered by a trust deed dated Aug. 5, 1897. The company reserves power to issue further debentures ranking *pari passu* with the above to the extent of £39,100. The whole of the above debentures rank after £150,000 6 per cent. debentures created in 1901. A trust deed, dated July 11, 1905 (supplemental to said trust deed of 1897), securing £75,000 debentures, created by resolution of June 20, 1905 (consisting of the £35,900 and £39,100 above mentioned), has also been registered. Property charged and trustees, as above.

FORTHCOMING EVENTS.

TUESDAY, JULY 25.

Junior Institution of Engineers.—At 6.30 p.m., visit to the New Vauxhall Bridge Works.

Permanent-Way Institution. — Summer convention begins on July 21, continuing till July 27, in the course of which a visit will be paid to Holland.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Turnu-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

West Ham.—The Council invite tenders for the erection of tramway offices and car depot, Greengate-street, Plaistow. Tenders by July 25.

Beckenham.—The Urban District Council invite tenders for (Section A) water-tube boilers; (B) steam alternator. Tenders by 22nd inst.

South Shields.—The Town Council invite tenders for the laying of the permanent way for the service line to the car-shed in Dean-road. Tenders by 22nd inst.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct-coupled steam set. See advertisement in last issue.

Brussels.—The Government Telegraph Department require tenders for 14,700 pine telegraph poles. Specification 76 may be obtained from their office at Brussels. Tenders by Aug. 9.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10 000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Calanas (Spain).—The Municipality require tenders for the installation and working for 10 years from Jan. 1, 1906, of the electric lighting of the town. Tenders by July 27 to the Alcalde of Calanas, province of Huelva, Spain.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

London, S.W.—The London County Council invites tenders for the manufacture, supply, and delivery of (*a*) one five-ton overhead electrically-driven travelling crane and (*b*) one 2½-ton overhead electrically-driven travelling crane. Tenders by 10 a.m. on July 25.

London, S.W.—The London County Council invites tenders for the manufacture, supply, and delivery, separately, of (*a*) double-deck car bodies with roof covers; (*b*) maximum traction swing bolster trucks for electrical cars; (*c*) complete electrical equipments for cars. Tenders by 10 a.m. on July 25.

Worthing.—The Corporation invite tenders for (1) supply and erection of one dry-back marine type steam-boiler with fittings; (2) supply and erection of steam feed, drain, and other piping; (3) supply of vulcanised bitumen-sheathed feeder and pilot cables; (4) supply of stoneware conduits. Tenders by 12 noon on 24th inst.

Ebbw Vale (Mon.).—Tenders are invited for the following, for the Ebbw Vale Urban District Council: (Section A) cables; (B) overhead lines; (C) street lamps and fittings; (D) meters. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders to the Clerk of the Ebbw Vale Urban District Council by 12 noon on Aug. 5.

Dublin.—Tenders are invited for the supply of three electric locomotives for haulage of refuse wagons on the city tramways; nearly 1,000 yards run of street tram tracks and electricity mains, overhead trolley wires, with street posts and connections; two electric and one steam capstan, etc. Specification, etc., may be inspected at the office of the city engineer, Mr. Spencer Harty, City Hall, Dublin. Tenders to the Chairman, Cleansing Committee, 3, Cork-hill, Dublin, by 12 noon on July 25.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23. See advertisement.

RESULTS OF TENDERS.

Loughborough.—The tender of Gent and Hurley, Leicester, at £386. 14s. 7d., has been accepted for an installation of telephonic communication between the various departments and works of the Corporation.

London County Council.—The tender of Mountain and Gibson, Bury, amounting to £2 360, has been accepted for four electrically-driven watering cars, with Westinghouse equipments similar to those fitted on the Council's electric tramcars.

King's Lynn.—The Town Council have accepted the following tenders for the electricity works: A. Dodman and Co., six fuse boxes at £3. 3s. 6d. each, six surface covers at £1. 15s. 9d. each; Pattrick and Thompsons, creosoted boards required for laying over the new cables, £6. 3s. 9d.; C. Copley, Limited, slack coal, 8s. per ton in summer and 8s. 6d. in winter.

Barrasford Sanatorium.—Messrs. Falconer, Cross, and Co., 4, St. Nicholas-buildings, Newcastle-on-Tyne, report an order for the complete installation of electric light and bells at the Barrasford Sanatorium, Northumberland, which is being built for the Newcastle-on-Tyne and Northumberland Branch of the National Association for the Prevention of Consumption, the work being carried out in accordance with a specification by Shepherd and Watney, of Leeds.

Ossett.—The Corporation have provisionally accepted the following tenders for the electricity works on condition that the Local Government Board sanction borrowing powers for the necessary works—viz.: Willans and Robinson, Rugby, engine, £1,115; Greenwood and Batley, Leeds, dynamo, £760; Electrical Power Storage Co., London, storage battery, £991; Spagnoletti and Co., London, switchboard, £314; Morris and Bastert, Loughborough, crane, £134; Johnson and Phillips, Old Charlton, cables, £1,402.

Cables.—Messrs. Johnson and Phillips, Old Charlton, report the following recent contracts: Belfast Borough Council, ·3 and ·1 vulcanised indiarubber cables; Eastbourne Corporation, high-tension concentric and low-tension triple-concentric paper-insulated cables; Gibraltar (Crown Agents for the Colonies), high and low tension concentric paper-insulated lead-covered cables, twin ditto, single ditto, and concentric and single vulcanised indiarubber cables; also for a quantity of junction boxes of various sizes.

BUSINESS NOTES.

TRACTION.

Perth.—About £500 is to be expended on tools for the repairing of the Corporation's tramway cars.

Manchester.—The Tramways Committee are considering the question of issuing weekly tickets.

Sunderland.—The Sunderland Tramways Committee are discussing the question of laying lines over the new Wear bridge.

Geneva Tramways Co.—The traffic receipts for the month of June, 1905, were 191,840fr., showing an increase on 1904 of 5,438fr.

Blackpool Electric Tramways (South).—A meeting of stock holders will be held at the Grand Hotel, Blackpool, on July 24 at 2.45 p.m.

Plymouth.—The Tramways Committee have been requested to consider and report upon the advisability of establishing a system of ½d. trams.

Paisley.—The Town Council have decided to approach the Paisley District Tramways Co. with regard to the establishment of a smooth service between the east and west ends of the town.

Stoke-on-Trent.—The Light Railway Commissioners have granted an application to the North Staffordshire Railway Co. for permission to use nine of its mineral branches for passenger traffic.

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Ramsbottom.—Messrs. Butcher and Barlow intend to apply to the Board of Trade for an extension of time in which to carry out the provisions of the Ramsbottom Tramway Order of 1903.

Glasgow Tramways Bill.—The Glasgow Corporation (Tramways Consolidation) Order Confirmation Bill is opposed by the National Telephone Co., Renfrew County Council, and Dumbarton County Council.

Swiss Railways.—A Laffan telegram states that the big Oerlikon engineering works, in conjunction with the German firm of Siemens and Schuckert, have completed a project to substitute electric traction for steam on all the federal railways.

Blagdon and Pensford Light Railway.—An inquiry has been held by the Light Railway Commissioners with regard to the Blagdon and Pensford light railway at the Pelican Hotel, Chew Magna. The Commissioners agreed to recommend the granting of the order.

Rochester.—Owing to the success of the trams from Chatham to Rochester, the Corporation have decided to at once extend the system to Borstal, a rural part of the city, at an outlay of upwards of £20,000. Upon completion, the lines are to be leased to the Chatham Light Railways Co.

Burton-upon-Trent.—Mr. Rowland stated at the last Town Council meeting that the reduced tramcar service in the mornings had only resulted in a reduction in the receipts of £2 per week. Previously the receipts had dropped to 4½d. per car mile for the period mentioned, but now they were 6·20d.

Leith.—It is doubtful whether the first section of the electric tramways will be opened this month owing to delay in connection with the equipment. There is a proposal before a sub-committee that workmen's tickets, available at any time of the day, be issued in bundles at a rate of 10d. per dozen 1d. tickets.

Edinburgh Suburban Electric Tramways.—An inquiry will be held in the County-buildings, Parliament-square, Edinburgh, to-day, at 10.30 a.m. The order is one incorporating the Edinburgh Suburban Electric Tramways Co., and empowering that company to make and maintain tramways and other works, and for other purposes.

Reading.—Plans have been prepared and arrangements have been made for improving the tramway lines at the junction of London-street with London-road, and also at the corner of the Craven-road and London-road, where the sharp curves in the tramway lines have caused frequent delays and inconvenience. An expenditure of about £500 is required.

Aberdeen.—Colonel von Donop, of the Board of Trade, on Saturday inspected the new tramway line in Bridge-street and Guild-street, Aberdeen, and also the portions of the line that have been doubled in Holburn-street and King-street. He expressed himself satisfied with the lines, and it is understood that he will give his sanction for their use.

North Metropolitan Tramways.—A further section of the recently-electrified tramway system connecting Finsbury Park and Stamford-hill with Lower Edmonton was opened on Wednesday. This completes the electrification of the whole of the 8½ miles of tramways in Middlesex acquired by the Metropolitan Electric Tramways from the North Metropolitan Tramways Co.

Blyton and Frodingham Light Railway Order.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of a light railway in the county of Lincoln from Blyton to Frodingham. Objections, addressed to the Assistant Secretary (Railway Department), Board of Trade, Whitehall-gardens, London, S.W., must be lodged with the Board on or before Aug. 4, 1905.

City to Waltham Abbey.—Mr. Gair Ashton's Committee of the House of Commons has passed the preamble of the North-East London Railway Bill, subject to the promoters constructing the tubes from the Monument to Hackney at such a depth as to admit of another pair of tubes being constructed above them. The workmen's fares between the City and Walthamstow must not exceed those charged by the Great Eastern Railway Co.

Woking and Bagshot Light Railway.—In consequence of an inquiry held on Monday, the Light Railway Commissioners have decided to recommend that the application of the West Surrey Light Railway Co. for the Woking and Bagshot Light Railway (Extension) Order be acceded to. This amended order only refers to 1½ miles of line between Horsell and Woking Junction, and to the erection of a generating station not exceeding 5,000-h.p. capacity.

Salford.—The total tramway receipts for the week ended July 17 amounted to £6 155, being about £1,500 more than the normal week's receipts, and the highest yet recorded. On the day of the Royal visit £1,405 was earned, and this also was a record for a single day's receipts. The traffic arrangements worked most satisfactorily, and, notwithstanding the large number of people who congregated each evening to witness the progress of the illuminated car, there has not been the slightest accident.

Devonport.—At a mass meeting held in the Victoria Park, Plymouth, to consider a resolution in regard to the Unemployed Bill, Mr. A. N. Stroud (Devonport) adversely criticised a system in connection with the tramways. This he described as follows: "Under that system if a man got 100 good marks he was entitled to a bonus of £1 a year, and if he got 100 demerit marks they entitled him to the sack." The marks were given by the inspectors. We need not trouble our readers with the rest of the remarks.

City and South London Railway Co.—The accounts for the half-year ended June 30 show a balance, after providing for the debenture stock interest, the payment of the dividend on the preference stocks, and the transfer to the renewal fund of £1,500, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £1,041. The dividend for the corresponding period last year was at the rate of 2½ per cent. per annum, carrying forward a balance of £701.

Cannock Electric Railway.—An inquiry has been held into an application to the Light Railway Commissioners by the Wolverhampton and Cannock Chase Railway Co. for an order authorising them to construct and work their projected railway as a light railway. The line is to be worked by electricity for mineral and passenger traffic. This order does not give the company power to supply electricity to adjacent collieries, and they will be open to treat with companies for power to themselves. The Commissioners decided to recommend the granting of an order.

North-East London Railway Bill.—Mr. Ashton's Select Committee of the House of Commons have inserted in this Bill clauses requiring the promoters to provide for the construction of the railway in such a manner as to give an additional pair of tube tunnels. A section was also included to cause the powers of the company to cease unless half the share capital had been subscribed in a *bona fide* manner within 12 months of the passing of the Act. The promoters were likewise required to construct at least two stations in the City and to carry workmen from Forest-road, Walthamstow, to the City and back for 2d. by trains arriving at any of the City stations up to seven o'clock in the morning.

Maidstone.—The adjourned inquiry by Sir Herbert Jekyll into the provisional order granted by the Light Railway Commissioners for the extension of the tramway system in Maidstone to Loose, *viâ* Gabriel's-hill and Stone-street, and to Penenden Heath, *viâ* Week-street and Boxley-road, was concluded on Wednesday week. Sir H. Jekyll said he should not attempt to give them any intimation that day as to what the Board's decision would be. Major Pringle had been down since the previous hearing, and inspected the proposed route. His report, together with the evidence which had been taken, would help them in coming to a decision, which would be communicated to the proper authority as soon as possible.

Newcastle.—The Tramways Committee have decided by a majority of 14 votes to 3 not to use the cars for advertising purposes at the present time. A sub-committee is to wait upon the Tyneside Tramway Co. to confer with regard to the difficulty in connection with working the trams at Fisher-hill, Walker. The general manager (Mr. Ernest Hatton) has been asked to report regarding the use of tokens by tramway officials and other persons connected with the Corporation, as complaints had been made to the committee that these tokens were being used by many when not travelling on Corporation or tramway business. Mr. Hatton's first quarterly statement of the result of the working of the trams for the first 13 weeks of the present financial year shows a profit of about £6,000 for that period. Mrs. Hudson, who had been injured by falling from a tramcar, is to receive £100.

Belfast.—At the last Electricity Committee meeting it was reported that 94 new cars were ready, and it is expected that the full number will be completed by the time the new system is ready for opening. Mr. Courtenay, tramway advertising contractor, attended in regard to the matter of advertisements on the new electric tramcars. He explained that his lease expired with the old company, but that there were still two years to run on the original lease. He had paid £1,400 per year as rent, and as the lease was not continued, he would be at a great loss of money, as many of his contracts had not yet expired. The committee, while expressing themselves against the idea of permitting advertisements to appear on the new tramcars, agreed to allow Mr. Courtenay to fit up one of the new cars for the committee's inspection. Quite a number of the old tramway routes are now closed for reconstruction.

Swansea.—The Swansea Tramways Co. consider that they should be rated as railways generally as far as the portions from Port Tennant to Bryn-road and from Mansel-street to Sketty are concerned. The Corporation contend that they are rateable in full. When the matter came before the Swansea Finance Committee on Friday, it was reported that the Wakefield and District Light Railways Co., who operated about 20 miles of track in Wakefield and the surrounding district, had refused to pay the district rate in full, and the Wakefield Corporation suggested that Councils interested should join in paying the costs of a test case. The Finance Committee have agreed to contribute towards the cost of a test case, provided the facts on which the Wakefield case is fought are parallel to the Swansea case. Several towns and districts have agreed to support Wakefield, and other places similarly affected are inquiring what support has been given to the proposal. It was decided to accept the tramways company's quarter on account.

Cardiff.—At Friday's meeting of the Tramways Committee, Mr. J. W. Courtis, in referring to the accounts for the year ended March 31 last, said the expenditure was put down at £113 390, showing a deficiency of £1,181, but there was £1,500 charged for uniforms in last year's accounts, which would not occur again for two or three years, and there was an accident fund to which 2½ per cent. had been contributed, realising £2,605, although the expenditure out of this fund for the last three years had averaged under £800. There was a sum of £25,000 in the reserve fund, notwithstanding the fact that all repairs and renewals had been paid out of revenue. The receipts were about £2,000 below the estimate of the manager, Mr. Ellis, apparently due to the general depression in trade throughout the country. This year the improvement which had taken place during the last three month, owing to the rearrangement of fares and distances, would be felt to a very much larger extent. Last year the cars carried 24,000,000 passengers, or 133 times the population of Cardiff, reckoning that at 180,000. The car mileage was 275 000 miles. It might be interesting to know that out of the 24,000,000 passengers, 22,500,000 took 1d. tickets, and only 130,000 1½d. tickets. They had carried 3 000,000 passengers on the Splott to Olive-street route for an average of 7·78d. per car mile, and the expenditure was, including loan charges, 9·1d. per car mile. The running charges—that is, leaving out loans—worked

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out at 5·8d. per car mile. The loan charges came to 3·3d., making the total 9·1d. The most profitable routes were Penylan, where the takings were 10·6d. per car mile, and Fair Oak-road, where the takings were 11·21d. per car mile. Broadway returned 10d. The committee agreed that some of the charges should be spread over two or three years, and in consequence, the accounts show a credit balance of £20. 17s. 6d., after setting aside £2,605. 5s. to the insurance fund, which now stands at £5,147.

Sheffield.—The report and accounts of the Corporation tramways for the year ended March 25, 1905, shows that a sum of £37,131 has been spent out of income in general repairs and maintenance during the year. The report shows the capital account as follows: capital expenditure to March 25, 1904, amounted to £988,316; deduct written off this year for depreciation of old horse track, £2,456—£985,860; expenditure during the year has been £57,721, showing a total capital expenditure to March 25, 1905, of £1,043,581. The income was £242,851. Receipts from passengers amounted to £240,565, an increase of £8 214. 7s. compared with last year. The total working expenses were £163,283, compared with £156,402 last year, an average cost of 6·477d. per car mile run. as compared with 6·507d. per car mile for the year ended March 25, 1904. After taking off £62,241 charges for interest on stock, mortgages, street improvements, sinking fund, etc., there is a surplus of £17,326 to be transferred to the accumulated surplus account. The following figures are available: total borrowing powers, £1,158,843. 12s. 4d.; borrowing powers exercised, £1,132 467. 15s. 2d.; unexhausted borrowing powers, £26,375. 17s. 2d.; gross capital expenditure, £1,135,565. 10s. 6d.; traffic revenue, £240,565. 16s. 11d.; working expenses, £163,283. 2s. 9d.; interest on capital, £40,027. 3s. 11d.; sinking fund, £23,954. 10s. 6d.; net balance, £41,341. 4s. 3d.; which has been disposed of as follows: sinking fund, £23,954. 10s. 6d.; depreciation, £60; surplus account, £17 326. 13s. 9d. Passengers carried, 63,952,283; total cost per unit, ·767d.; number of units used per car mile, 1·720; percentage of working expenses to receipts, 67·235; average traffic revenue per car mile, 9·543d.; average working expenses per car mile, 6·477d. Scale of fares—average distance: ½d. half mile; 2½ miles, 1d; average per mile, ½d. Number of cars in stock, 248. Total sinking fund, £138,829. 11s. 2d.; sinking fund applied in reduction of debt, £95,727. 15s. 3d.; reserve or renewals fund, £46,946. 10s. 6d.

London County Council. — The Highways Committee have submitted the following report: "The Council has recently decided to proceed with the construction and equipment of certain new tramways which have been authorised from time to time, and also with the reconstruction of the northern route of the late South London Tramways Company's system. It is, therefore, necessary to consider the question of obtaining the additional cars which will be required for use on these lines. In addition, the present car services can with advantage be considerably increased when the Greenwich generating station is opened, which will probably be early in 1906. For these purposes we suggest that steps should at once be taken for the supply of 150 cars. In connection with the tramcars used upon the Clapham route, there has been difficulty in arranging for the construction of roof covers that would pass under the bridges at Clapham and Balham, which have a specially low headway. As new cars have now to be purchased, we think that it will be desirable to arrange for the purchase of cars of a special type which can be utilised on the Clapham route as well as on the other lines. The type of car which we have inspected and suggest should be used for the Clapham lines has an inside headway of over 6ft. The cover is constructed for the whole of the car roof, ventilation being obtained by means of openings in the windows at either end as well as by the sliding glass sides. The arrangement of seats on the top of the car provides accommodation for two additional passengers. The staircases are of the direct pattern, and meet the views of the Commissioner of Police with regard to the side view of the motormen. The total expenditure is covered by the several estimates approved from time to time for the provision of cars in connection with the construction and reconstruction of tramways. We have arranged that the specification for the supply of the cars shall provide for the submission of alternative tenders for (1) the car bodies; (2) the car trucks; and (3) the motor equipments, etc., as we think that this will be an economic course to adopt and may facilitate delivery. We recommend (*a*) that expenditure on capital account not exceeding £126,000 be sanctioned in respect of the purchase of 150 double-decked, roof-covered electric cars for use on the London County Council tramways; (*b*) that the Highways Committee be authorised to obtain tenders, and to take the other preliminary steps necessary in connection with the obtaining of the cars referred to in the foregoing resolution."

Trams over Bridges.—It will be remembered that the second reading of the Bill in which the London County Council sought powers to construct and work tramways over Westminster and Blackfriars Bridges and along the Victoria-embankment, and joining up the existing lines on the Surrey side, was only saved in the House of Commons by the casting vote of the late Speaker, and the late Speaker sent it to a Select Committee, who passed it subject to an arrangement between the City Corporation and the authorities at Spring-gardens with reference to Blackfriars Bridge. Subsequently such an arrangement was come to at a prolonged sitting of the Court of Common Council. On Monday, Lord Newton unsuccessfully asked that this stage might be postponed until Thursday. He said the Bill had only just come before their lordships, and as he understood there was to be a motion for its rejection on the second reading, it was desirable that they should have a little more time to consider it. The Bill came before the House of Lords on Tuesday, and was rejected by a majority of 31, 97 peers voting. From a report in the *Daily Telegraph* we gather that Viscount Ridley said the leading feature of the Bill was most objectionable. Many attempts had been made to bring the tramways over the bridges, but till this year that power had invariably been refused. This year the second reading was only carried in the House of Commons by the casting vote of the Speaker. But the Bill now before them was a very different measure to the one which the House of Commons read a second time. It would do no good to anyone, would cause extraordinary inconvenience, and would retard that improved facility for traffic which they all desired. In the first place, it sought to connect on the other side of Westminster Bridge two existing tramlines, and when these would be running on a half-minute service over the bridge, it would be easy to imagine how greatly the ordinary traffic over the bridge to Waterloo Station would be interfered with. Then when the lines got over the bridge they would run on to the Embankment at a distance of only 2ft. from the pavement, an arrangement which would most seriously interfere with the traffic on this side of the bridge. Then it ran along the Embankment, on which for the purposes of beautifying London the ratepayers had spent a million not many years ago. Finally, it would turn on to Blackfriars Bridge, again at a distance of 2ft. from the pavement, and once more to the serious inconvenience of the traffic in that place. He was desirous of supporting the extension of tramways, and his opposition to this measure was not at all directed to the fact that these tramways were proposed by any particular body. If these lines were to connect the north with the south there would be something to say for the scheme, but that was the very part of the Bill which was thrown out by the House of Commons Committee. These lines were not only inconvenient but useless, and could not be carried out without further legislation, for before the County Council could proceed to construct them the City Corporation would have to obtain power to widen Blackfriars Bridge. This was clearly not a moment to add to the already existing complications of London street traffic by the multiplication of interests and systems of traffic, and so to create new difficulties. Nobody could say at this moment that the motor omnibus would not supersede the tramway. The Lord Chancellor said it was a mistake to say that the Commission was in favour of the scheme. What they did was to go with great care and minuteness into a system of tramways that might be arranged so as to be of great public advantage. They did not see the necessity of tramways across the bridges except as part of a great big scheme. In his opinion there was not sufficient case made out for the Bill. He regarded with considerable apprehension a scheme which would give to the County Council such enormous power, although he did not distrust the present Council. The traffic of London, which was always increasing, would be still further inconvenienced by such a system of tramways. Viscount Ridley has sent the following highly interesting letter to the editor of the *Times*: "Sir,—Will you allow me to make clear through your columns a point which no report of yesterday's proceedings on the London County Council's Tramways Bill in the House of Lords makes sufficiently apparent? The Bill dealt with several new tramlines, three of which were uncontested and not very important. I moved the rejection of the Bill because of two new lines only—those, namely, to be made across Blackfriars and Westminster Bridges and down the Embankment. In the course of debate it appeared that much importance was attached by the London County Council to certain new tramlines which nobody desired to oppose, but which, on the motion which I had made for the rejection of the Bill, would have suffered the same fate as the lines we did desire to oppose. I thereupon, at the suggestion of Lord James, offered to withdraw my motion and allow the second reading to proceed on the understanding that I should be allowed to move an instruction to the committee to strike out the tramlines to which objection was taken, thus allowing the uncontested tramlines to be gone on with. Objection was taken to this course by peers sitting on the front Opposition bench, and no option was accordingly left to me but to throw out the whole Bill. The responsibility, therefore, for delaying the construction of the lines which were said to be required, and which no one wished to stop, must rest on those members of the front Opposition bench who refused to come to an understanding which would have secured the passage of the uncontested parts of the Bill, while enabling us to throw out the lines to which we objected.—I am, yours faithfully, RIDLEY."

LIGHTING AND GENERAL.

Tewkesbury.—The Bill confirming the Corporation's electric lighting order has passed the Examiners.

Perth.—The Electricity Committee have fixed the price of current for the electric tramways at 1½d. per unit.

Cheshunt.—The North Metropolitan Electric Co. are applying for an order to supply electric light in Cheshunt.

Honiton.—Messrs. Purvis, of Exeter, intend to apply for a provisional order for the electric lighting of the town.

Loughborough.—The Corporation have decided to introduce electric light into another of the principal squares of the town.

Radiographic Station.—The *Globe* says that a permanent radiographic station has been established at Ferrol, in Spain.

Ince-in-Makerfield.—The United Electric Light and Traction Co. intend to apply for an electric lighting provisional order.

Devonport.—A special committee is considering the lighting of the borough, including the lighting by electricity of Marlborough-street.

Shepton Mallet.—The Shepton Mallet Gas Co. (Electric Lighting) Bill has passed the House of Commons Select Committee on Unopposed Bills.

Cheltenham.—At the last Town Council meeting the question of Mr. Kilgour's successor was mentioned, and was reserved for a special motion.

Dundee.—It is proposed to remove the electric arc lamps opposite the town's offices in Commercial-street, and substitute a special type of incandescent lamp.

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Rugby.—An inquiry has been held into the application of the District Council for powers to borrow £450 for street-lighting and £2,000 for electric lighting.

Penzance.—It is proposed to empower a small committee to act in connection with the Penzance Electric Lighting Co. in obtaining an electric lighting provisional order.

South London Electric Supply Co.—The sale of current for the quarter ended June 30 last amounted to £16,620 against £15,654 for the corresponding quarter of last year.

Armstrong College, Newcastle-upon-Tyne.—Matriculation and exhibition examinations begin Sept. 25. Lectures begin Oct. 3, 1905. Full particulars appear in our advertisement columns.

St. Marylebone.—Plans by Mr. F. A. Wilkinson, electrical engineer and manager, showing positions of feeder pillar boxes it is proposed to erect in the streets of the borough, have been agreed to.

Stafford.—Arrangements are being made with the Tudor Accumulator Co. for the renewal of the battery at the electricity works during the current financial year, the estimated net cost being £800.

Whitehaven.—The Brush Electrical Engineering Co. intend to apply to the Board of Trade for a provisional order to supply electric energy for public or private use within the area of the borough.

Eton.—An application by the Postmaster-General for consent to place an underground telegraphic line along the road from the Council's boundary at Salt-hill to the Slough Post Office has been granted upon the usual terms.

London Electric Supply Bills.—The County of London Electricity Supply Bill was on the 19th inst. ordered to be reported for third reading. The Central Electric Supply Bill will come before the Committee to-day.

Lowestoft.—The Town Council have decided to oppose that part of the telephone agreement which proposes to give the company power to lay underground cables in any part of the country without permission of the local authorities.

Dalkeith.—The minutes of the previous monthly meeting were confirmed on Monday after a prolonged discussion. They referred to a refusal to entertain a proposal of the Electric Supply Corporation to extend the public electric lighting along the Bonnyrigg-road.

Outing.—The employés of the Electrical Co. held their annual outing at the Crown Hotel and pleasure gardens, Broxbourne, Herts, on Saturday, July 1. Sports were held during the morning, and a number of excellent prizes were secured by successful candidates in the different races, etc.

Northampton Institute.—Full day courses in the theory and practice of mechanical, electrical, and horological engineering will commence on Monday, Oct. 2, 1905. Entrance examination on Wednesday and Thursday, Sept. 27 and 28. Full particulars in our advertisement columns.

Truro.—Four firms intend to apply for a provisional order to supply electricity within the Council's area. The Electric Light Committee's report recommending the Council to permit a company to instal the electric light in the city, the Corporation applying for the necessary provisional order on terms to be agreed upon, has been rejected.

Tiverton.—As nothing further has been heard from the Local Government Board with respect to the loan applied for for the electric lighting scheme, the Government inquiry into which was held nearly a year ago, the Council have decided to send a deputation to the Board to ascertain definitely whether or not the loan would be sanctioned.

Falkirk.—The British Electric Plant Co., Alloa, have obtained an order from the Corporation for the complete equipment of electric motors for their new gasworks. These gasworks are probably the first in Great Britain to be completely and exclusively driven throughout by electric motors. The current will be supplied from the Corporation electric supply station.

New Issue.—Subscriptions are invited at par for 23,000 shares of £1 each in the "Otto" Electrical Manufacturing Co. (1905). The company, which has a capital of £75,000, has been formed to acquire and extend the business of the "Otto" Electrical Manufacturing Co. The business consists of the machinery and plant and patents belonging to the old company. There are works at Stockport-road, Longsight, Manchester.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Durham Collieries Electric Power Co.'s 100,000 6 per cent. cumulative preference shares of £1 each. The committee have been asked to allow Sunderland District Electric Tramways £160,000 5 per cent. first mortgage debentures of £100 each to be quoted in the official list.

Brighton.—The accounts of the electricity undertaking for the past year show a gross profit of £36,565. The net surplus, after providing for all charges, including interest on capital and sinking fund, contributions for the redemption of debt, is £5 381. This sum it is proposed to carry to the reserve fund, which will then amount to £21,112. The number of consumers at the end of the year under review was 4,256, against 4,037 in the previous year.

Edinburgh.—At the Town Council's last meeting the recommendation with regard to the distribution of the £21,000 balance on the electric lighting accounts was carried, with the amendment that the £4,000 be credited to the relief of rates instead of the streets account, as formerly proposed. Mr. Macpherson pointed out that the 7,250 consumers of current, who had contributed £119,350, had already paid their quota towards the maintenance of the streets.

Accidents.—At the Westinghouse power station at Neasden, John O'Malley, electrician, Willesden, and a boy named Martin Ruddy, of Willesden, on entering one of the transformer chambers became entangled in live wires. O'Malley was instantly killed, and Ruddy, who was badly burned, was removed to the hospital. Late on Sunday night an accident occurred on the Birmingham and Midland Tramway Co.'s electric tramway at Oldbury. A car conveying about 25 passengers fell over on its side through missing the points at a loop. Fourteen of the passengers on the top of the car were injured. We understand that after being attended by medical men on the spot they were all able to return to their homes.

Islington.—It is proposed to alter the sliding scale of 7d. per unit for the first hour's daily consumption throughout the quarter at their maximum demand in the quarter and 4d. per unit for all consumption beyond to a sliding scale of 7d. and 3d. per unit respectively. Further, it is proposed that the present uniform rate of 5d. per unit for lighting be reduced to 4d. per unit; that the price to private consumers for arc purposes be 3½d. per unit; that the present rates for the supply of electricity for power, heating, and cooking purposes be altered from 2d., 1½d., and 1½d. to a uniform rate of 1d. per unit; that the time limit in the case of supply of electricity for power be abolished; that the rate be uniform throughout the 24 hours; that a discount of 2½ per cent. be allowed on all quarterly accounts exceeding £5, and of 5 per cent. on all quarterly accounts exceeding £10, provided such accounts are paid within 14 days of presentation; and that the foregoing charges take effect as from the end of next September quarter.

J. G. White and Co.—This well-known contracting company, which has constructed the permanent way and other electric traction and supply equipments for a large number of important undertakings in the United Kingdom and abroad, is about to offer for subscription 5,000 6 per cent. preference shares of £10 each, making its total capital £200,000. The contracts actually completed since the formation of the company in 1900 represent an aggregate value of £2,113,200, while further contracts have been secured and are now in hand equal to £1,779,000. The proceeds from the present issue are to be used to extend the general business of the company and partly to complete the Ritz Hotel, now under construction by the Waring-White Building Company. The preference shares are entitled to a further share of the profits up to 12 per cent. after the ordinary shares have received 6 per cent. The actual rate already paid has ranged from 6 to 10 per cent. Further details of the issue will be found elsewhere. The list will close on or before July 27, 1905.

Bermondsey.—Mr. Heenan, the newly-appointed borough electrical engineer, took up his duties on Friday, June 30. The Electric Lighting Committee have expressed their high appreciation of the manner in which Mr. Doran, the chief assistant electrical engineer, had superintended the undertaking between the departure of the former chief engineer and the arrival of his successor. The committee recommended that his salary be increased to £200 per annum, but in consequence of a standing order of the Council applications for increase can only be considered in February of each year. The highest load observed in June was 432 kw., as against 209 kw. for the corresponding month of last year. The expenditure of the year ending March 31, 1905, was £10 875 and the income £12 015. The cost per unit sold for coal and fuel was ·45d.; for oil, waste, water, and engine-room stores, ·04d.; wages, ·16d.; repairs, ·08d., or a total works' cost of ·73d. The committee estimate that the expenditure for the year ending March 31, 1906, is £16,208, and the outgoings £13,906 or a surplus on the forthcoming financial year of £2 302. From Oct. 1 next the charge for power purposes is to be 1½d. per unit for the first four hours' average daily use of the maximum demand, and ¾d. per unit for all electricity consumed after.

Institute of Marine Engineers.—The Institute of Marine Engineers on July 15 visited the United Asbestos Co.'s works at Hatefield. The works are excellently situated on the banks of canal, which affords a means of transit for goods, and the employés carry on the work under conditions which contrast favourably with those within the confines of a densely-populated district, while the employers are more free from the burden of taxes which in many cases is a factor to be considered in making a business a profitable investment, or a municipality the poorer for the lack of it. The process of manufacture of asbestos is of considerable interest, and may be briefly described. Blocks of the crude asbestos are placed in a crushing machine where the fibres are separated. These are then sorted out and taken to different departments according to their suitability. In one department the fibres are spun into yarn and afterwards woven into cloth, or interwoven with wire and made into various forms of packing for steam glands. The spinning and weaving machines attracted a great deal of attention. The manufacture of joints for manhole doors and covers was watched with keen interest, as was also the making of asbestos millboard from the pulp, which is deposited on blankets, and is from thence taken up by a specially prepared roller on which the pulp is deposited to a desired thickness, shown by a gauge suspended from a bracket. The sheets of millboard are then cut and ready for drying. The laboratory is a special feature in connection with the works, where careful tests are carried on to prove the quality of asbestos, indiarubber, and other raw materials used in the manufacture of the various articles. After the inspection the party was grouped, and a photograph taken, and a souvenir of the visit presented to each member of the party, which contained samples of asbestos in its various stages of manufacture. After luncheon a vote of thanks was accorded to the United Asbestos Co. for their kindness, regret being expressed that Mr. Fisher, the secretary and general manager, had not returned from abroad in time to preside over the gathering. Mr. Hawkridge, the assistant manager, acting in his stead. A vote of thanks was also given to Mr. McCallum, the works manager, and his staff for the explanations which were so freely given to enquiries. A very interesting paper dealing with this subject was read by Mr. S. H. H. Barratt, A.M.I.C.E., lubricant and boiler covering manager, who gave particulars of numerous tests.

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Arlecdon and Frizington.—At the last District Council meeting an offer was favourably discussed in which it was stated that the West Cumberland Electric Power and Tramways Company were about to start almost immediately to lay the road and generating station, from which current would be supplied at very reasonable rates to all parts of West Cumberland.

Telegraph Clerks.—The Liverpool Branch Committee of the Postal Telegraph Clerks' Association have passed a resolution deprecating the language used by the Postmaster-General in the House of Commons on the occasion of the debate on the Post Office Estimates on the 6th inst., and emphatically repudiating his charges of "blood-sucking" and "blackmailing" by Post Office servants.

Opening of Manchester Dock.—Messrs. Dorman and Smith inform us that the switch used to open the new dock at Manchester by his Majesty the King on the 13th inst. was made for the Ship Canal Company by them. This switch was one of their "C" type. They point out that their switches are good enough for kings as well as strong enough for navvies. The actual switch used by his Majesty is now to be seen in Messrs. Elkington's window, St. Ann's-square, Manchester.

Fire.—In reference to the slight fire which occurred at Verity's Limited on Saturday, we are informed that fortunately the damage done is of the most trivial description, and in no way interferes with the ordinary course of the business. The portion of the premises affected is only a skylight in the centre of one of the fittings showrooms, underneath which some drapery caught alight, presumably due to spontaneous combustion, caused by the heat rays of the sun on an uneven piece of glass.

Walsall.—According to the last report the total number of consumers supplied on June 30 last was 419. During the past month the total units generated at the station was 106,980. The total output from the main generators were 103,530 units. The total units from the transformers were 79,728 (estimated). The total units registered on the meters were 79,232. The machinery was run for 686 hours. The wages paid amounted to £124. Sanction has been received to the borrowing of £1,350 for electric lighting purposes.

Swanage.—At the last meeting of the Urban District Council letters were read from Cecil Cooper and Co., electric light and power engineers and contractors, 14, Gloucester-road, South Kensington, London, S.W.; Foot and Milne, electrical engineers and contractors, Princess-mansions, 66, Victoria-street, S.W.; and the Bournemouth and Poole Electricity Supply Co., Moorgate-court, Moorgate-place, London, E.C., stating that it was their intention to apply during the ensuing session of Parliament for electric lighting provisional orders within the district.

King's Lynn.—The engineer's last report shows new applications for 305 8-c.p. lamps, making a total of 21,279 from private consumers, and four additional consumers, making a total of 523. The following figures are available: **May**, 1905—units generated, 30,795 (1904, 28,424); total units sold to private consumers (light and power), 14,769 (13,534); units sold at lighting rates, 5,541 (4,525); units sold at power rates, 9,228 (9,059); cost of fuel, stores, repairs, and wages at station, £118. 4s. 7d. (£118. 15s. 2d.); cost per unit generated, 0·9215d. (1·0027d.); wages of lamplighters and outside staff, £28. 14s. 11d. (£28. 10s. 9d).

Radcliffe.—The electrical engineer's last report shows that the electricity generated during May was as follows—viz.: lighting section, 5,100 units; tramways, section No. 1, Stopes and Black-lane, 8,453 units; No. 2, Blackburn-street, 3,814 units; No. 3, New-road, 3,454 units—total, 15,721 units. During the month the works had worked satisfactorily. The Council have refused the Lancashire Electric Power Co. permission to supply electricity to The Hawthorns, Ringley-road, but have confirmed the arrangement made by the surveyor with the company to allow them to carry their cables over the canal by means of the Council's footbridge, on payment of a wayleave of 5s. per annum.

St. Pancras.—The Borough Council has for some time supplied electric current for motive power at 1d. per unit during five hours of the day, and they have now decided to charge up to 24 hours the same rates as those specified in the Administrative County of London and District Power Bill, ranging from 0·94d. per unit for six hours to 0·609d. per unit for 24 hours—*i.e.*, 1½d. per unit for the first two hours' average use per day of the maximum demand and ½d. per unit for all in excess of this. This works out at 1d. per unit for a five-hour regular load per day. Factories using current will be allowed after Aug. 1 to light their premises at 1d. per unit up to 20 per cent. of the units they have used for power.

Underground Telegraph.—The Middlesbrough Chamber of Commerce last week discussed a letter in which Lord Stanley said that there was no present intention of continuing underground telegraph lines northwards from Leeds. Edinburgh would be reached by an extension of the main line, and not through the North-East Counties. The secretary referred to a statement made by Mr. Austen Chamberlain, as Postmaster-General in 1903, in a communication to the Associated Chambers of Commerce, which was to the effect that the pipes would be extended to Carlisle, Bradford, and Leeds, and eventually to Newcastle and other Tyneside towns. It was decided to call the Postmaster-General's attention to this discrepancy between his statement and that of his predecessor.

Birmingham.—The Electric Supply Committee have had under consideration several important questions relating to works of extension rendered necessary by the Corporation tram scheme. The site of the old General Hospital in Summer-lane is being utilised for the provision of a large generating station, but in order to furnish the several tram routes with the required electrical power when the Corporation takes over the trams, it will be necessary to provide several sub-stations centrally situated so far as the several routes are concerned. Thus for the Dudley-road section it has been decided to erect a sub-station in Rosebery-street, and other similar stations are to be established in Upper Trinity-street and Lower Edward-street. The expenditure for which the committee will ask authority will be about £50,000.

London Gazette.—The partnership between Joseph Blanchet Rowell and John Arthur Henderson, electrical engineers and contractors, 19, Old Queen-street, Westminster, has been dissolved by mutual consent. Thomas Hindle, chartered accountant, District-chambers, Darwen, has been appointed trustee in the estate of Alexander Holmes and Alexander McCallum, electrical engineers, Crown Works, Darwen. Arthur Samuel Cully, 24, Railway-approach, London Bridge, S.E., has been released from trusteeship in the estate of William Denham, electrical engineer, 5, Century-buildings, London-road, Croydon, Surrey. The partnership between William George Leather, Thomas Hanson Cockin, and William James Riley, trading as the Windus Electric Company, at 25, Howard-street, Sheffield, has been dissolved, and the business will be carried on by the said William George Leather solely.

Bath.—Mr. Evans's notice of motion has been withdrawn. It reads as follows: "That in consideration of the excessive charge now made for the public electric lighting in Bath, it is desirable in the interest of its ratepayers that the charge per lamp be immediately reduced by one-half—viz., £12 each for the large arc lamps, and all smaller lamps charged proportionately, or failing this reduction, gas be substituted for lighting the whole area now lighted by electricity." He asked for permission to withdraw the last part from the words "proportionately" to the end. At the last Town Council's meeting a report of a special committee was adopted, recommending that the Surveying Committee be asked to provide private lines between the surveyor's office and the destructor works, the stables, and Dog-lane and Greentree yards; and that when these are constructed the present National Telephone service for the destructor works be discontinued. The cost of the whole of the work in connection with the lines is not to exceed £120, and the upkeep is estimated at from £4 to £5 per annum.

PROVISIONAL PATENTS, 1905

JULY 10.

14146. Improved means for controlling the trolley arms of electric tramcars. John Coleman Fergusson and Frederick Hitch, 128, Colmore-row, Birmingham.

14196. Improvements in or relating to Rontgen tubes. Kurt August Steizel, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, July 11, 1904, being date of application in Germany.) (Complete specification.)

14208. Improved electrical switch apparatus for supplying current-consuming devices on several motorcars of electrically-propelled trains. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

14209. Improvements in apparatus for supplying electrical energy to a network by the aid of an auxiliary current generator and an auxiliary line wire. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

14210. Improved regulating switch apparatus for increasing or decreasing the pressure of a network in finely-divided stages. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

14211. Starting apparatus with controller drum for induction motors. Siemens-Schuckertwerke G. m. b. H., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 3, 1904, being date of application in Germany.) (Complete specification.)

14214. Improvements in electric furnaces. Fredrik Adolf Kjellin, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 11, 1904, being date of application in Switzerland.) (Complete specification.)

14221. Improvements in means for producing current or radiations for a transportable wireless transmitter station. William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft fur drahtlose Telegraphie G. m. b. H., Germany.) (Complete specification.)

14222. Improvements relating to the suspension of electric motors of locomotives. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States. (Complete specification.)

JULY 11.

8886a. Improvements in wireless telegraph transmitting apparatus. Harry Shoemaker, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, April 27, 1905.) (Complete specification.)

8886b. Improvements in wireless telegraph receiving apparatus. Harry Shoemaker, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, April 27, 1905). (Complete specification.)

14356. Electric heating cartridges. August Voelker, 100, Wellington-street, Glasgow.

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14293. Improvements in electrical heating apparatus. Charles McIntyre and Alfred Upton Alcock, 1, Queen Victoria-street, London.

14297. Improvements in surface-contact electric traction systems. Edward Albert Mitchell and the Dolter Electric Traction, Limited, 46, Lincoln's-inn-fields, London.

14314. Improvements in or relating to microphone apparatus for telephone and other circuits. Quirino Majorana, 111, Hatton-garden, London. (Complete specification.)

14317. Improvements in polyphase commutating machines. The Elektricitäts Act. Ges., vormals W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, July 11, 1904, being date of application in Germany.) (Complete specification.)

14318. Improvements in and relating to electric ignition gear for explosion motors. Gustave Cornilleau and Auguste Sainte-Beuve, 323 High Holborn, London. (Date applied for under Patents Act, 1901, Dec. 29, 1904, being date of application in France.) (Complete specification.)

14320. Improvement in single-phase alternating-current motors. Siemens-Schuckertwerke G. m. b. H., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 13 1904, being date of application in Germany.) (Complete specification.)

14333. Improvements in electric furnaces. Paul Girod, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 12.

6640a. Improvements in and relating to electricity meters. Carl Wilhelm John Busch and Hugo Roosen, 65, Chancery-lane, London. (Date applied for under Patents Rule 9, March 29, 1905.)

7822a. Improvements in and relating to controllers for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Date applied for under Patents Rule 9, April 12, 1905.)

12160a. Electrolytic process for obtaining fixed gases from any suitable carburant. Alexandre Auguste Eveno, 65, Chancery-lane, London. (Date applied for under Patents Rule 9, June 10, 1905.)

14345. Improvements in or relating to electric switches for use in connection with motor controllers, and for analogous purposes. The Electric and Ordnance Accessories Company, Limited, Robert Frederick Hall, and Joseph Richardson Garner, 24, Temple-row, Birmingham.

14366. Improvements in electric sparking plugs for internal-combustion engine ignition. Rankin Kennedy, 60, Norse-road, Scotstown, Glasgow.

14390. Improvements in the manufacture of electrical resistances. Charles Ruzicka, Olun House, Surrey-street, Strand, London.

14401. Improvements in alternate-current induction motors. Louis John Hunt and the Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool.

14417. Improvements in and relating to electrical connections for accumulators, induction coils, sparking devices, and the like. William Gard, 18, Southampton-buildings, Chancery-lane, London.

14420. Improvements in electrically-operated cranes, hauling gear, and similar appliances. George Robert Hingeberg, Daniel George Jones, Frederick Lawrence Berry, and Ellis Middleton, 47, Lincoln's-inn-fields, London.

JULY 13.

14441. Improved means for suspending and sustaining electric lamps and the like at any desired height. William Whitaker, jun., and Arthur Bright Wass, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, July 14, 1904, being date of application in United States.) (Complete specification.)

14457. Improvements in and connected with electromagnetic annunciators acting simultaneously as choking coils. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Akt. Ges. Mix und Genest, Germany.)

14461. Improvements in electric organ actions. Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

14465. Improvements in automatic cut-outs or switching devices for electrical indicating means. George Harrison, 11, Southampton-buildings, Chancery-lane, London. (The Electric Railway Improvement Company, United States.) (Complete specification.)

14466. Improved electric apparatus for interlocking electric signals and points. Edmond Meyer Tudor Boddam, 23, Savernake-road, London.

14471. Improvements relating to switching devices for use in electric flash advertising. Leonard Kingswill Job, 322, High Holborn, London.

14483. Improvements in automatic electric switches. James Joseph Coachman, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14490. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14491. Improvements in incandescent electric lamps and methods of making the same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

JULY 14.

14496. Improvements in electrolytic or liquid resistance apparatus for electric regulators, electric motor starters, or the like. Hugo Hirst and Charles Samuel Mathew Medlen, 71, Queen Victoria-street, London.

14511. Improvements in electricity meters. Sydney Holmwood Holden and Chamberlain and Hookham, Limited, 4, New Bartholomew-street, Birmingham.

14518. An improved system of electric ignition for gas or petrol engines and the like. Walter Shelverton Frost, 135, High-street, Homerton, London.

14526. Improvements in arc lamps. Bernard Mervyn Drake, 66, Victoria-street, Westminster, London.

14550. Improvements in or relating to electric alternating-current switches. Charles William Scott Crawley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14555. Improvements in devices for protecting electric distribution systems and apparatus against reversal of energy. The British Thomson-Houston Company, Limited, and Jonathan E. Woodbridge, 83, Cannon-street, London.

14566. Improvements in and relating to electric circuit interrupting devices. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

14567. Improvements in methods of regulating alternating-current dynamo-electric machines. The Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, July 15, 1904, being date of application in Germany.) (Complete specification.)

JULY 15.

14582. Improvements in or relating to low-tension electric ignition mechanism for internal-combustion motors. James Sidney Critchley, Woodbury, Church-road, Shortlands, Kent.

14612. Improvements in apparatus for use in combination with electric stop motions as used on drawing, slubbing, and other similar machines for preparing and spinning cotton and other fibrous materials. Thomas Chadwick, Penny Bank-chambers, Halifax.

14614 Improved electric stop motion for drawing, slubbing, and intermediate frames. Tom Schofield, 254, Colne-road, Burnley.

14615. Improvements in and relating to electric arc lamps. Crompton and Co., Limited, and Arthur John Hodgson, 55, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 3.

1904.

10748 Dynamos or the like. Vandervell and Proctor.

15312. Means for the manufacture of brasses or bushes for the bearings of shafts, axles, or the like, more especially applicable to electromotors. Tomson and Hanna.

15344. Automatic safety device, particularly applicable in connection with falling overhead trolley wires, or other wires passing over or running parallel with same Berry and Rush.

15384 Memorandum and like appliances for use in connection with telephones and for other purposes. Gamble.

15386. Mechanical and electrical elevator for goods, especially goods contained in sacks. Rubaudo, Estier, Estier, Mallet, and Mouren.

15455. Electric relays for automatic circuit breakers and the like. Field, Garrard, and Ferranti Limited.

15599. Electric alarm for indicating the heating of bearings. Thomson.

15627. Electric clocks Bowell.

15796. Alternating electric current distributing systems. Metz and Price.

16728. Compounding dynamo-electric machines for three-wire systems. (Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, July 31, 1903.)

17016. Control systems for electric translating devices, particularly adapted for use for controlling motors on electrically-propelled vehicles British Thomson-Houston Company, Limited. (General Electric Company.)

17425. Self-regulating dynamo-electric machines. Rosenberg and Rosenberg.

17674. Telephones. Port.

17813 Systems of electric motor control. British Thomson-Houston Company, Limited. (General Electric Company.)

18646. Electric plug and socket couplings. Richert.

18317 Electric switches. Kennedy-McGregor, and Wren.

18378 Combined electric switches and fuses. Hornby.

18840. Processes of electro-deposition. British Thomson-Houston Company, Limited. (General Electric Company.)

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18546. Electric incandescent lamps whereby two or more lamps are governed by one central connecting cap, or the like. Byng and Crawshaw.

18592. Electric railways. Carolan. (General Electric Company.)

19365. Metallic conduits for electric wires and cables. Isherwood.

19390. Casing or conduit for electric conductors. McHardy.

20783. Electrical telegraphs and controlling apparatus. Vyvyan and Newitt. (Secret document under Sec. 44, Patents, etc., Act, 1883.)

21217. Automatic telegraphic apparatus. Damaskinos.

22905. Electro-thermic fans. de Mare.

29145. Space telegraphy. Stone. (Date applied for under International Convention, April 11, 1904.)

29146. Support for aerial conductors used in space telegraphy. Stone. (Date applied for under International Convention, May 3, 1904.)

1905.

1072. Incandescent electric lamps. Gerow and Gerow.

1583. Induction regulators for electric currents. Finzi. (Date applied for under International Convention, Jan. 27, 1904.)

3525. Apparatus for producing electric reactions in gases by aid of electric arcs Birkeland. (Date applied for under International Convention, Feb. 20, 1904.)

3913. Apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line. Turchi and Bruné. (Date applied for under International Convention, April 2, 1904.)

5220. Vapour electric lamps. Thomas. (Date applied for under International Convention, March 28, 1904.)

8253. Electric light hanger for walls. Lau. (Date applied for under International Convention, April 25, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	87-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¼-⅜
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	92-95
—— 4½ per cent. 2nd Debenture Stock	100 ..	77-80
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	3 ..	1¼-2⅛
—— 5 per cent. Debentures	100 ..	96-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1¼-1⅜
—— "A" Shares, 01-017,139	5 ..	2-2¼
—— 5 per cent. Debentures	100 ..	89 94
—— 4 per cent. Deb. Stock, Red.	100 ..	85 88
Electric Construction, Nos. 1 to 112,100	2 ..	¼-⅜
—— 7 per cent. Cumulative Pref.	2 ..	1⅛-1¼
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	93-96 xd
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-96
General Electric Company (1900), 5 per cent. Cum. Pref...	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	11¼-12¼
—— 4½ per cent. Prefereuce	5 ..	5⅛-5⅜
—— 4½ per cent. Debentures	100 ..	109 111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	31-33 xd
—— 5 per cent. Bonds	100 ..	101-103
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	11¾-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11¼-12¼
—— 4½ per cent. Debenture Stock, Red	100 ..	107 108
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9¼-10¼
—— 7 per cent. Preference	5 ..	9-10
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9 9¼
—— Nos. 60,001-80,000	5 ..	8¾ 9¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	105-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	6⅛-6⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5⅜-5⅝
—— 4 per cent. Debenture Stock, Red.	100 ..	104-106
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5 ..	4 13/16 5 1/16
—— ditto (1903) 40,001-80,000	5 ..	4 13/16-5 1/16
Chelsea Electricity Supply	5 ..	6 6½
—— 4½ per cent. Debentures	100 ..	108-110
City of London, Ordinary	10 ..	10-11¼ xd
—— 6 per cent. Cumulative Pref.	10 ..	13-14 xd
—— 5 per cent. Debenture Stock	100 ..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	105 105
County of London Electric Supply, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5⅛-6 xd
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	105-107 xd
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	101-104
Havana Electricity, 1-15,000	10 ..	9¼-10¼
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅞-8¼
Isle of Wight Elec Lt. and Pwr., 4½ p c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	⅜-½
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11¼-12¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¼-10¼
London Electric, Ordinary	3 ..	1¼-2½
—— 6 per cent. Pref.	5 ..	4¼-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 100,001-300,000	5 ..	9⅛ 9⅞
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 4½ per cent. Cum. Pref.	5 ..	5⅛-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	99-101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	98-101
—— Preference	4 ..	100-102
Notting Hill Electric Lighting	10 ..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6¼-7
—— 4 per cent. Debenture Stock	100 ..	98-100 xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	2¼-3
—— 4 per cent. Debenture Stock	100 ..	78-82
South London, Ordinary	5 ..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1 ..	⅜-½
—— 7 per cent. Cum. Pref.	1 ..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-109
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13½-14¼
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-99
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5¼-5⅜
Westminster, Ordinary	5 ..	12-13
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5 ..	6¼-6⅜
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 ..	5⅞-6¼
—— Ord.	5 ..	8⅜-8¾
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100 ..	104-106
Barcelona Tramways, Ord., 1-20,000	10 ..	13¼-13⅞
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9,-10
—— 5 per cent. Deb., Red., 1-600	100 ..	99-102
—— 4½ per cent. Red. Deb. Stock	100 ..	96-100
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord, 1-75,000	5 ..	1-1½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	92-96
British Columbia Electric Railway Co., Ord. Def.	100 ..	105-108
—— Ord. Pref.	100 ..	98-101
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	102-105 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	98-101 xd
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9¼-9⅝
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11¼-11⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-124
—— 4½ per cent. 2nd Deb. Stock	100 ..	97-99
Buenos Ayres and Belgrano Trams.	5 ..	3 1/16-3 5/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	6 7/16-6 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	6-6¼
—— 5 per cent. Deb. Stock, Red.	100 ..	106-107
—— Prov. Cert., all paid	100 ..	101-104
Buenos Ayres Electric Trams., 5 p c. Deb. Stk., Red.	100 ..	96-98
Calcutta Tramways, 1-102,268	5 ..	8⅝-8¾
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	106-108
Cape Electric Tramways, Nos. 1-480,000	1 ..	1⅛-1⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4¾-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102-104
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14¼
—— 6 per cent. Cum. Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4 per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 ..	2¾-3¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	98-101
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk, Rd.	100 ..	101-103
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	9/32-11/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	104-106
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	£1,000 ..	104-108 xd
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	103-105
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum. Pref	10 ..	9¼-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,132 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 —	90-92
—— 4 per cent. Pref.	100 ..	101-103
—— ,, ,, deferred	100 ..	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	110-112 xd

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	120-123
—— ,, ,, ,, '95	100	119-122
—— ,, ,, ,, '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	93-100
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111-112
—— Deferred Stock	100	107½-108½
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5¾
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock. Red.	100	102½-101½
Oriental Telephone and Electric Company	1	1¼-1½
—— 6 per cent. Cum. Pref.	1	1⅛-1¼

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 15	1,578	1,819	- 241	- 403h	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 15	440	503	- 33	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 16	1,142	1,127	+ 15	- 223	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 15	328	341	- 13	+ 959	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 12	1,072	1,086	- 14	+ 598	24	24	,, 25	48,875	8,661,720	985,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 13	1,482	1,420	+ 62	+ 1,555	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 15	884	964	- 80	- 193	16½	16½	Dec. 31	31,846	2,325 677	579,254	3 28	13·19	—	7·27
Bolton Corporation	,, 16	2,149	2,033	+ 115	+ 983	40	38	March 31	95 765	20,235,196	2 161,130	1·13	10 63	2,394	6·14
Bournemouth Corporation	,, 12	1,573	1,265	+ 307	—	16 82	16 82	,, 31	55,276	10,058,288	1 121,623	1 32	11 83	3,225	7·19
Bradford Corporation	,, 15	4,772	5,211	- 439	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 16	1,176	1,213	- 37	+ 818h	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 14	5,366	5,645	- 279	—	51½	51½	Dec. 31	259,739	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 15	1,2 6	1,263	+ 23	—	10 60	10·60	March 3	—	—	—	—	—	—	
Burton Corporation	,, 16	350	423	- 63	- 419	8½	8½	,, 31	17,960	3,8 8 269	454,082	1·07	9 21	2 058	6·76
Cardiff Corporation	,, 15	2,188	2,223	- 35	+ 649	26†	—	,, 31	112,209	21,131,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 15	244	231	+ 13	- 378	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 15	6,064	6,232	- 168	- 222h	6	6	,, 31	317,528	44,875,547	1,281,214	1·86	65 10	57,931	35·80
City and South London Railway	,, 9	2,300	2,335	- 36	— h	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 4	286	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 13	610	612	- 2	+ 635	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 14	266	259	+ 7	+ 183	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	,, 31	11,250	2,853,200	281,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 14	141	144	- 3	— h	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 14	4,520	4,324	+ 196	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 14	1,260	1,203	+ 157											
Dundee City Tramways	,, 12	855	814	+ 41	—	22	23	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 15	399	304	+ 95	+ 1,016	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 15	16,114	15,109	+ 1,005	+ 6,181h	144½	143	May 31	756,480	196,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	June 7	302	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	July 12	1,797	1,842	- 45	—	35½	33	March 31	74,019	17,819,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 15	1,453	1,428	+ 25	+ 971	35	35	,, 31	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 15	2,275	2,263	+ 7	+ 77	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 5	122	142	—	—	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 5	240	217	+ 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 15	6,207	6,400	- 196	+ 4,173	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,223,507	1	9·79	—	4·82
Liverpool Corporation	,, 8	11,276	11,159	+ 77	+ 9,562	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 16	1,606	1,722	- 116	— h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 8	16,703	14,116	+2,593	+41,700	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 15	153	—	—	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 15	16,911	13,486	+3,425	+10,285	149	131½	March 31	631,956	126,930,875	14,123,124	1·19	10 73	4,299	6·99
Nelson Corporation	,, 15	152	128	+ 23	+ 231	—	2½	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 15	3,737	4,155	- 518	—	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10 98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 16	1 821	1 275	+ 546	+ 7,177	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 15	2,493	2,557	- 78	- 307	—	29	,, 31	95,702	19,625,323	197,499	1·17	11·63	—	—
Reading Corporation	June 29	670	647	+ 23	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	396,547	1·24	9·24	1,102	7·92
Rotherham Corporation	July 13	563	504	+ 59	—	9½	7½	,, 31	23,563	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 17	6,155	4,384	+1,771	+ 5,193	70½	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	,, 15	293	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 18	6,664	4,901	+1,763	+ 3,982	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 12	1,121	1,089	+ 31	- 222	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	,, 6	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 7	785	654	+ 131	+ 511	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 16	1,567	1,554	+ 13	+ 387	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 12	217	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 15	897	927	- 30	+ 536	11·85	10 5	,, 31	38,768	7,412 881	778,851	1·30	11 94	3,271	7·54
Warrington Corporation	,, 13	342	332	+ 10	+ 175	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 13	1,731	1,149	+ 582	+ 9,483	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 12	918	843	+ 74	—	—	7½	,, 31	—	—	—	—	—	—	—

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Junior Institution of Engineers.—Mr. Dugald Clerk, M.I.C.E., the well-known gas-engine expert, has been elected president of the Junior Institution of Engineers for the ensuing session.

University Grants.—Parliament is asked to grant £100,000 in aid of university colleges for the year 1905-6. The proposed grants are as follows: Manchester, £12,000; University College, London, £10,000; Liverpool, £10,000; Birmingham, £9,000; Leeds, £8,000; King's College, London, £7,800; Newcastle-on-Tyne, £6,000; Nottingham, £5,800; Sheffield, £4,600; Bedford College, London, £4,000; Bristol, £4,000; Reading, £3,400; Southampton, £3,400; Dundee, £1,000—£89,000. The remaining £11,000 will be reserved for distribution in March next.

Single-Phase Traction.—The French Westinghouse Company, having its headquarters in Paris, have recently secured another important contract for the equipment of an Italian railway on the single-phase system. The line in question is the Bergamo-Valle Brembana Railway. The length of the road will be 20 miles. It will be served by five 30-ton locomotives equipped with four single-phase motors of 75 h.p. capacity each, with multiple-unit control and pneumatically operated bow trolleys. The value of the contract is said to be £300,000. It will be remembered that the same company are equipping the Rome-Civita Castellana Railway on the single-phase system.

The Central Electric Supply Bill.—The Bill by which the Central Electric Supply Company seek to build a large generating station alongside the Regent's Canal in St. Marylebone in order to supply electricity to that borough, to Hampstead, Paddington, Westminster, St. Pancras, Holborn, and adjoining parishes, was to have been discussed before the House of Commons committee of which Sir A. H. Brown is chairman. This has been avoided by an agreement with the Corporation of St. Marylebone, under which the electricity generated at the new station is only to be supplied through the Westminster and St. James's Electricity Supply Companies. These are the real promoters, as the Central Electric Supply Company was formed to give a bulk supply to them. An agreement was also come to as to the buildings with the London County Council, which will allow of the Bill passing the committee.

Electric Fire-Alarms.—From an Aberdeen paper we glean the following facts as to the automatic action of the May-Oatway fire-alarms. One night last week an outbreak of fire had occurred at the meal mill in Berryden, belonging to the Northern Co-operative Company. The fire was caused by an over-heated bush on the first floor of the mill, and at once the May-Oatway alarm automatically notified the fire brigade of the outbreak. Nothing was known at the mill about the fire until a telephone message was received from the fire brigade station. On receipt of the information steps were instantly taken to put out the fire, and the result was that by the time the brigade had arrived the flames were extinguished. The fire would in all probability have been a serious one, owing to the nature of the surroundings and the character of the woodwork, had not a quick alarm been given by the automatic installation.

Strand-to-Angel Tramways.—We referred last week to the proposals of the London Traffic Commission for the increase of through tramway traffic in London. The Highways Committee of the London County Council have now recommended the completion of a line from the Strand to the Angel at Islington, which will form eventually an important link in the series of connections in question. We give in the "Traction Notes" more particulars of this tramway, which will run from the Strand through the subway under the new street to Holborn. It then comes to the surface and the electric cars will proceed on the lines now leased by the North Metropolitan Tramway Company. The only thing which can be urged against the scheme is that it stops at the Strand instead of continuing along the Embankment and over the bridges to the trawway system south of the Thames. For this defect the House of Lords are responsible.

The Faraday House Journal.—The last issue of this journal, which is run by the students at Faraday House, contains an interesting *résumé* of the history of the institution. An illustration is given of the house in Red Lion-square where the Hammond Electrical Engineering College was located from 1882 to 1885. Other homes of the institution are illustrated, and finally a good description is given of the new premises in Southampton-row, which were opened in May last. The success of students who have passed through the institution is shown by the number of prominent electrical engineers who obtained their first knowledge of electrical matters at one or other of the buildings in question. With the new laboratories the facilities for experimental work will enable a higher class of instruction to be given, and also a large number of students can be provided for. The standardising department is also enlarged, and in this good work should be done in the future as has been the case in the past. The journal contains a number of interesting notes as to the work being done by past students.

New Books.—Prof. Robert H. Smith, A.M.I.C.E., M.I.M.E., M.I.E.E., etc., has just published a large volume, profusely supplied with curves and tables, on "Commercial Economy in Steam and other Thermal Power Plants, as dependent upon Physical Efficiency, Capital Charges, and Working Costs." Mr. H. Malcolm Hodson, A.M.I.M.E., is responsible for the diagrams. The work is published by Archibald Constable and Co., Limited, 16, St. James's-street, Haymarket, at 24s. net.—We have also received from Harper Bros. a volume just published on "Electric Traction," by the same author, who in his preface says that he has restricted his remarks entirely to the subject of traction, with the exclusion of all explanations of electrical machinery and electrical action that are general and common to the whole of electrical engineering. The author has purposely kept within the range of things actually and successfully accomplished on a commercial scale in Europe. He has, therefore, merely made mention of proposals for single-phase traction, and has devoted only a short part of one chapter to electric traction on common roads.

St. Marylebone Smoke Nuisance.—The Public Health Committee of the Borough Council of St. Marylebone have received a report from the medical officer of health as to a nuisance caused by the smoking of the north shaft of the Council's new generating station at Richmond-street. Mr. Arthur Wright has stated that this is not caused by using an improper sort of coal, but is entirely due to having to raise steam prior to the completion of all the auxiliary apparatus, and that when the mechanical stokers are used there will be no need to fear any reasonable complaint being made on this subject again, and that the mechanical stokers will be in position very shortly. The committee are not satisfied with this, and decided that in view of the fact that the nuisance remains unabated, and also having regard to the difficult position of having to deal with other offenders of like nuisances, who are naturally taking advantage of the position, all the facts sholud be reported to the Council, with a view to securing that the nuisance caused by the emission of black smoke from the

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north shaft of the electric generating station in Richmond-street be permanently abated. It seems likely, therefore, that the Council may decide to issue a summons against itself.

New Zealand International Exhibition.—The Government of New Zealand has decided to hold, during the summer of 1906-7, an international exhibition at Christchurch, Canterbury, New Zealand, in which all the nations of the world have been invited to participate. The object of the exhibition is educational, and it is intended to demonstrate the resources and possibilities of the colony as one of the world's food-producing factors, and its vast mineral resources. The exhibition will open in November, 1906, and remain open until the early part of April, 1907. It is also intended to bring under the notice of the more industrial nations of the world the great field the colony of New Zealand offers as an outlet for enterprise and for the use and consumption of all manner of up-to-date appliances and manufactures. The exhibition buildings will be erected in Hagley Park, Christchurch, where some 400 acres are available. The advantages the colony possesses as a tourist resort will be brought to the notice of visitors to the exhibition. The full programme of the various departments is not yet to hand. Applications for space should be sent to the secretary of the Local Committee at Christchurch. There are good openings for electric power plant in the colony in the development of its mineral wealth.

Fessenden Transatlantic Telegraphy. — The experiments in wireless telegraphy which are to be carried out between Machrihanish Bay and Boston, under license from the Postmaster-General, will prove what the National Electric Signalling Company can do with the Fessenden system of wireless telegraphy. The preparations for the signalling station at Machrihanish are well in hand. We are informed that a tower 400ft. high and 3ft. in diameter, with cross spars on the top 56ft. long, is to be erected by the Brown Hoisting Machinery Company of New York. The base will be formed by a bed of concrete, while at a distance of 6ft. from the ground the tower will be fixed to the foundation. Insulated steel guys placed every 100ft. from the ground and fixed to foundations of concrete will keep the tower in position. Within the tower will be a stairway leading to the top, with balconies every 100ft. The material for the tower, etc., is at present on the way from America. It is expected that the station will be ready in three months. The tower on the American side is already completed. It is situated a little north of Boston. The National Electric Signalling Company hope, through the stations at Boston and Machrihanish, to set up an efficient service of communication between Great Britain and America, and to so perfect their system that messages sent by it cannot be tapped.

Central Technical College.—At a meeting of the council of the City and Guilds of London Institute held on Monday last, the diploma of "Associate of the City and Guilds Institute" was awarded to the following matriculated third-year students of the Central Technical College who have completed a full course of instruction as prescribed by the council : — Civil and mechanical engineering: C. J. Balding (Bramwell medal), R. W. Allen, C. M. Baissac, A. M. Beale, G. E. W. Bridge, R. W. Buttemer, F. C. Cooper, J. A. Denney, L. J. M. Guggenheim, G. W. Halse, C. Herbert, J. Hodgkinson, C. B. Job, L. King, S. Lacey, A. J. H. Laing, A. R. Mitchell, J. E. Montgomery, K. Newton, A. R. Reed, L. M. Regnard, G. M. Smith. Electrical engineering: W. H. Grinstead (Siemens medal and premium), A. J. Aldridge, C. R. Bland, E. B. Brown, J. L. Cook, P. G. Dani, P. Eisler, R. R. Elliott, O. Faber, W. M. Hooton, H. R. Hudson, G. Johnson, N. H. Martin, C. R. McGowan, C. E. Nightingale, H. K. B. Reed, F. C. Street, F. W. Strickland, K. J. Thomson, F. L. N. Tuck, W. Turner, A. Vipan, E. C. Webber. Chemistry: W. H. Eagle, F. J. Harris, W. J. Wilson. In addition to the above, certificates have been awarded to 32 matriculated third-year students who have completed a full course of instruction at the Central Technical College and to 68 students who have completed a full course of instruction at the Technical College, Finsbury.

Iron and Steel Institute.—The autumn meeting of he Iron and Steel Institute will be held at Sheffield on Tuesday, Wednesday, Thursday, and Friday, Sept. 26, 27, 28, and 29, 1905. Mr. R. A. Hadfield is the president of the institute. The Cutlers' Hall, Sheffield, will be used as the hon. secretaries' office, and the meetings will be held in the new university buildings. The following papers have been offered for reading: "On the Metallurgical Department of Sheffield University," by Prof. J. O. Arnold, Sheffield; "On the Thermal Transformation of Carbon Steels," by Prof. J O. Arnold and A. McWilliam, Sheffield; "On the Nature of Troostite," by Dr. Carl Benedicks, Upsala; "On the Occurrence of Copper, Cobalt, and Nickel in American Pig Irons," by Prof. E. D. Campbell, Ann Arbor, Michigan; "On Pipe in Steel Ingots," by J. E. Fletcher, Sheffield; "On Steel for Motorcar Construction,' by L. Guillet, Paris; "On the Presence of Greenish-coloured Markings in the Fractured Surface of Test Pieces," by Captain H. G. Howorth, R.A., Sheffield; "On Overheated Steel," by Arthur W. Richards, Grangetown, and J. E. Stead, F.R.S., member of council; "On Segregation in Steel Ingots," by B. Talbot, Middlesbrough; "On a Manipulator for Steel Bars," by Douglas Upton, Jarrow; "On Machinery for Breaking Pig Iron," by Cecil Walton, Whitehaven; "On the Influence of Carbon on Nickel and Iron," by George B. Waterhouse, New York. A large number of visits to works in the district have been arranged, and the social side of the programme has not been neglected.

Kieff Exhibition.—We are informed that the fourth congress of Russian electricians is to be held from April 2 to 15 next year at Kieff, under the authority of the Government. The meeting is organised by the Imperial Technical Society of Russia and by the town authorities of Kieff. The object of the meeting is to enable Russian electricians to meet together in order to discuss the actual state of the industry, and to witness trials of the most recent developments in electrical science. In order that this may be done, an electrical exhibition is being organised. This is to be opened on March 25, and will last for about three months. The exhibition will be divided into various departments, and special attention is to be paid to the application of electrical power to different industries and to agriculture. Apparatus connected with the application of electricity in medical science will form another department of the exhibition. The Minister of Finance has arranged that foreign exhibitors shall be able to send exhibits into Russia without payment of import duties, provided that the goods are returned within three months of the closing of the exhibition. The municipality of Kieff is making arrangements for a number of congresses during the time that the exhibition is open. These congresses will be devoted respectively to telegraph work, to electric traction, electrochemistry, and other special departments of electrical engineering. The position of the town is in the centre of the most successful industrial districts in Russia, so that the exhibition should command the support of those most in need of the latest applications of electrical engineering. We understand that all the dates given above are in the Russian style.

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Marine Turbines.—At last week's meeting of the Institution of Naval Architects a paper was read by Mr. William Gray, in which a comparison was drawn between the performances of turbines and reciprocating engines in the Midland Railway Company's steamers for its Irish and Isle of Man services. The new fleet consists of four vessels, two being fitted with reciprocating engines and two with Parsons marine turbines. The results of the official trials, he said, threw some light on the relative economy of the two systems of propulsion at various speeds, and showed that from 14 knots to 20 knots the turbine was more economical. The maximum difference occurred between 19 and 20 knots, which was the working speed of the vessels on service. In regard to coal consumption, the turbine did 20·3 knots for the same amount of coal as the reciprocating engine had at 19·5 knots. A further economy in the turbine steamers was effected in the amount of oil used for lubrication. The logs showed that this amounted in both steamers to five gallons per single trip. Speaking generally, the performances of the turbine steamers had been greatly superior to those of the steamers fitted with reciprocating engines. It was not possible to make a quantitative analysis of the cost of upkeep, but so far the turbines had cost practically nothing, excepting the cost of repairs due to an accident, and they required very little attention compared with what was necessary in the very best running engines of the reciprocating type. There could be no doubt that one great benefit derived from the use of turbines was the elimination of the vibration inseparable from the use of reciprocating engines in Channel steamers.

The Pacific Cable.—An account relating to the working of the Pacific Cable Act, with the report of the chairman of the Pacific Cable Board, has been published as a House of Commons paper. The report shows that the numbers of messages and words transmitted during the year 1904 5 were approximately 177,968 and 2,056,953 respectively, of which 106,782 messages and 1,183,929 words were inter-colonial. The audited traffic figures for 1903·4 amounted to 176,824 messages and 2,097,897 words, of which 108,211 messages and 1,232,928 words were inter-colonial. The actual expenditure of the Board on the service of the cable during the 12 months ended March 31, 1905, amounted to £50,751. 11s. 2d., against £54,824. 19s. 8d. in the previous year. The total receipts amounted to £87,446. 10s. 8d. (including a special item of £5,118. 15s. on account of repair services rendered by the "Iris"), against £80,118. 13s. 3d. last year. The surplus on actual working was, therefore, £36,694. 19s. 6d. The Board, however, set aside £35,000 for the renewal fund, and they had also to provide a sum of £77,544. 18s. for interest and sinking fund. The sinking fund will extinguish in 50 years the entire capital expenditure. Adding these payments to the expenditure, the deficiency on the year's operations amounts to £75,849. 18s. 6d., against £87,751. 4s. 5d. in the previous year. This deficiency has to be made good by the contributing Governments. Although in the year 1904-5 the receipts were swelled by the earnings of the "Iris," an item which cannot be expected to recur, it is satisfactory to note that the deficiency to be met by the contributing Governments in the second year of the cable's working is less than the annuity due on account of capital.

Magnetisation by Direct and Alternating Currents.—In a contribution to a recent issue of the *Elektrotechnische Zeitschrift*, E. Gumlich and P. Rose consider the differences between magnetisation by direct and alternating currents respectively, and the reasons of the differences observed. The authors go very thoroughly into the matter, illustrating their experiments with the aid of some interesting diagrams. It must suffice here, however, to give their principal conclusion in brief. Up to a frequency of about 50 periods per second the magnetisability of dynamo sheet iron of 0·5mm. thickness by alternating current differed but slightly from that obtaining with direct current. The observed differences—which for higher inductions of B = 12,000 to 14,000 and upwards completely disappear—are attributable in part to eddy currents, while for the rest they would seem to be accounted for by a certain magnetic lag. The value obtained from the formula

$$\frac{W}{p} = A[\eta B^{1.6} + p f B^2]$$

for Steinmetz's coefficient η coincides within the limit of the errors of observation with the values for η resulting from the static tests. The fact, however, that the values for the eddy-current coefficient, f, up to about B = 12,000 decrease with increasing induction, favours the deduction that the second expression on the right of the equation, hitherto ascribed entirely to the consumption of energy through eddy currents, is due in some degree to hysteresis. The following formula

$$\frac{W}{p} = A\{\eta B^{1.6} + p [\epsilon (12{,}000 - B) B^{1.6} + f' B^2]\}$$

has proved useful to represent the total watt consumption through hysteresis and eddy-current losses, in which the expression containing the factor ϵ is to be taken into account only for inductions up to B = 12,000, and left out for higher values.

London County Council Trams.—The Highways Committee of the London County Council are by no means prepared to accept as final the decision of the House of Lords as to the running of tramways over the bridges and along the Embankment. The Parliamentary Committee of the Council have also a good deal to say on the matter, and emphasise the fact that the decision of the House of Lords in throwing out the Bill was arrived at without a due consideration of the proposed tramway extensions other than those discussed. The following extract shows the general trend of the committee's report: "We cannot express too strongly our feeling at this high-handed policy of the House of Lords. We feel that there is great reason for the public to resent the action of a majority of the Upper House in using parliamentary powers, which should only be exercised for the benefit of the public, to support individual views and interests, and we are not surprised to find that an outburst of indignation has been occasioned throughout London. The ill-considered action of the House is further illustrated by the fact that the Bill was rejected as a whole, although it contained the important proposals referred to below, none of which were apparently thought by the House to deserve a moment's consideration. These proposals were: the extension of time for some four miles of tramways authorised in 1900, the electrification of the authorised tramways over Vauxhall Bridge, the diversion of the tramway subway at the Embankment end, the extension of the authorised subway tramway from the Strand to the Embankment, the deviation *vid* Stondon Park of the Lewisham and Forest Hill tramway authorised last session, and a short new line from the Crystal Palace to the county boundary. We strongly advise the Council to reintroduce next session in its entirety the Bill which was rejected by the House of Lords on July 18, 1905, and to include therein such other schemes as the Council, on the recommendation of the Highways Committee, may think fit to sanction." It will be seen from the above that the House of Lords have, by their refusal to refer the Bill to committee, hung up tramway extensions which were distinctly not controversial in

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character. The report of the Royal Commission on London Traffic should help the application next year for the facilities now refused.

Change of Pressure.—Mr. Sims Williams, barrister-at-law, last week held an inquiry on behalf of the Board of Trade into the proposed change of pressure in the supply of electricity to the consumers in the borough of St. Marylebone. Electricity was formerly supplied in the borough by the Metropolitan Electric Supply Company, but by the St. Marylebone Electric Lighting Act, 1901, the company sold their undertaking to the Borough Council for a sum fixed by arbitration at £1,212,000. Under the Act the Borough Council were to supply electricity by continuous current under a system to be approved by the Board of Trade. Up to the present time the Metropolitan Electric Supply Company has been supplying electricity partly by alternating and partly by continuous current, and with a considerable number of declared pressures. The Borough Council propose to supply at a pressure of 240 volts. Those consumers who were supplied before March, 1896, may, under the Board of Trade regulations, withhold their consent to a change of pressure, and have done so. The County Council have approved of the change on certain conditions. Mr. Arthur A. Wright, the consulting engineer to the Borough Council, gave evidence as to the benefits to be derived from the proposed change of system and increased pressure to 240 volts. He said that the proposed system would be more reliable and less dangerous than the present one, and would prove more economical in working. The objectors said that the change would entail great inconvenience and expense, besides an increased risk of fire, which might affect the validity of their insurance policies. It was also urged by the medical faculty in the borough that their electrical appliances were not adapted to the increased pressure. Mr. Sims Williams will forward his report and recommendations to the Board of Trade in due course, but we cannot doubt but that the change will be enforced. This is only right, as the Council have to pay for any alteration to consumers' wiring necessitated by the change.

Double-Filament Telephone Lamp.—Accompanying is an illustration of a double-filament lamp which has

been introduced by Messrs. Mix and Genest for use in telephone exchanges. An objection to the employment of incandescent electric lamps for telephone signalling purposes has been that the failure of a lamp cannot be at once detected, since but one control lamp is provided for each group of lamps. To ensure that a call signal attracts notice at the switchboard, notwithstanding the failure of a particular lamp, special control relays are now generally provided with resistance for inserting automatically in parallel with the lamps. These relays serve to switch in the lamp which controls a large number of call lamps, as soon as a call is made. But such an arrangement is subject to the disadvantage that the failure of a lamp can be immediately detected only when there is no second call at the moment. Moreover, the control lamps show that a lamp is defective, but do not indicate which—hence loss of time in testing, with consequent disturbance of the service. In order to avoid these objections the new lamp under notice has been designed. This lamp combines in itself the call and control signals. It is novel in that, instead of a separate resistance for switching in parallel, the lamp contains a second filament, which is not noticeable so long as the principal filament remains intact. The auxiliary filament is of higher resistance than the principal filament, and consequently has a longer life. Should the illuminating filament break, the auxiliary filament assumes a dull red glow, thus indicating the defect. The watt consumption of the lamp is the same as for the ordinary type of carbon-filament lamp, plus the loss in the auxiliary filament. Further details will be found in a recent issue of the *Elektrotechnische Zeitschrift*.

Electric Refrigerators.—Mr. J. C. Chamberlain contributes to the *Electrical Review* of New York an interesting article on the use of small automatic refrigerators driven by electric motors. We need hardly here recapitulate the advantages of mechanical refrigeration over the older methods employing ice as cooling agent. For large cold-storage schemes in this country mechanical refrigeration is always employed. It is rather to the author's schemes for small plants for small hotel and domestic purposes that attention should be drawn. For such work, plants requiring from 2 h.p. to 15 h.p. to drive can be conveniently installed and worked by electrical energy from the public mains. With automatic regulation the cost of supervision, which has hitherto largely prevented the use of such small plants, can be eliminated, and there is no more difficulty in introducing this automatic control than in other cases of electrical driving. The author gives a table to show that with ice at 15s. a ton a small plant driven by a 2-h.p. motor will save its own cost in under five years if the ice required per day in the summer now amounts to 1,700lb. The cost for electrical energy in order to do this is taken at 1½d. per unit, which is reasonable in view of the special character of the load. Thus the refrigerating load demand is the exact reverse of a lighting load, not only during the months of the year, but during the hours of each day. It is a summer load, and very desirable because the lighting requirements are then comparatively small. It is a long load in the summer months, when the operation of automatic refrigerating plants will average 16 to 20 hours each day. The duration of daily load will, of course, follow the weather conditions from the summer to the winter months. It is a day load at any time of the year, being continuous during the daytime, when the cooled supplies in refrigerating boxes are being removed and replaced by new supplies to be cooled. Electrical engineers in this country responsible for central-station working will fully appreciate the advantages of such a load, and we know of one or two instances in which breweries have been supplied with power at considerably lower rates than 1½d. per unit on the understanding that the power in question was used for refrigeration purposes. With the increase in the size of the plant the advantages in favour of the mechanical refrigerator go up rapidly, as is shown by the author's tables.

Tramway Experts.—The city of Birmingham is favoured by the large number of tramway experts amongst its citizens, and by the free way in which these place their

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knowledge at the disposal of the community. In the first place, the Corporation have secured as their tramway manager Mr. Alfred Baker, and under his advice the passing of the horse and steam trams has been expedited. That the trolley system has been adopted has offended the City Association, and the executive committee of this association has issued a final report condemning the system. The status of the members of this committee is not disclosed, but their report shows how fit they are to condemn the trolley. "Having drawn attention to the large number of fatal and other accidents which have recently happened on tramways using the overhead system, the committee point out that they were thankful to the Lord Mayor (Alderman C. G. Beale) for the assurance given seven months ago that the mode of traction was not yet determined for Birmingham. They are now astonished to find that in spite of that assurance the Tramways Committee is 'hurrying forward the laying of as many routes as possible upon the overhead trolley system without any genuine attempt to inquire into other systems of traction which are really safe and equally convenient.' Having given a great deal of time to the question, the committee express the conviction that some of the surface-contact systems which are being adopted in other English towns are vastly superior to, and, they believe, as cheap to work as the overhead trolley system. Moreover, they are certain that within a very short space of time motor omnibuses should be so perfected as to become the best and cheapest form of traction for many routes. The only reason for the adoption of the trolley seems to them to be the false one of economy on the ground that it is the cheapest system to lay down. But if economy without efficiency is to be the ideal for Birmingham, they hold that the horse and steam trams should be retained, as the capital expenditure on the overhead system is about 50 per cent. more than either. Further, they state, notwithstanding Mr. Alfred Baker's remarks to the contrary, that motor omnibuses require much less capital outlay, and are as cheap or cheaper to run." The Birmingham tramways have already been the field for experiments, as for years there have been four distinct systems of driving employed—*ie*, the trolley, accumulator traction, steam trams, and horse cars. The financial returns from them were available to the above committee, and we are somewhat surprised that any uncertainty should still exist as to the best system. Still, it is useless to be an expert or a committee of experts if you do not differ from the standard practice whenever possible.

Wireless Telegraphy.—The information given in a return on this subject asked for by the House of Commons deals firstly with the working arrangement between the Marconi Company and the General Post Office for the transmission of messages to ships at sea. This arrangement was in active operation from Jan. 1 last to March 31. During that time 111 messages were handed in at post offices to be transmitted to ships at sea. Of these, as far as the records of the Post Office show, 21 failed to be delivered. In 16 of these instances a refund was applied for, and in six cases refund was not granted because the Marconi Company declined to entertain the application on the ground that the telegram had been accepted, at the sender's risk, after the hour shown in the company's sailing list as the latest at which such a telegram should be sent. During the same time no less than 1,655 messages were received from ships at sea and telegraphed to the general public over the Post Office wires. The returns as to the number of licenses which have been applied for under the Wireless Telegraph Act of 1904, show not only the applications, but which have been granted and which refused. We were surprised to see that no less than 73 licenses had been applied for, but the majority of these are for experimental work. In practically every case where the experimental work is such that it would not interfere with commercial systems the license has been granted. In consequence of this we find that every system which has been brought to public notice has been granted one or more licenses, which will allow of further developments being made towards commercial working. For Transatlantic signalling the following applications have been made. The Anglo-American Telegraph Company wish to carry out trials between North America and Valentia, in Ireland; the system to be used is not disclosed, and the Postmaster-General has the license under consideration. The De Forest Wireless Telegraph Company have been offered a license which would enable them to work a signalling station in the Hebrides, or on the West Coast of Scotland, for communication with America; this would also be experimental in the first instance. The company's application for other licenses for commercial ship to shore communication has not been granted in regard to the majority of the localities indicated, on the ground that there would be risk of interference with other stations. They have, however, been offered a license for sites in certain specified localities. Their application for providing inland communication for Press purposes between London, Manchester, Liverpool, Glasgow, and Belfast has not been granted yet, as further information is required by the Postmaster-General respecting the same. The Marconi Company have applied for a number of licenses for commercial working, both on their own account and in connection with Lloyd's. A license is in preparation which will enable the company to establish commercial communication with America and with ships at considerable distance from Poldhu, in Cornwall. The same applies to their application for commercial communication with ships at comparatively short distances from a large number of signalling stations. A license is being executed in favour of the National Electric Signalling Company, who will experiment with Transatlantic signalling from Machrihanish Bay with the Fessenden system. It will be seen, therefore, that a good deal of work is likely to be undertaken by various companies for long-distance signalling which should prove not only the commercial feasibility of any one installation, but also the question of whether the sending of messages across the Atlantic can be simultaneously undertaken by several signalling stations at once. It will also be seen whether the large amount of energy required for sending these messages can be discharged without interfering with short-distance equipments round the coast. The Armstrong-Orling system is to be used partly for experimental purposes and partly for private business between Ballinasloe and Taughmaconnel, a distance of 50 miles. The Lodge-Muirhead system has been refused commercial application from Dover, the Isle of Wight, the Lizard, and Fastnet, on the ground of risk of interference with other stations, but a license is offered for sites in other districts. An application for a license is under consideration from the Midland Railway Company for the use of this system from Heysham and the company's steamers. The general conclusion to be drawn from the return is that a very large number of people are experimenting with wireless telegraphy, and that the Postmaster-General is not using the Wireless Telegraph Act to prevent research work. It seems, however, that until the non-interference of competing systems has been established, he is not prepared to grant licenses for two companies to work in the same area.

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THE CALCUTTA ELECTRIC TRAMWAYS SYSTEM.

Due to more immediate interests nearer home, it was not until a few years ago that attention was directed to the possibilities of lucrative tramway undertakings in the East. Electric traction has infused new life into systems which formerly employed steam and animal traction, and the success of such conversions has been followed by numerous concessions for electric tramways in places such as Hong-Kong, Singapore, Manilla, Rangoon, Mandalay, Tokio, Batavia, Penang, Colombo, and others. The largest and most important of the tramway systems in the East is that of Calcutta, and is of more than usual interest, having regard to the conditions under which it operates. It is hardly necessary to say that Calcutta, the metropolis of India and the seat of Government, is one of the largest and most important cities of the East. It is a very large port, and the centre of the extensive Indian trade in tea, jute, and general produce and merchandise. On account of its low-lying position, an extensive system of artificial drainage has been adopted, and, though fairly well carried out, is not nearly sufficient to cope with the extraordinary downpours during the rainy season, which flood the streets in certain sections of the city for the greater part of the day, sometimes to a depth of about 2ft. and upwards. Another climatic condition which causes great damage and difficulty from a traffic point of view is the number of severe wind-storms, approximating to cyclones, which sweep over the city at the beginning and the close of the rainy season (which lasts from the middle of June to the end of September), often with destructive effects, uprooting trees, unroofing houses, and causing general damage.

Calcutta is divided into three natural parts: the European business district, practically confined to an area of 250 acres, located in the west central portion of the city, bordering on the eastern bank of the River Hooghly; the native residential and business district, located in the northern part; and the European residential district, located in the southern portion of the city. The total population, with certain adjoining suburbs, is about 1,000,000, which does not include the municipality of Howrah, located on the opposite side of the Hooghly river, having a population of 157,594, nor two other suburbs which will soon come within the tramway zone, and which have an additional population of 51,806. The total population can thus be put down at 1¼ million. In the native town, the streets, as in all Oriental cities, are narrow, and lined for the most part with unprepossessing houses and huts, which are very densely peopled, one ward having a density of 281 per acre, or 180,000 per square mile. Broad roads are, however, now being cut through the native quarters, and the congested districts, which have up till lately been the hot-bed of epidemics and plague, are being opened out, and this work is the beginning of a large improvement scheme upon which the Government has entered. The southern European residential portion is traversed by wide and well-paved roads, which are lined with very commodious and roomy houses, inhabited for the most part by Europeans. The European community does not differ essentially in composition from that of other large cities of the East (where there is an almost entire absence of the European artisan). The official element is very strong, and the professions in general are well represented, while there is a larger number of European merchants. The total number of Europeans and allied races resident in Calcutta during the cold weather is approximately 14,000.

The tramway company was registered in England on Dec. 23, 1880, and operated its system by steam trains on the Kidderpore section, and horse cars on the remaining section, until 1901, when the original concession expired. In 1899 an agreement was entered into with the Corporation whereby the company was granted a new concession for 30 years from Jan. 1, 1901, in consideration of the company converting the system from horse to electric traction within three years. The capital authorised is £700,000 in £5 ordinary shares, all of which have been issued, in addition to which there is a 4½ per cent. debenture issue of £350,000. The company's head office is 1, Queen Victoria-street, London, and in Calcutta its representative is Mr. Martyn Wells, managing agent, Mr. A. J. J. Pfeiffer being assistant manager and chief engineer.

The electrification of the tramway system was carried out according to the most modern plans in everything as regards central-station equipment, overhead and underground conductors, rolling-stock, etc., and especial attention in design was given to adopt the plant to the peculiarities of tropical and local conditions. The engineers and contractors were Messrs. Dick, Kerr, and Co., of London and Preston, for all work except the buildings and the reconstruction of the permanent way, which was carried out by the company itself. All the rails, ironwork, bonds, etc., for the permanent-way work were, however, furnished by Messrs. Dick, Kerr, and Co. The entire conversion was creditably carried through in a comparatively short time, and the various parts of the plant have since then worked well under the most trying conditions. It is very gratifying to note that throughout the whole period of conversion from horse to electric traction both the company's officials and the contractors received the greatest help and encouragement from the various Government and local authorities.

Present Routes.—As in all Oriental cities, the streets are narrow, especially in the native quarter, and as the bulk of the riding public are natives, the authorities very wisely sanctioned the laying of lines in the main native thoroughfares, although these are much narrower than ordinarily found in large cities of the West, but hardly more so than in some of the smaller old towns of Europe. The Chitpore-road, which forms one of two main arteries of the native section, is probably unique as regards density of traffic, including foot-passengers, carriages, and carts, besides the electric cars, but even with this dense traffic the Western visitor is astonished to see how well and efficiently the tram service is kept up. The tracks in all narrow streets are laid as much to the side as is possible, and the distance, in many cases, from the nearest rail to the kerb does not exceed 2ft. This is necessary in order to give sufficient clearance on the other side of the tracks to accommodate at least one vehicle. As remarked above in the description of Calcutta, the entire area of the city is flat. There are no grades to speak of, except when crossing three bridges, the approaches to which do not exceed 150 200 yards, the grades being not more than 4 per cent.

The present tramway routes, covering a total length of 23 route miles double track throughout, all radiate from one small section of the city, where the majority of the Government offices and European business houses are located, in the west central portion bordering on the river. This small district is the objective point of thousands of natives from all directions in and about Calcutta, who have business in the courts and numerous offices. The cars on the various lines are run to either one of two termini, one being at the loop near the High Court (Fig. 1); the second the Esplanade Junction, at the intersection of Dhurrumtollah-street with Chowringee-road, the latter forming the junction between the northern and southern lines. The number of cars at these two points is during the rush hours very large, trains following one another in close proximity. The number of trains arriving at these points per day amounts on an average to: High Court, 750; Esplanade Junction, 1,150. The northern section of the city is served by three routes, the central portion by three, and the southern portion (including suburbs) by two, all double-tracked. A few years ago a fine large road (the Harrison-road) running east and west was cut through from Sealdah railway station to the bank of the river at the Floating Bridge (Fig. 2), which now forms the main artery of the cross city traffic in the native district. A double line of traffic has just been laid down the centre of the road, and will shortly be opened for traffic. There are eight main routes, and these, with two exceptions, can be considered city lines. The Chowringhee line runs southward to a densely-populated suburb, Bhowanipore, touching upon the way the western extremity of the European residential zone. On this route is also located a famous Hindoo temple, which attracts a constant native traffic throughout the year, and during certain holy festivals the

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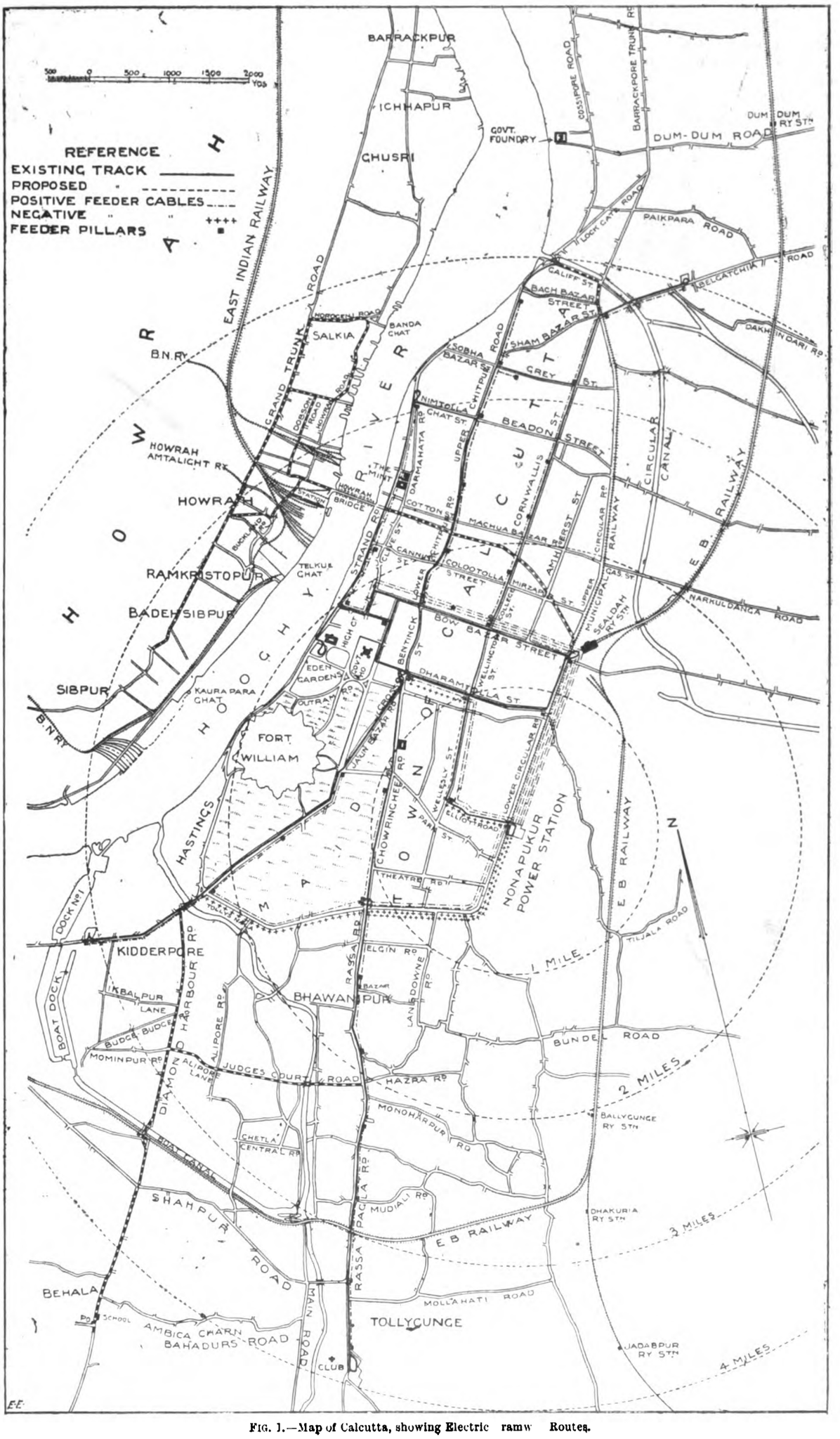

FIG. 1.—Map of Calcutta, showing Electric ramw Routes.

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service has to be doubled to cope with the rush. The line to Kidderpore feeds the populated suburb which lies to the south, near the river, caters to the large traffic between the extensive docks and Calcutta, and derives a large traffic from the race meets which are held on the racecourse on the Maidan.

The total route mileage (all double track) at present is 24·75, with Harrison-road included. On the basis of a tributary population of approximately 800,000, the route mileage per 1,000 people would be ·031, as against about ·08 found in England and an average of about ·25 to ·30 found in the United States of America in cities of about one-third population of Calcutta. The low mileage *per capita* is due to the congested condition of the native quarters, which cover not nearly the area of an equally populated Western city.

Traffic.—All tramways in India, which likewise holds good for the East in general, have, of course, mainly to depend upon the natives for their earnings, since Europeans form but a very small part of the population, and in investigating the possible establishment of a system, due weight must be given to their characteristics, habits, average income, and occupations. In Calcutta the average income of the native working-man and labourer is not sufficient to permit him to ride freely, and in consequence he is but a small factor in the earning powers of a tramway, the main fundamental revenue being derived from the business and professional classes and Government employés. The native is a great litigant, and will spend any amount of money and time over the smallest case, and in consequence of this characteristic the courts located in various parts of the city employ a great many clerks and other officers, and daily attract a large number of people, the major part of who use the tramway. Another class of rider is the clerk in European business houses and Government offices which are located in the well-defined districts mentioned above. Native traders do considerable business among themselves in distinct parts of the city, in what are called bazars, which afford constant interchange of traffic. All the above constitute the steady riding factor, or regular traffic with two "rush" points per day, on which the tramways may depend. The "floating" traffic, which is by no means small, is created mainly by the temples of the Hindoos or mosques of the Mohammedans, which constantly attract extensive crowds for worship, but which on many days, especially on those which are holy or sacred, form the objective points of many thousands of devotees from the city as well as the surrounding districts. This religious feature is a valuable asset in the earnings of all Eastern tramways, provided always that these objective points are sufficiently far removed from the centre of the native population to induce them to ride rather than walk.

The first line under electric traction in Calcutta was open for regular service on March 27, 1902, and the entire

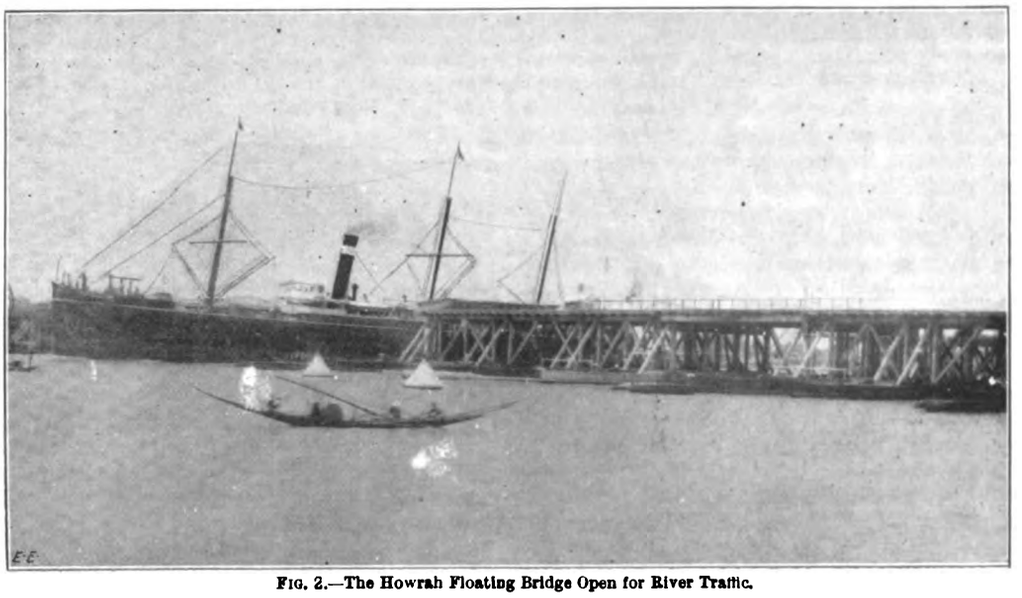

FIG. 2.—The Howrah Floating Bridge Open for River Traffic.

FIG. 3.—Dalhousie Square, showing Side-Pole Construction.

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system was operated electrically on Nov. 20, 1902. An exceptionally large increase of traffic immediately followed the opening of each section, which, however, was to be expected, since, under the steam and horse traction, there was only one class for passengers, and due to the severe climatic conditions of excessive heat and humidity prevalent in Calcutta during the summer months, and the consequent exhaustion of the horses, even this second-class service was not nearly sufficient to cater efficiently to the riding public. The total traffic revenue increase with electric traction over that of horse traction after two years of operation is about 75 per cent. This increase is due not only to more accommodation furnished in the shape of extra car mileage for the second-class passengers, but because the motorcars which serve the first class developed an altogether new source of revenue, since people are now riding who in past years never made use of the tramway, and especially is this the case with European and the better class of natives.

FIG. 4.—Strand Road, Calcutta, at the intersection of the approach to Howrah Bridge.

The car service, or rather train service, regulated carefully according to requirements, begins at 5 a.m. and ends at 10.30 p.m. The native being an early riser, traffic begins quite briskly in the morning, takes a sudden rise at 9.30 to 11 a.m. during the office traffic, falls off during the afternoon, increases rapidly again at 4.30 for the return office traffic, and is practically finished at 9.30 in the evening, since the native travels about but very little at night. The maximum number of trains operated at one time during an ordinary weekday on the present 46 miles of single track is 132, this being increased to 145 on race days, and during the recent Pujah festival of the Hindoos (corresponding to our Christmas in importance) the then full equipment of 151 trains was required, the traffic to the temple at Kalighat from all parts of the city being very large. Although there are well-recognised fixed stopping places on the system, it has not been found practicable to make use of them exclusively on account of the very severe conditions of heat and rain, which make it necessary for the comfort of passengers to set them down and pick them up wherever they may require.

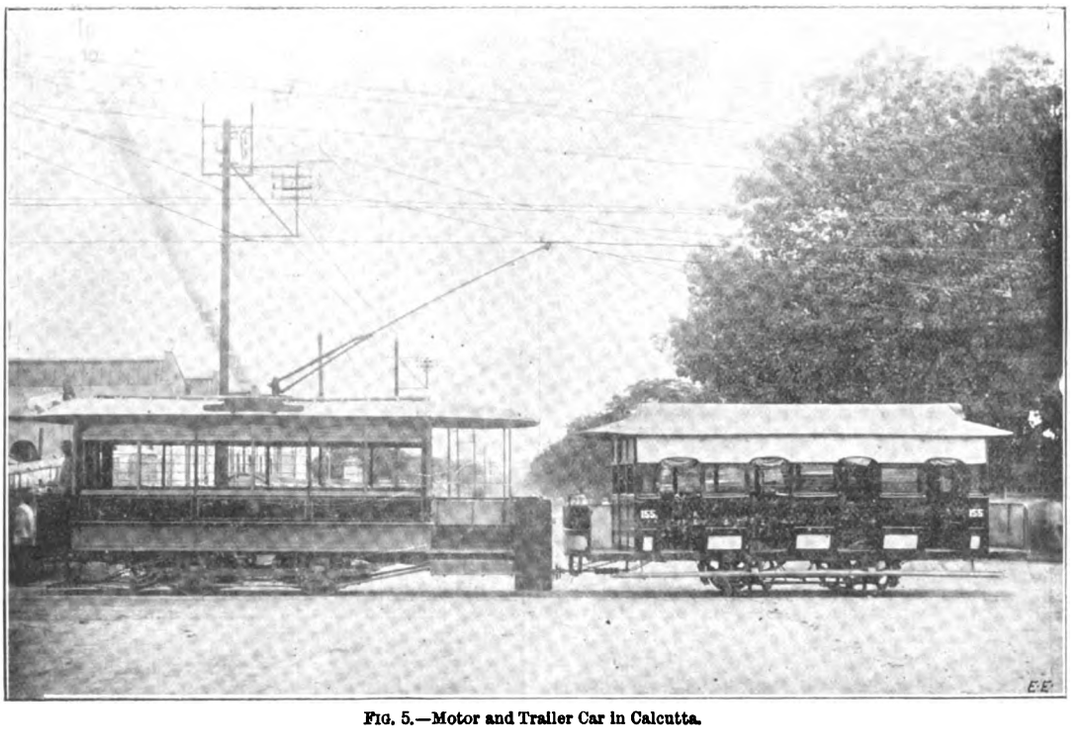

FIG. 5.—Motor and Trailer Car in Calcutta.

The traffic staff is all native, with the exception of the superintendent and his two first assistants, who are Europeans. A considerable number are traffic employés from the old horse-car days, and in consequence had the experience which made their initiation into electrical traction comparatively easy. Drivers of old horse cars were taken on to act as motormen, and right from the start acquitted themselves admirably, it being really

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astonishing to note with what skill and coolness they handle a heavy train in the narrow streets, full of people and vehicular traffic and native conveyances. Conductors are checked and supervised very carefully by a comparatively large staff of checkers and inspectors, who are promoted from the ranks of conductors.

A few traffic results are herewith given which might be of interest to show how they compare with those found in the West: total number of passengers carried per year, 21,000,000; total yearly train miles run, 3,300,000; passengers per train mile, 6·4; average distance travelled per passenger, 2 to 2¾ miles; average fare per passenger, 1·46d.; traffic operating expense per train mile, 1·25d. The operating expenditure per train mile, as noted, is about 1·25d., which includes salaries and expenses for the superintendent, assistants, motormen and conductors, regulators, starters, cashiers, etc. This is about 40 per cent. of the results in England, and 30 per cent. of those in the States.

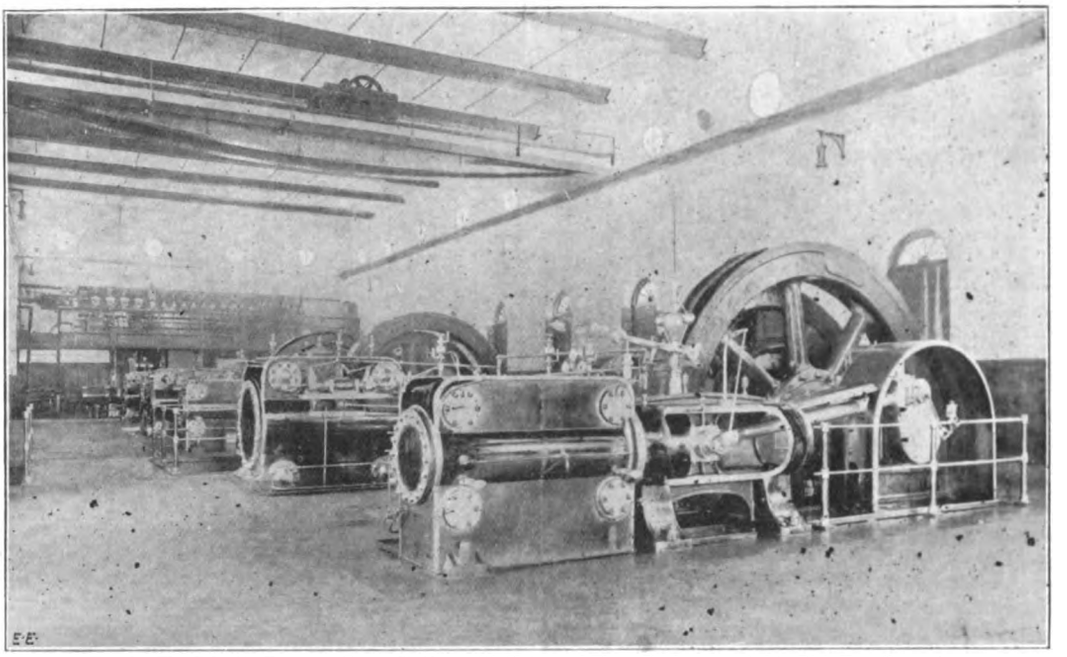

FIG. 6.—The Calcutta Tramway Power Station, with Yates and Thom Engines coupled to Dick-Kerr Generators.

Permanent Way.—A considerable portion of the track in the early days of the company was single with turn-outs. This was found to be very unsatisfactory, especially in an Eastern city where an accurate schedule timing, such as is required to give a satisfactory service with single track and turn-outs, was practically impossible. The track was gradually doubled throughout, the last line being the Kidderpore section, just before the introduction of electric traction. Some of the reconstruction was started as far back as 1892, but the bulk of it was completed three or four years ago. The gauge of the track is the standard

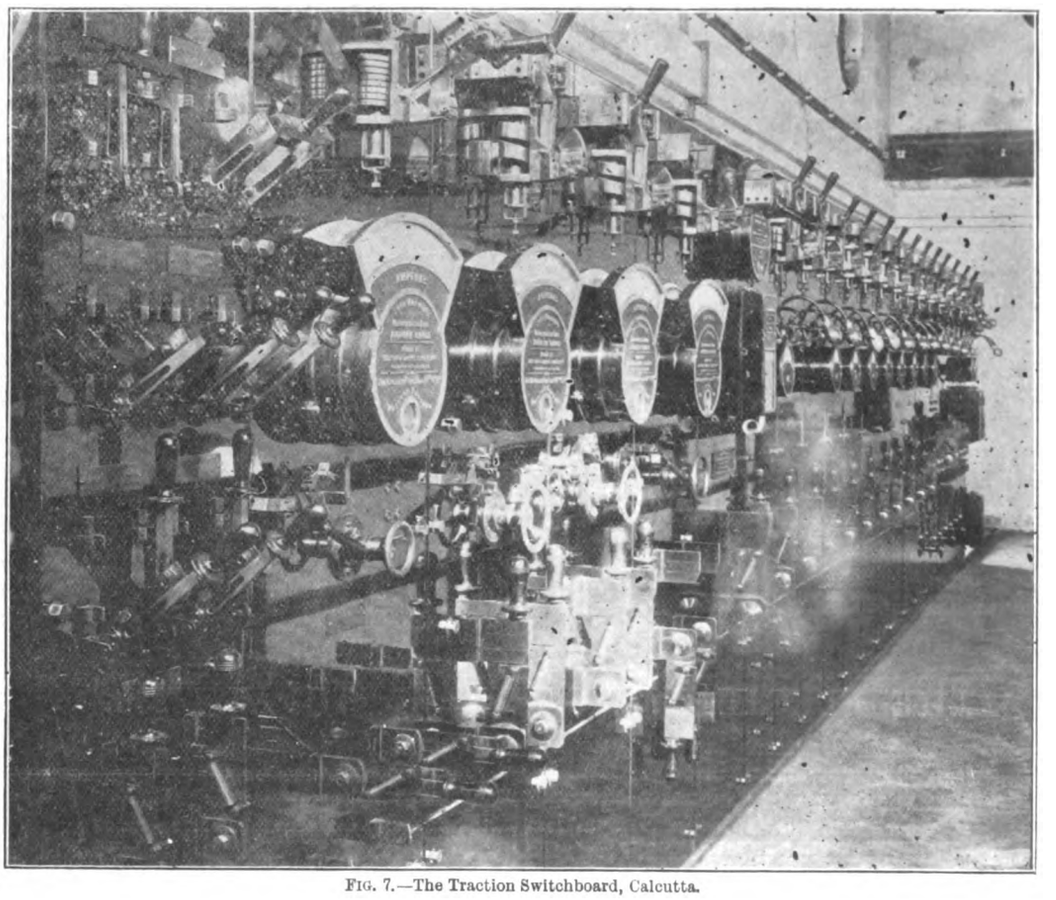

FIG. 7.—The Traction Switchboard, Calcutta.

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4ft. 8½in. Girder rail was substituted for the old box rail throughout, the rail on some of the sections which were first reconstructed being 95lb. per yard with ¾in. and ⅞in. groove, but all the later types, and those which are now being used on extension work, consist of a 101lb. rail with 1⅛in. groove. In spite of the heavy traffic to which some of the lines are subject, the track has stood well, and where it has given way it has probably been due to the sinking of the subsoil. The usual tie-bar construction is employed, five bars being provided on an average per rail length of 30ft., each bar weighing 15¼lb., including check-nuts and bolts. The rail is embedded on a lime concrete stringer, having a width of 16in. and a depth of 9in. This concrete is made up of ten parts broken brick, three parts of ground brick, and two parts of slaked lime. The above method of making-up concrete is prevalent in Calcutta, since broken stone is expensive, as is likewise good sharp sand, and the high price of Portland cement prohibits its use in this connection. The lime concrete, with the above composition and material, makes a very good substitute for the ordinary cement concrete, though more care is required to consolidate it, and a greater time is necessary to enable it to set properly. The edges of the rails on all lines in the city are paved to a width of 18in. on the outside of the double-track rails and 9in. on the inside, Indian granite setts being used. In some streets, and parts of streets where the track is specially heavy, paving is carried straight across the double track to a width of 18in. on the outside of the extreme rails. The setts are embedded in sand, and grouted with four parts of river sand and one of Portland cement. In its agreement with the Corporation, the company undertakes to keep the roadway in proper repair to within 18in. on the outside of the extreme rails. Two No. 4/0 B. & S. Neptune bonds are used for every joint, the bonds spanning the fishplate, and having a length of 2ft. 6in. The track is adequately cross-bonded.

Overhead Line.—This system is worked throughout by means of the overhead trolley, and on account of the peculiar conditions existing, a part of the lines had to be equipped for the side-running type. Of the 23 miles of route, 20 per cent. is centre-pole construction, 30 per cent. is side-bracket construction, and 50 per cent. is span-wire construction. The poles used are made up of steel tubes varying in thickness and weight according to the requirements of their location. Each is built up of three sections, socketed into each other, giving the general appearance of a gradual taper. The average distance between the poles varies from 100ft. to 110ft. on the straight. All the poles are 27ft. 6in. high; the light poles weigh 673lb. and the heavy poles weigh 1,032lb. each. The brackets used on the side-running portions vary in length from 3ft. for centre-pole to 15ft. side-pole construction, the internal diameter of the tubes being 2in.

The trolley wire is of hard-drawn copper of 3/0 S.W.G. gauge, and is generally supported by double insulating hangers of the rigid suspension type, but flexible suspension has been substituted for these on that section of the Chowringhee lines where the speed attained is greater than the average, so as to lessen the effect of the blow on the cars. A similar improvement will be made on the Kidderpur line. The angle of the trolley pole varies considerably on the different side-running sections, the maximum outreach, which is on the Chowringhee line, being 4ft.

Feeder and Return Distribution.—The general arrangement of the feeder system, both positive and negative, is shown on Fig. 1, from which can be seen that the majority of the feeding cables are led to the central point of the city, where all lines converge. There are nine positive feeder cables, varying in cross-section from ·19 to ·6215 square inch, which emanate from the power-house and connected to 43 feeder and section pillars distributed over the various routes. The return or negative cables are three in number, one of them having a cross-section of ·7942 square inch and the other two ·3 square inch each. These are connected to points of the track, as shown on the map.

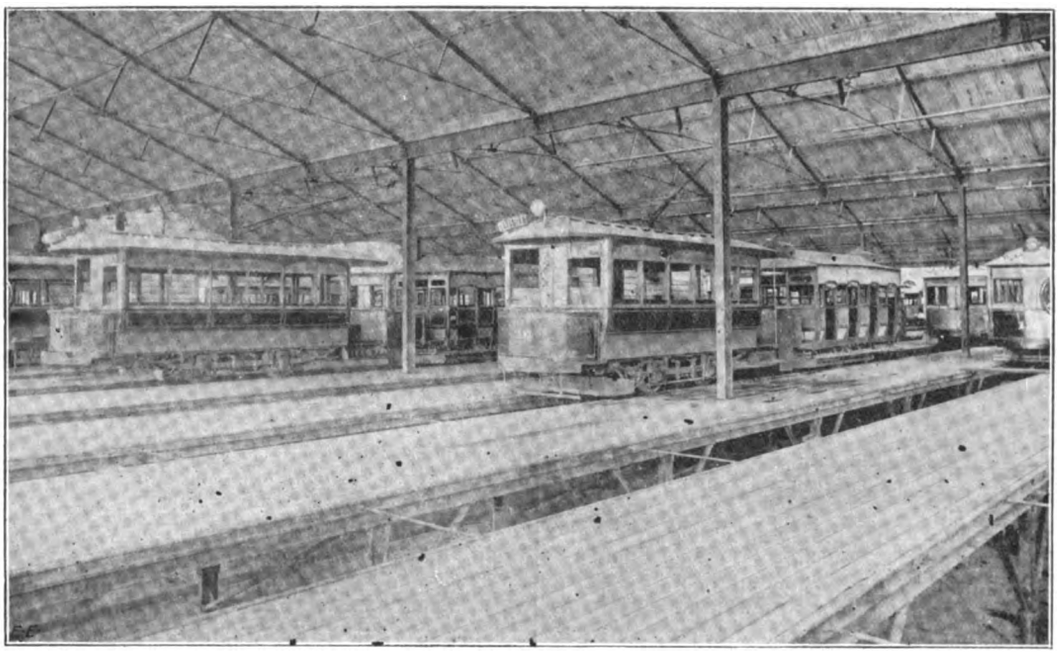

FIG. 8.—The Nonapukur Car Shed, showing the Raised Rails, which allow ready access to inspect the motors.

All cables are paper-insulated and protected by heavy lead sheaths, and were laid underground in cast-iron troughs on the solid system, the troughs as a rule being located along the outside margin of the tramway right-of-way. The cables are supported in the troughs by wooden bridges, and the whole trough is filled in with a special pitch compound. The troughs themselves are laid in a trench varying from 16in. to 24in. in depth, according to the nature of the ground. This system of laying has given rise to difficulties due to the cast-iron covers of the troughs being too thin and easily pierced by the picks of excavators. Several burn-outs of cables have been traced to this cause, and to obviate and eliminate this danger as much as possible, in all future cablelaying earthenware troughs are now being used with covers 1¼in. thick. It has been found that this thickness will withstand ordinary negligence in the digging up of the roadway. In order to forestall any difficulties which might arise due to the sinking of the soil, these earthenware troughs, especially in cases when they will carry high-tension cables in connection with the plant extensions, are embedded on a concrete stringer 6in. thick. The cables used for connecting from the feeder pillars to the trolley wires are $^{61}/_{17}$ S.W.G. rubber insulated, heavily braided, and lead covered. The feeder pillars themselves are made up of a cast-iron box, which is raised 2ft. from the ground in those places where there is danger of the pillar being flooded due to the rains. Each pillar contains

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the usual standard switches and connections mounted on a marble or slate switchboard.

Rolling-Stock.—When converting from horse to electric traction, it was decided to adopt the train system, consisting of one motor and one trailer car, the former serving first-class passengers represented by Europeans and well-to-do natives who previously never made use of the tramways, and the latter providing accommodation for the old patrons. This system made it necessary to construct loops or triangles at various points of the lines for the turning of the trains. At present there are 171 single-deck motorcars, of which 96 are of the open type and 75 of the closed type. The motorcar bodies and equipments were made at the Preston works of Messrs. Dick, Kerr, and Co., and the trucks were furnished by Messrs. J. G. Brill and Co.

The car bodies (Fig. 5) are of plain strong construction, made to suit the climatic conditions, teak wood being used throughout, as being impervious to the ravages of white ants. The closed cars have a total seating capacity of 70. The open-type cars, which have a seating capacity of 40 passengers, are single-ended with the entrance from one side only, this being dictated by the loop system that was adopted.

The electrical equipment for each car, as manufactured by Messrs. Dick, Kerr, and Co., consists of two motors with one controller and all accessories. Each motor has a normal output of 25 h.p. under the standard rating. It might be pointed out that the motors have had to stand very severe operating conditions due to the heavy rains, which during the rainy season flood certain parts of the city to a depth of several feet, as already mentioned above. Heavy showers come on so rapidly, that the drainage system is incapable of satisfactorily coping with excess of water, which makes it difficult at times to get the cars out of the low-lying districts, which flood in remarkable short space of time.

Power Station.—The situation of the power station with respect to the tramway system can be seen on Fig. 1, and the general lay-out of the station plant on Fig. 6. The building is a brick structure, covered on the outside and inside with sand plaster, the usual form of building construction prevalent in India. The chimney is constructed of brick, and has a height of 150ft., inside diameter at top 7ft. 6in., and the base of the chimney is 36ft. square.

The equipment of the engine-room at present consists of three main engine-dynamo units of the same design, in addition to which there is a supplementary unit of smaller capacity, suitable for supplying current during the hours when the traffic is light, and likewise in working in conjunction with two of the large units to carry the maximum load in the station, thus leaving one large unit in reserve. The three large engines are of the horizontal cross compound condensing type, with dynamo and flywheel located between the high and low pressure sides of the engine. They are of the Yates and Thom type, and run at 90 revolutions per minute with a working pressure of 120lb. per square inch, and under these conditions the engines develop at their most economical operating point about 675 i.h.p. They are, however, capable of working satisfactorily up to 950 i.h.p., representing 25 per cent. overload. The cylinders are 21in. and 40in. in diameter, with a stroke of 3ft. 6in. The valve gear for working the admission valves is a well-tried release or trip gear of the improved "Dobson" type, consisting of hardened-steel catch plates attached to blocks which are connected by links to the steam valve levers, and have also spindles or rams coupled to the dash-pot pistons. The governor is of the quick-speed type with centre weight and cross arms, designed so as to give the necessary sensitiveness, combined with ample power to overcome the resistance of the tripper gear. A sensitive knock-off appliance is fitted to the governor arranged to disconnect the trippers and hold them in such a position as to prevent steam being admitted to the cylinders, in case the ergine should attain an excessive speed, or an accident happening to the governing gear. The flywheel is about 16½ft. diameter, constructed in sections, and has a weight of about 29 tons. The smaller engine is of the Robb-Armstrong automatic cut-off tandem compound side-crank D.C. type. The indicated horse-power is 250, with 135lb. initial pressure when cutting off at about one-third stroke in high-pressure cylinder at 200 revolutions per minute.

Each of the three large generators constituting part of the main unit is a standard direct-coupled continuous-current railway generator, as manufactured by Messrs. Dick, Kerr, and Co. The normal output of each of these generators is 500 kw., the normal current load rating being that with a working E.M.F. of 550 volts at the terminals of the machine. Each of these generators can safely carry 25 per cent. overload for an hour without injurious heating. The efficiency of each generator is about 95 per cent. full load and about 93¾ per cent. half load. The generator which is coupled to the smaller engine unit has a capacity of 150 kw., and is direct coupled to the engine, the general arrangement and mechanical and electrical features of this machine being practically the same as those for the larger units.

The switchboard is of the panel type, constructed of enamelled slate and supported by an iron framework, the whole placed on a gallery at one end of the engine-room and overlooking the same. The board consists of four generator panels, one main output panel, ten feeder panels, one lighting panel, one motor panel, three negative booster panels, and one Board of Trade panel. The general arrangement is shown in Fig. 7. For assisting the rail-return distribution, so as to comply with the regulations, which are that no part of the track return should show a greater drop than seven volts, three boosters have been installed, connected to the track by insulated return cables. These boosters have a respective capacity of 800 amperes at 80 volts, 300 amperes at 120 volts, and 300 amperes at 70 volts. The engine-room is spanned with the usual overhead crane, designed to lift 15 tons, the manipulation being accomplished by hand.

In the boiler-room there are at present six boilers of the Galloway (Lancashire) type, 30ft. long by 8ft. in diameter, the interior consisting of two furnaces joined into one Galloway flue, the furnaces being 3ft. 3in. in diameter, solid welded longitudinally and flanged transversely. To the present plant has just been added one Babcock and Wilcox boiler, which will not only help out the present installation, but will form part of the large extensions to the entire plant, which will be touched upon below. There are three Weir's patent direct-acting feed pumps, each having ample capacity to supply water for four of the boilers, thus leaving one in reserve for the present nominal output of the power-house. The pumps are 7in. in diameter by 9½in. steam-cylinder, and have a stroke of 18in. Each pump is capable of delivering 30,000lb. of water per hour. Ample cold storage is provided by bunkers immediately opposite the boiler fronts, it being possible to store sufficient coal to operate the plant for four weeks. In connection with the boiler plant a Green's economiser, consisting of 480 tubes, is provided.

The condensing plant is located in the basement of the engine-room, and consists of a surface condenser of sufficient capacity to deal with the exhaust from all three main engines, together with two steam-driven air-pumps (each having a capacity of two units), and two electrically-driven centrifugal circulating pumps, each pump being capable of discharging 72,000 gallons of water per hour through the condensers, and up to the water inlet on the cooling towers. The pumps are mounted on a self-contained bed-plate, with a 35-h.p. motor coupled direct. This plant, in conjunction with the cooling towers described below, is calculated for condensing 36,000lb. of exhaust steam per hour. When this amount of steam is being condensed, and the pumps are working at full speed, a vacuum of about 21in. to 22in. is obtained in the condenser during the cold season, when the atmosphere is dry. During the rains, however, the humidity in the atmosphere is large, and, in consequence, the efficiency of the cooling towers is very much reduced, making it possible to attain a vacuum of only 18in to 19in. with maximum load in the station. At present there are two towers with fan draught installed for the purpose of cooling the water from the condensers, one being of Klein's patent type, the other, which was recently installed, being of the Zschocke type. Both are rectangular towers 23ft. by 20ft. by 40ft. high, divided into two sections.

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Four car-sheds, located at various extremities of the system, have been provided to house the present rolling-stock. The principal shed is that at Nonapookur, located on the same premises as the power station. Adjoining the sheds are the workshops, smithy, foundry, paint and wood-working shops, armature-winding department, etc., and it is here that all extensive repairs to car bodies, trucks, and equipments are carried out, the other three sheds attending to small petty repairs to controllers, lights, and miscellaneous equipments. The Nonapukur car-shed and workshop is shown in Fig. 8 Extensions are now being made to the existing building to accommodate the rolling-stock which has been and will be added to the present equipment, due to the increased service which will shortly be run.

Extensions to System.—To provide sufficient power for additional trains which will have to be run to cope with the steadily increasing traffic demands on the existing lines, and also for the tram service on Harrison-road and several new suburban lines which will be opened in the near future, the power station is being considerably increased, three-phase alternating-current generators being installed generating 6,600 volts direct, the current being transmitted to several rotary converter sub-stations in outlying parts of the city by means of duplicate three-core cable laid separately on the solid system in earthenware troughing. These extensions to plant will form the subject of a future article.

SWANSEA ELECTRICITY UNDERTAKING AND TRAMWAY DEPARTMENT.*

BY C. A L. PRUSMANN, M.I.E.E., A.M.I.M.E., BOROUGH ELECTRICAL ENGINEER.

BUILDINGS.

The buildings situate at the Strand generating station comprise the following: pump-room, boiler-house, economiser shed, engine-room, battery-room, test-room, mess-room, store-room, coal stores, joiners' shop, chief engineer's office, assistant and charge engineers' office, clerk's office, timekeeper's office, bathroom, lavatories, weigh-room, passages and corridors, yards, and chimney shaft.

Pump-Room.—The pump-room is equipped with (1) one three-throw pump by Messrs. Yates and Thom, driven by a shunt-wound motor by Messrs. the British Schuckert Company. The pump is capable of delivering 2,000 gallons of water per hour through an economiser against a boiler pressure of 160lb. per square inch. (2) One three-throw pump by Messrs. Yates and Thom, driven by a single-cylinder engine by Messrs. Yates and Thom. The pump is capable of delivering 2,000 gallons of water per hour through an economiser against a boiler pressure of 160lb. per square inch. (3) One steam-driven "Weir" pump, capable of delivering 4,000 gallons of water per hour through an economiser against boiler pressure of 160lb. per square inch. All the above pumps receive their supply of water from tank situated above the pump-room, which tank is constructed in two divisions; the whole having the following dimensions, 28ft. by 7ft. by 11ft. This tank is supplied with water from the town mains, passing through "Kennedy" water-meters. The steam supply to the pumps is in duplicate, and the arrangement of feed pipes is such as to admit of the pumps delivering boiler feed to the boilers, either direct into the boilers or through the fuel economiser.

Boiler-House.—The boiler-house is equipped with five "Lancashire" boilers by Messrs. Yates and Thom; each boiler is 30ft. long and 7ft. 6in. diameter. They are designed for generating steam at a pressure of 160lb. per square inch. The furnaces are arranged for hand firing, natural draught being employed. The fuel is tipped in front of the boilers through the iron doors adjoining the railway siding, along which the coal trucks are brought. Each boiler is fitted with duplicate water-gauges, duplicate boiler feed check valves, and a pressure gauge. The boilers supply steam to the engine-room by means of duplicate ranges.

Economiser Shed.—The economiser shed is fitted with an economiser by Messrs. Green and Sons, consisting of 190 tubes, designed for working in conjunction with the aforementioned boilers. This economiser is fitted with full complement of valves, fittings, etc. The scrapers of the economiser are driven by a 1-h.p. motor, by Messrs. the British Thomson-Houston Company.

Engine-Room.—The present engine-room is equipped with the undermentioned machinery, plant, switchgear, etc.: (1) One 75-kw. shunt-wound multipolar British Schuckert dynamo coupled direct to a high-speed three-crank compound "Willans" enclosed-type engine, running at a speed of 450 r.p.m. This steam generator is suitable for lighting purposes only. (2) One 225-kw. shunt-wound multipolar British Schuckert dynamo, coupled direct to a marine triple-expansion open-type engine, by Messrs. J. and H. Maclaren, running at a speed of 150 r.p.m., and capable of developing 450 i.h.p. This steam generator is suitable for tramway and lighting purposes. (3) Two 600-kw. shunt and compound wound multipolar "British Westinghouse" dynamos, coupled direct to two marine triple-expansion open-type engines, by Messrs. J. and H. Maclaren, running at a speed of 125 r.p.m., and capable of developing 1,100 i.h.p. each. These steam generators are suitable for both lighting and tramways. The above engines are designed for a pressure of 160lb. per square inch at the engine stop-valves. All four engines are arranged to work either condensing or non-condensing. The 75-kw. steam generator is fitted with a three-throw jet condenser, by Messrs. Yates and Thom, which is driven by means of a 15-b.h.p. shunt-wound electric motor, by Messrs. the British Schuckert Company, coupled direct to the condenser. The 225-kw. steam generator drives, by means of four 1½in. ropes, a jet condenser by Messrs. Yates and Thom. Each of the two 600-kw. steam generators drive, by means of links worked off the intermediate cross-head, a surface condenser by Messrs. Maclaren. In all cases the circulating water for the condensers is obtained from the north dock. Before leaving the main steam-engines and dynamos, it may be of interest to note that when the destructor works engine and dynamo are in operation the condition of affairs will be as follows: One of the 500-kw. generators will be utilised for lighting. The 225-kw. generator at the destructor works will supply those tramways for which the Corporation have to find electrical energy, leaving at the Strand station one 600-kw. generator, to act as a stand-by to both lighting and tramways, and a 225-kw. and a 75-kw. generator to meet immediate future demands for lighting. It will, therefore, be seen that both the lighting and the tramways will be worked with a minimum of stand-by plant, which means an important reduction in the amount of capital charges. Leaving the main generators, and turning to the smaller electrical plant, this consists of: (4) One motor booster for the purpose of charging the batteries, the booster side having a capacity of 165 amperes at 185 volts. The motor side consists of a shunt-wound motor. The combined motor booster is by Messrs. the British Schuckert Company, running at a speed of 765 r.p.m. (5) One 40-kw. shunt-wound balancer, by Messrs. the British Schuckert Company. This machine is utilised for taking up the difference in load on either side of the three-wire system, and runs at a speed of 550 r.p.m. (6) One negative tramway booster, for the purpose of keeping down to within Board of Trade requirements the difference in pressure along the tramrails. This booster has a capacity of 250 amperes at 35 volts, and is by Messrs. D. Bruce Peebles and Co. (7) One milking booster. This is a portable booster for charging up individual cells of the battery, made by Messrs. the British Schuckert Company. (8) The main lighting switchboard. This is situated on the south wall of the engine-room, and is by Messrs. the British Schuckert Company, and comprises: three main feeder panels, one battery panel, one balancer panel, one total output panel, one motor booster panel, and eight main feeder panels. In addition to the above panels on the main lighting switchboard, there are two generator panels, and one feeder panel, by Messrs. the British Westinghouse Company. The whole of the above mentioned are fitted with the full complement of recording instruments, safety

*Paper read at a district meeting of the Incorporated Association of Municipal and County Engineers at Swansea, July 14.

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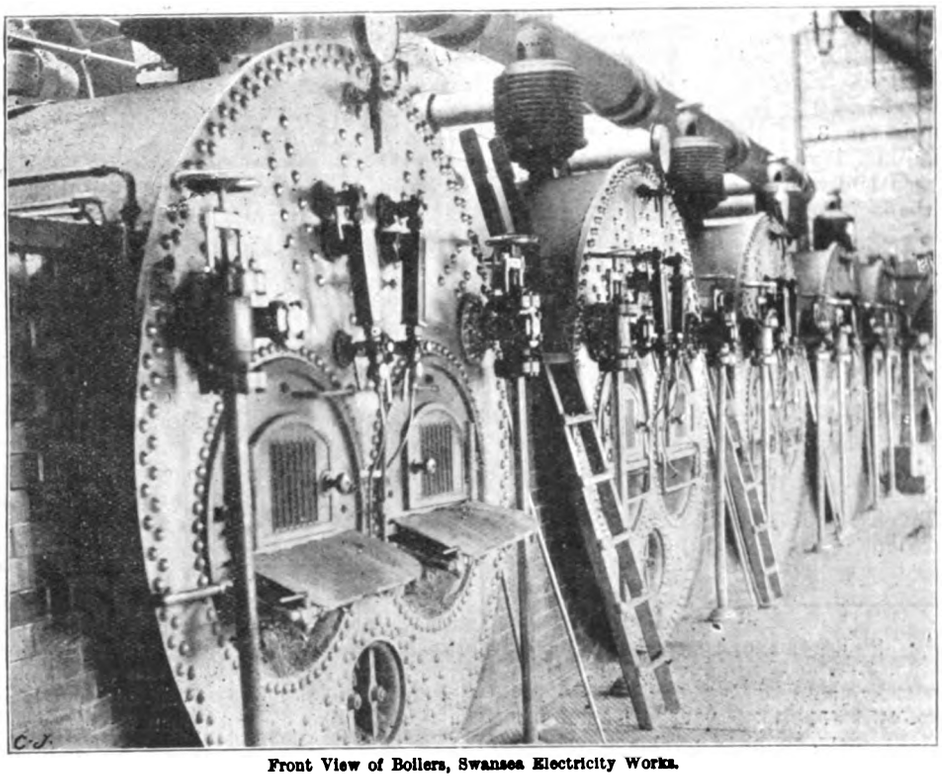
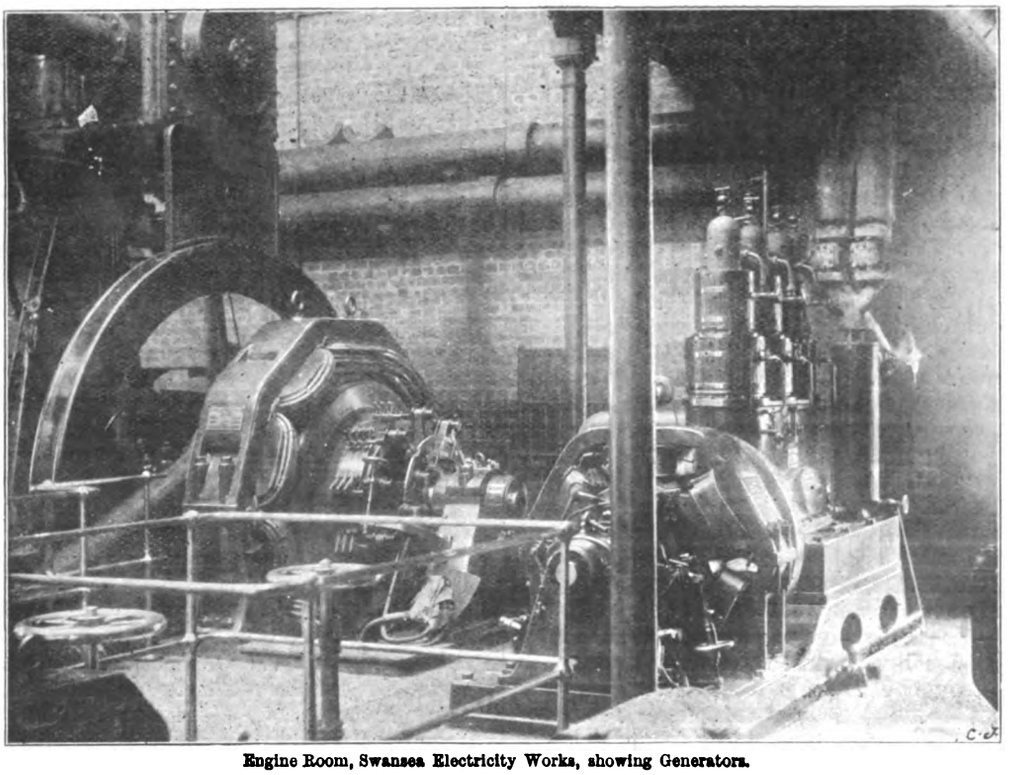
devices, switches, fuses, general instruments, and appliances. The street arc lighting board is distinct from the main board, and is arranged for controlling six series of arc lamps, consisting of nine lamps to a series. (9) The new tramway switchboard. This is situated on the east wall of the engine-room, and is by Messrs. Dorman and Smith. The whole of the switchgear, instruments, etc., on this board are mounted on blue marble. The board comprises one Board of Trade panel, one negative booster panel, one panel for the motor of the negative booster, one total output pane and two feeder panels, containing two feeders on each panel. The back of this board is particularly free to access, for inspection, overhauling, etc. (10) The steam to the engines is carried along the east and west sides of the engine-room by means of duplicate steel pipes on either side, fitted with full complement of valves, etc. (11) The engine-room is spanned by means of a 10-ton hand travelling crane, by Messrs. Carrick and Ritchie. It will be observed that a certain space of the engine-room has not been tiled. In this space it is proposed to fix the high-tension alternators, driven by continuous-current, low-tension motors for supplying electrical energy to the outlying districts.



Front View of Boilers, Swansea Electricity Works.

Battery-Room.—The battery-room is situated on the east side of the engine-room, and contains 258 cells, divided up in two halves on either side of the three-wire system. The capacity of the battery is 650 ampere-hours, and is by Messrs. the Tudor Accumulator Company.



Engine Room, Swansea Electricity Works, showing Generators.

Test-Room.—The test-room is situated on the ground floor on the south side of the engine-room, and is provided with numerous instruments for carrying out meter, arc lamp, mains installation, and dynamo tests.

Coal Stores.—The present coal stores are adjacent to the south side of the boiler-house and are capable of storing approximately 200 tons of coal.

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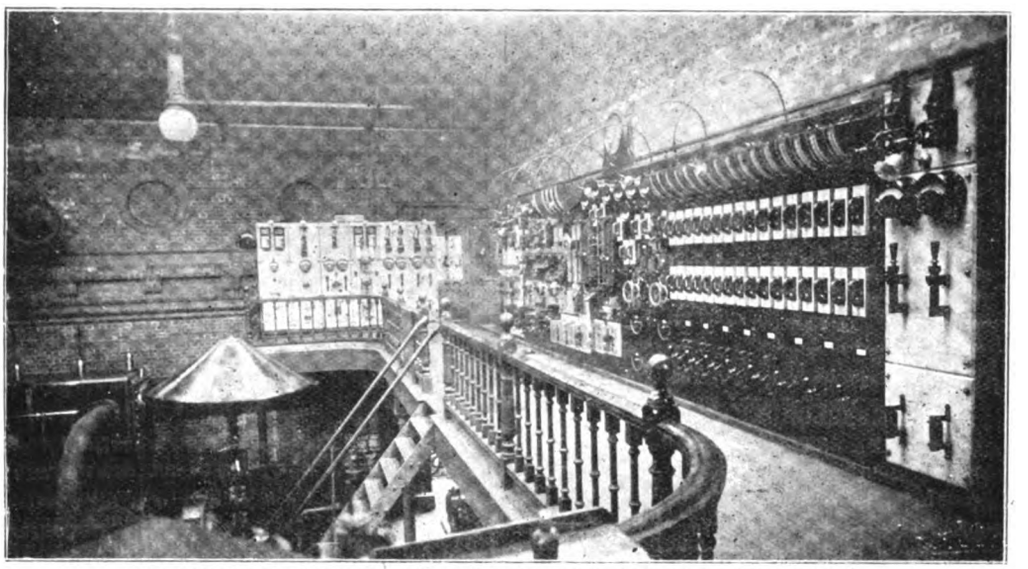
Feeders and Distributing Mains.

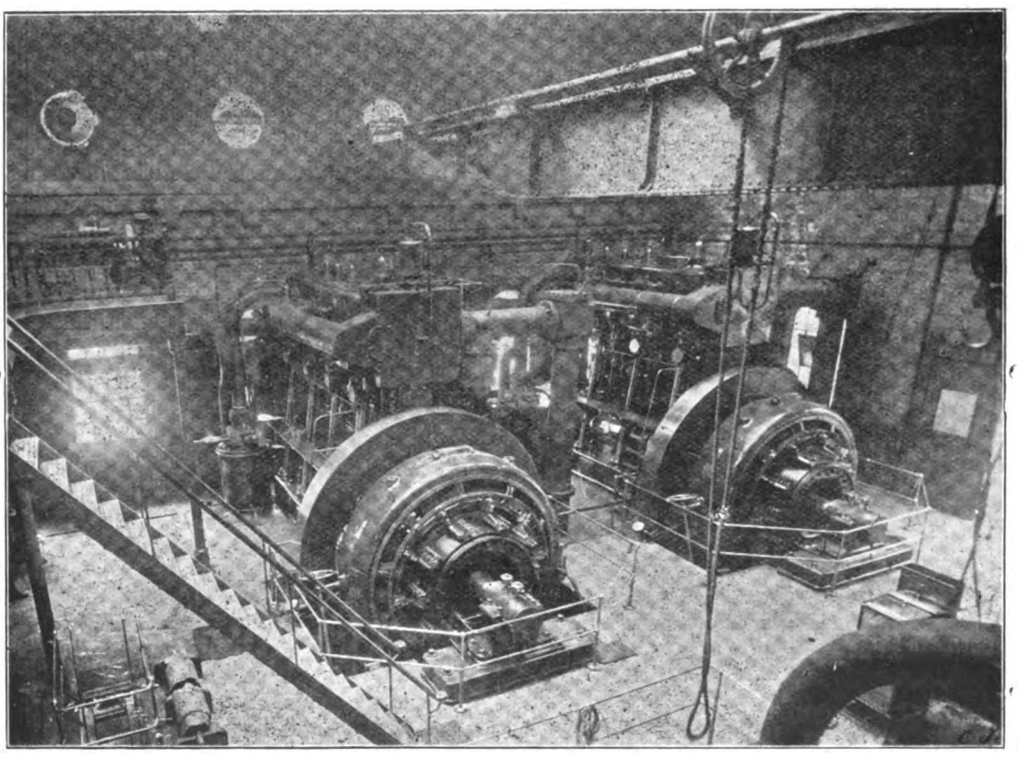
The supply of electrical energy to the town for lighting purposes is delivered by means of (1) Eight main feeders and six sub-feeders—The whole of these feeders are of the hygroscopic, triple-concentric, lead-covered type, and are drawn into 3in. "Albion Clay" and "Doulton" earthenware ducts. The cables are by Messrs. Callender's Cable and Construction Company, and vary in size from the largest, 0·4, 0·2, 0·4 square inch, to the smallest 0·2, 0·1, 0·2 square inch. (2) Main feeder cables crossing the north dock and the new cut—These are of the single-core, submarine, double-wire, armoured type, by Messrs. Callender's Cable and Construction Company, and are laid direct in the bed of the north dock and new cut. (3) Distributing cables—These are fed by means of the above-mentioned feeder cables, and are of the fibre insulation, hygroscopic, lead-covered type, laid in U-shaped earthenware troughs, filled in with bitumen, and finally covered by means of tiles. The cables have a sectional area of 0·1, 0·06, 0·1 square inch. (4) Service cables—The service cables are triple-concentric, and concentric, hygroscopic fibre insulation, lead covered, and laid in a similar manner to the distributing cables. The sectional area of the service cables used are 0·022 concentric and 0·05, 0·025, 0 05 triple concentric. (5) Feeder cables—These are connected to the distributing cables by means of feeder pillars fixed above the surface of the footways, and when these distributing cables are required to be disconnected, this is effected by means of underground disconnecting network boxes fitted with footway and roadway frames and covers. All feeder pillars and underground fittings are by Messrs. Callender's Cable and Construction Company.



Switchboard Gallery, Swansea Electricity Works, showing Lighting and Traction Boards.

Consumers' Meters and Indicators.

Consumers have fitted in their premises (1) meters made by one of the following: Messrs. Chamberlain and Hookham, Ferranti, Aron Meter Company, Reason Company, and the Bastian Meter Company; (2) indicators of the "Wright" type, made by Messrs. the Reason Company; (3) "Reason" fuse boxes are used in consumers' premises.



View of Engine Room from Switchboard Gallery, Swansea Electricity Works.

Equipment in Engine-Room at Destructor Works.

The equipment at the destructor works engine-room, which is to supply electrical energy to the new tramways and light railways, will consist of a 225-kw. engine and dynamo. This engine and dynamo have been removed

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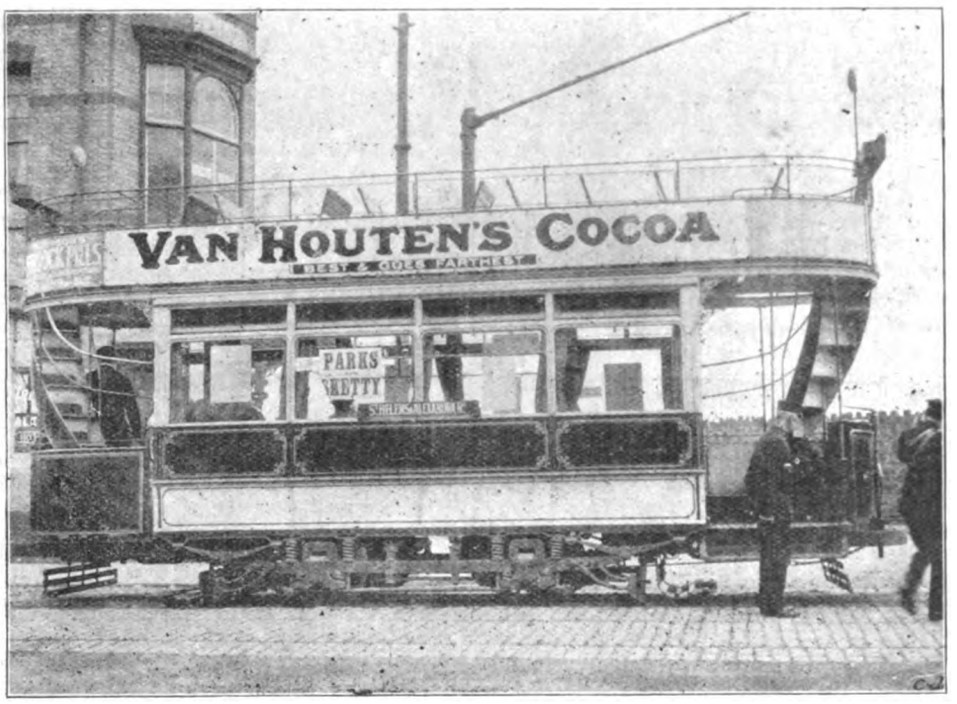
from the Strand generating station, and so altered to enable it to meet tramway requirements. A tramway switchboard will be installed, which is a duplicate of the one at present in use in the Strand station, also tramway booster. The steam to the generating set at these works will be obtained from the boiler, which in the ordinary way will generate steam by means of refuse, and the steam-pipes connecting this boiler with the steam-engine will be laid underground from the boiler in the destructor works to the engine-room. The engine-room at the destructor works is equipped with an eight-ton crane, by Messrs. Herbert Morris and Bastert. The building at these works, as far as the electricity department is concerned, comprises engine-room, offices, stores, and lavatories.

Tramway Overhead Equipment.

The Swansea Corporation have nearly completed some 12 miles of electric tramways and light railways. The bulk being now in operation, and the remaining section it is hoped will be open in the near future. The overhead equipment of these tramways and light railways has been carried out by span-wire and bracket-arm construction; no centre poles have been employed, and no bracket arms over 15ft. 6in. have been used. The line has been erected for straight under-running trolleys, with fixed trolley heads.



Electric Tramcar, Swansea.

Owing to the peculiar atmospheric conditions which prevail in Swansea on account of the various works in the neighbourhood, it has been deemed advisable to use only phosphor-bronze for span and guard wires, as against the usual practice of steel wire, as it has been found that the life of a steel wire under the conditions in Swansea is very short indeed. This course, undoubtedly, has added very considerably to the cost of construction, but it is hoped that the maintenance of the overhead equipment will be very much reduced on this account, and the life greatly prolonged. The size of the trolley wire used is 2/0 S.W.G. Double insulation is used throughout. The whole of the rails are bonded by means of 4/0 "Chicago" crown bonds. Two bonds being used at each fishplate. The track is cross-bonded, and clear way bonded every 40 yards. Special bonds are used at all points, crossings, junctions, etc. Every third tramway pole is earthed on to the rails. In accordance with usual practice, the line is divided up into half-mile sections, and is fed at a pressure of 550 volts. The tramways and light railways in Swansea are interesting from one or two standpoints. Prior to the laying down of the Corporation tramways and light railways, the electrical tramway system was entirely in the hands of Messrs. the Swansea Improvements and Tramways Company, who owned the whole of the overhead equipment, cables, etc., and who supplied electrical energy to the tramways from their own generating station. The new tramways and light railways are leased to the company under certain conditions existing between the company and the Corporation, the company supplying electrical energy to certain portions of the new lines, and the Corporation supplying the remainder, and a very considerable length of the old company's lines are now being supplied by the Corporation. It will, therefore, be seen that the tramways and light railways in Swansea are supplied by means of three distinct generating stations, two of which are owned by the Corporation, the third by the company. The two owned by the Corporation are the main generating station situated in the Strand and at the destructor works. In the ordinary course those sections of tramways which the Corporation have to supply with electrical energy will receive a supply from the destructor works. The main station will take up the supply on those occasions when the load on the tramways is too great for the destructor works to deal with or when the destructor works are shut down for repairs, overhauling, etc. As far as possible, arrangements have also been made to enable the tramway company's station to supply current to those sections, which in the ordinary course receive their energy from the Corporation works, in the event of a breakdown happening at the Corporation works, and *vice versâ*. By adopting this course, it will be seen that the amount of stand-by plant is reduced to as low as possible, as the spare machinery at the Strand station will act as a stand-by to both tramways and lighting. It is, of course, assumed, and the writer believes safely so, that a breakdown to lighting and tramways will not occur simultaneously. The remaining points in connection with the new light railways which should be mentioned are, namely, running cars over the drawbridge spanning the north dock lock, and the swingbridge crossing the River Tawe. In the case of both these bridges, the current is automatically disconnected and connected, when the bridges are open and closed, in such a manner as to make it impossible for a car to approach the dock or the river to within a dangerous distance while the bridges are open. The writer is not aware that a similar case has had to be dealt with in any town in the United Kingdom. The work of installing the overhead equipment has been entrusted to Messrs. Dick, Kerr, and Co. It is interesting to note that all the tramway poles have been made in the town—namely, by Messrs. the British Mannesmann Tube Company.

Tramway Cables.

The whole of the tramway cables for the Corporation's

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new tramways and light railways consist of vulcanised, non-hygroscopic, unsheathed cables, laid solid in 2½in. earthen troughs filled in with bitumen, and finished off with tiles on top. Alongside all of these cables in every case have been laid a number of "Albion Clay" 3in. earthenware conduits, so that in the event of extensions being required in the future, cables will be able to be drawn into these spare ducts without the reopening of any roadway except at intervals of approximately 100 yards, where it may be required to build draw-pits. This, however, will cause very little, if any, inconvenience to traffic of any description. The reason that these draw-pits have not been put in during the laying of the spare ducts, is on account of the fact that possibly the spare ducts may not be required for a considerable time, and, therefore, in the meantime, the capital outlay of the draw-pits and frames and covers is saved, and if these are required at a future date, they can very easily be installed. It is interesting to note that the whole of the tramway cables, after entering the Strand generating station, are kept absolutely distinct from all lighting cables, and are laid in a separate trench very easy of access. It is, therefore, quite impossible to make the mistake, in the case of an emergency, either to lighting or tramway cables, of confusing the two sets of mains.

ELECTRIC TRACTION IN GERMANY.

According to the latest statistics published in the *Elektrotechnische Zeitschrift*, it appears that the towns and districts in Germany provided with electric tramways or railways numbered 138 on Oct. 1, 1904, an increase of four as compared with the returns for 1903. The length of route covered has increased about 100 km., amounting to 3,800 km. The number of motorcars employed has increased from 8,702 to 9,034. This increase is not in proportion to that of the length of route traversed, whence it may be deducted that the traffic on the older lines has increased in average density. The total output of the generating plant available for traction load has increased by only about 1½ per cent., while the total output of accumulators on traction load shows an increase somewhat greater in extent, the total accumulator capacity installed amounting on the date in question to 39,809 kw. The small increase in generator output is accounted for by the fact that the Hanover tramways return only 4,555 kw. as against 10,063 kw. in 1903. No material change has occurred in the system of working most in vogue. There is a strong tendency to abandon conduit and accumulator systems in favour of the overhead trolley throughout for street railways, principally for reasons of economy. Mixed working by trolley and accumulator cars is retained only in Dresden, while trolley working in conjunction with sections of conduit line exists in Berlin, Dresden, and Dusseldorf. The reliability of the conduit system as compared with that of the overhead trolley line leaves much to be desired, according to German experience, so that its entire substitution by the last-named is apparently only a question of time. Lead and return overhead conductors are provided over sections of the Königsberg lines. Accumulator traction pure and simple on tramways is retained only on a section 4·2 km. long in Bremerhaven, while the remaining portion of the system, comprising some 11·4 km. of track, is still worked by horses. It is, however, intended to equip the whole of the lines for the overhead trolley system of working. On the other hand, it is interesting to note that accumulator traction has held its own on railways proper, and even been extended in some instances. The Ludwigshafen-Mundenheim local railway still retains its service of accumulator cars after 10 years' experience of their working. This line has a length of 5·2 km. It maintains two cars, one being equipped with two motors of 12 h.p. each, and the other with one motor of 20 h.p. No figures are given as to the cost. Further, the Kgl. Bayer-Pfälz Railways have accumulator traction on 10 sections of line, with a total length of 288 km. In this case six accumulator cars are employed, each equipped with two 40-h.p. motors. These cars act as auxiliaries to the steam-hauled trains for local service on the main and branch lines of the system, ordinary passenger cars being attached to form trains when necessary. Similar services are being tried, more or less experimentally, on the main-line sections Augsburg-Gessertshausen, Karlsruhe-Graben, and Dresden-Cossebaude. A third rail is used on the main-line section Berlin-Gross-Lichterfelde, and on the Berlin elevated and underground railway; while an iron conductor rail is also employed on the Barmen-Elberfeld suspended railway. It is noteworthy that single-phase alternating current continues to gain ground. Due to the successful trials on the main-line section Niederschönweide-Spindlersfeld, this system has been adopted for the Hamburg-Altona Railway and its extensions, the work being already in hand. Moreover, single-phase has been substituted by the Siemens-Schuckert Co. for the three-phase system of working formerly employed on the Murnau-Oberammergau local line. Other traction plants of similar type have been installed by German engineers in Austria, Belgium, and elsewhere, and plans are in hand for the introduction of the same system on the Berlin town and ring railway. With regard to traction without rails, minor difficulties, it appears, have been overcome, and the system is now giving satisfaction in working. Experience so far also promises commercial success, but it is too early to speak of definite results. In all, there are six routes worked on this system, having a total length of 21 7 km., the carriage of goods being the principal use to which the cars are put.

It remains to add that the large volume of traction work in hand promises well for future returns from a relative point of view.

GRIMSBY ELECTRICITY ACCOUNTS.

In the accounts of the Grimsby Corporation electricity department for the year ended March 31. 1905, the total capital expenditure to that date is stated as £80,937. Abstracts of the revenue account, balance-sheet, and statement of electricity, sold, etc. are appended.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	3,014	3	9
Distribution of electricity	253	3	6
Attending and repairs to public lamps	354	5	2
Rents, rates, and taxes	317	8	4
Management expenses, salaries, etc.	835	11	4
Law expenses negotiating loans	172	17	3
Special charges—insurances, etc.	76	18	0
	5,024	7	4
Amount set aside for bad debts	68	0	1
Balance carried to profit and loss account	5,786	7	3
	£10,878	14	8

Cr. Income.	£	s.	d.
By sale of current by meter	10,446	11	0
Rental of meters and sale of lamps	277	6	7
Discount received	154	14	9
Balance from last account		2	4
	£10,878	14	8

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	79,000	0	0
Sundry creditors	2,501	4	3
Balance at credit of net revenue account	895	5	9
Sinking fund account	6,841	9	6
Provision for bad debts	68	0	1
	£89,305	19	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	80,937	15	6
Stores on hand	1,852	7	8
Sundry debtors for current supplied	2,910	12	4
Other debtors	208	4	11
Securities held (cost price)	1,390	17	10
Sinking fund on deposit	1,918	8	0
Cash in hand	87	13	4
	£89,305	19	7

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			1,159,144
Quantity sold: Private consumers by meter	458,224		
Public lighting	102,986		1,024,982
Traction	463,772		
Quantity used on works			58,087
Quantity unaccounted for			76,045
Total maximum supply demanded (kilowatts)			647

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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"THE ACCOUNTANT" AND DEPRECIATION.

It is with a feeling somewhat akin to despair that we challenge the *Accountant* to make good its position with regard to municipal work, and especially in regard to depreciation of tramways. In its last issue it has a leading article on "Municipalities and Depreciation," the tenor of which is, if our memory serves us correctly, of the same character as of many a previous article in its columns. The *Accountant* aspires to the position of autocrat in the cult of accountancy. To venture to differ with its dogmatisms is to put oneself into jeopardy. A slip is serious, and will result in the one who slips being pilloried to all eternity as far as it is possible for the *Accountant* to do so. Still, the subject is of importance, and must not be left in the slip-shod position it holds, where every writer and speaker defines everything as it pleases him in order to make his own case good. At present there is no shadow of agreement anywhere, but on this point dogmatism. From our reading of the *Accountant* we gather that all municipal accounts are kept in a childish manner, while corresponding companies' accounts are flawless. Is it possible to get a common starting point—where all are agreed—then to see wherein we differ in the various divergencies from that point? Municipal action is open to enough adverse criticism without innuendo or variant definitions. Here is a problem for the *Accountant*. The B.E.T. is a company; the Brighton concern is that of a municipality. Both keep accounts. The accounts such as they are can be examined. Will our contemporary with its wealth of expert knowledge examine these sets of accounts and pronounce which treats depreciation in the best manner? We also want to know what really a compulsory sinking fund is if it is not compulsory depreciation? If, as we for the moment dogmatically assert, a sinking fund is depreciation, the minor question may arise, is it too small? So far as a municipality is concerned, the question of enough is settled by a higher authority; hence if the amount is in the estimation of the *Accountant* not enough, its work should be to prove its case to the higher authority. What exactly does the *Accountant* mean when it writes about depreciation? Till we get that definition we cannot tell how far the sneering suggestiveness of the phrase "certainly ought to be no difficulty in showing *very* substantial profits" is warranted. A large part of the article we have referred to merely discusses a verbal quibble. The *Accountant* says: "We altogether fail to grasp the point of the argument." If that be quite true, it means that the writer is incompetent to criticise; but is it? We feel grave doubts on this point. The committee criticised says that repairs are made out of revenue. The engineer says no extensive replacements will be required for five or six years, also that revenue is increasing. The suggestion of the committee is, rightly or wrongly, that the increasing revenue will be sufficient to meet any demands for repairs, etc., even at the end of five or six years; and, therefore, no further special provision is necessary. The so-called dead charge is surely partly or wholly met by the sinking fund, and does not need any separate fund unless the sinking fund is shown to be too small. The whole case may be summed up in a few words. Municipal affairs are to be condemned, and the mode of condemnation is to discuss "depreciation"—a blessed word like Mesopotamia—which nobody defines or understands. Nothing the municipalities can do in their accounts amounts to depreciation, and any lapse in the accounts is due to lack of depreciation, but what the change is to be in order to conform to abstract requirements neither the *Accountant* nor any of the opposition ever tell us. If the respected opponents to municipal trading will tell us that such trading is neither fish, fowl, nor good red herring,

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and that trading of any kind involves risk, we will agree; but to be continually harping upon a string that only exists in the imagination of dreamers serves only to rouse the combative instincts of those who want to get at the truth, and only the truth. The one great question so far as accounts are concerned is, are they clear enough to show solvency or insolvency? Is there absolute certainty that assets are equivalent or more than equivalent to liabilities? The question of the rights or wrongs of municipal trading is another matter.

CORRESPONDENCE.

ADDRESS WANTED.

Will "W. J. H.," the writer of an article entitled "Notes on the Care and Management of Dynamos," recently published by us, kindly send his full address.—[ED. *E. E.*]

ROYAL COMMISSION ON LONDON TRAFFIC.

In our last issue we published a *résumé* of the report of the above Commission dealing specially with their recommendations as to tramway extensions and road improvements.

With respect to tube and other underground railways, the adequacy of the central urban facilities of transport for the distribution of passengers arriving at the main-line stations in London is discussed, with the conclusion that after the underground railways now under construction or in process of electrification are in operation, all the main-line terminals, with the exception of Paddington, Victoria, and Fenchurch-street, are sufficiently provided for. To meet the case of Victoria the Commission recommend the extension of the North-West London Railway from Marble Arch.

In regard to urban railways the conclusion is stated as follows: "We have come to the conclusion that, when the 'tube' railways already authorised have been completed, with the addition of the line we have suggested from Victoria to Marble Arch, the most pressing requirements of railway communication within the central area, as distinguished from the suburbs, will have been fairly provided for. We think, however, that greater attention should be paid to providing interchange stations wherever lines running north and south intersect those running east and west, and that wherever it is possible this accommodation for the public should be afforded."

The Commission then discuss the practicability of securing the construction of further underground railways in London. They express their reliance on private enterprise to provide any extensions needed. All that is necessary is to see that no discouragement shall be created for private enterprise by the system of procedure under which railway undertakings are authorised, or by the imposition of undue burdens proposed on, or exaction of impossible conditions from, promoters. If public assistance is inevitable, and the Commission think that neither the construction of unremunerative underground railway lines or the running of unremunerative trains should be laid on railway companies, the Commission suggest various methods of assistance—the remission of rates, direct subscription to capital or guarantee of receipts by local authorities, permission to railway companies to acquire large tracts of land before development, and, in cases, permission for construction underneath the parks.

The Commission then discuss the relative advantages of tubes and shallow railways under the four heads of (1) economy of cost of construction; (2) avoidance of interference with street traffic; (3) avoidance of damage to property; (4) ventilation, convenience of access, etc. But although they report in favour of the shallow railway as against the tube, they recognise that the construction of the former is in may cases quite impracticable.

The Commission state that all large systems of mechanical traction can be worked most economically and with the greatest advantage to the public when they are under one and the same management, and believe that amalgamation can be carried out in such a way as to be profitable to the shareholders and advantageous to the public, but they think that it should only be sanctioned on terms and conditions which fully secure the interests of the public.

The Powers and Duties of the Proposed Traffic Board.

The authority which the Commission recommend to be established should be a Traffic Board, and should discharge definite and practical duties. It should make a yearly report to Parliament on locomotion, transport, and traffic in "Greater London," dealing with the whole subject, including such matters as the control of traffic, the regulation of the statutory powers of breaking up the streets for various purposes, the removal of any special obstructions to traffic, the provision of new lines of railway or tramway, and calling attention to any errors or oversights in the maintenance of streets and roads on the part of local or street authorities. It would also deal with the question of street improvements, including street widenings and the construction of new streets, as well as the provision of alternative routes, and of facilities for dealing with cross traffic.

The most important function of the Board would be the preliminary examination, before consideration by Parliament, of Bills seeking statutory powers for the construction or extension of works affecting the means of locomotion and transport in "Greater London."

The Board would sit continuously, and Bills that required serious amendment could remain before the Board until the necessary antecedent formalities were completed. The Board would use its discretion as to suggesting amendments in Bills, in order to bring the particular proposals before it into harmony with any general scheme which might be approved for the provision of facilities for locomotion and transport in London. It would be at the option of the promoters of the Bill to accept or reject such suggestions. The Board could also with advantage settle, subject to the approval of Parliament, all clauses for the protection of public or private interests. On completion of their inquiry, the Board would pass on the Bill, with all amendments accepted by the promoters, to Parliament, accompanied by a report. The members of the Board, or any of them, or a representative of the Board, might be required to attend before select committees of Parliament to explain the grounds of their report or recommendations, and to give advice on any subjects referred to them. The Board would also deal with or report upon any questions which might be referred to them by a select committee of Parliament.

If required to do so by Government or by a local authority, with the approval of Government, the Board should prepare schemes for works for or in connection with or report upon the provision of means of locomotion or transport in any district. The Board might also hear and determine all disputes relating to through running or the interchange of traffic on or between railways and tramways, or as to by-laws, whether between local authorities or private companies; and could perform a useful service by facilitating and suggesting amalgamation or joint working under suitable conditions, which its position as preliminary examiner of Bills would afford it special facilities for so doing.

The services of the Board would be valuable in connection with the abolition of the "veto" in the case of tramways, because the existence of such a body would at any rate lessen the objection to such a measure on the part of the authorities now possessing the "veto." Though the nature of the duties which it is suggested the Board could perform have been indicated in general terms, the Commission strongly deprecate the idea that the list of duties is exhaustive. Experience and further consideration will doubtless show that other duties may, with advantage, be added to those which they have mentioned.

As regards the constitution of the Board, what is required for such purposes, in the opinion of the Commission, is a small number of specially qualified persons, selected solely on the ground of their competence, and holding office for a con-

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siderable period, subject always to good behaviour. They suggest the Board should consist of a chairman and not more than four nor less than two other members; and prefer that there should be not more than three members in all. No member of the Board should engage in any business, or have any interests, which might conflict, or appear to conflict, with the proper discharge of his official duties; nor should he be a member of any local authority in London; or have any occupation which would limit the time which he could devote to the work of the Board. What appears, they think, to be really essential is that the members of the Board should be capable men of business, energetic, impartial, and able to devote, if necessary, their whole time to the work of the Board. The Board would keep in touch with all the local and other authorities in Greater London, and maintain a friendly attitude towards them and towards all companies and persons that work railways, tramways, or other means for facilitating locomotion and transport. The cost of the Board, with that of its establishment, in excess of the fees levied in connection with it, should be levied rateably from the local areas within its jurisdiction.

THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

(*Continued from page 97.*)

Amongst other witnesses for the Bill was Sir WILLIAM WHITE. As director of Messrs. Swan, Hunter, and Richardson, shipbuilders, he was convinced of the advantage of electric driving for shipyards. His firm took power from the Tyneside company. A similar movement was taking place in other Tyneside shipbuilding yards, and, indeed, among the industries of the district generally. This was owing to the success of the great system for supplying electric power established in that part of the country by the promoters of the present Bill. His firm paid $\frac{7}{10}$d. per unit for electrical power, and had found it profitable to abandon their own generating station. The experience of Tyneside convinced him that the scheme before the committee would be beneficial to London.

A number of manufacturers were also heard in favour of the Bill.

Mr. J. FALCONAR, as director of the limited company formed to promote the Bill, explained the financial side of the scheme. His co-promoters numbered 70, of whom 42 were London gentlemen largely interested in manufacturing enterprises, and the rest were gentlemen mostly connected with the Tyne. The amount first suggested as sufficient for promotion purposes was £12,000, but this amount was afterwards increased to £50,000, of which £47,000 had been subscribed. That was the actual cash which had been subscribed up to the present, but the witness had no doubt that the capital of five millions sterling would be raised without difficulty. The promoters and their friends would take up the whole of the first issue without appealing to the public. So far as the financial side of the scheme was concerned, the promoters had been advised by Baring Bros. The Newcastle Company had had no difficulty in raising a million, and recently had obtained £350,000 for the Durham power scheme. He had carefully considered the purchase clause, and thought that the 50 years' period was reasonable. The period recognised by Parliament under the Electric Lighting Act of 1888-89 was 42 years, and he had started with that as a basis, and having regard to the fact that one must expend one's capital in anticipation to a much larger extent when dealing with a supply of electricity for power purposes than when dealing with lighting. Some allowance should, therefore, be made on that account. Under the Electric Lighting Acts there was no sliding scale, the companies being at liberty to make as much as they could out of the public during their period of concession. In such a business as was contemplated under the Bill there must be very heavy initial capital expenditure, and returns would not come in for some years. Success depended upon liberal and prudent expenditure of capital as demands arose; there must be looking ahead, and the promoters must be prepared to undertake the risk. The terms of purchase would be the amount of capital expenditure at the date of transfer certified by a Board of Trade auditor year by year. There would be considerable advantage in definitely fixing the terms. Investors would know what the purchase price would be. Much injury had resulted in the past from the doubt as to what a company would receive in the event of purchase. Nobody knew the effect of the purchase clause in the Tramway Act until the first term of 21 years ran out, and then there was great difference in judicial opinion even in the House of Lords. The purchase clause had been submitted to the Board of Trade, and certain verbal alterations had been made. As regarded opposition from local authorities, the following had withdrawn their objections to the Bill: the Borough Councils of Chelsea, Greenwich, Stepney, and Wandsworth, the borough of Croydon, the Urban District Councils of Barking Town, Grays Thurrock, Wanstead, Woodford, Chislehurst, Bexley, Erith, and the Maldens and Coombe, the Rural District Councils of Croydon, Dartford, and Bromley, and the Essex County Council. The following companies had also withdrawn their opposition: the Kent Electric Power Company, the County of London Electric Supply Company, the County of Surrey Electric Power Distribution Company, and the Bromley Electric Power and Lighting Company.

The principal sub-section in the clause for the protection of Croydon reads as follows: "(1) The powers of the principal Acts and this Act and of the Acts incorporated herewith shall not be exercised within the county borough of Croydon, except (*a*) for the purpose of obtaining access through the said borough to places beyond; (*b*) for the purpose of supplying energy to railway companies whose lines pass through the said borough or to any dock, canal navigation, or Government department; and (*c*) for the purpose of supplying energy to the Corporation by agreement only for the purpose of any tramways, waterworks, electrical, or other undertaking. (2) Any electric lines proposed to be laid down by the company within the borough for the purposes mentioned in the preceding sub-section shall be laid down in such lines or routes as the Corporation and the company may agree, and such electric lines shall be laid in trenches of such reasonable dimensions as the Corporation in their discretion may direct in writing under their common seal, and the company shall be subject to any reasonable terms and conditions which the Corporation may from time to time attach to any such consent." The remaining sub-sections make the company responsible for moving mains in the event of street widening, and for any damage done by the construction of mains to Corporation property.

Under cross-examination, Mr. Falconar said that there was nothing in the Bill to prevent the promoters making a profit by the sale of their right. The reputation of the promoters was, however, at stake. Two million pounds would suffice to start the undertaking. There were no provisional contracts or undertakings or understandings with German firms or anybody else; the promoters were untrammelled by any conditions; manufacturers generally were their friends, and a good many local authorities and companies.

The CHAIRMAN asked if the Board of Trade, through its auditor, would enforce a reasonable allowance for depreciation of plant.

Mr. FALCONAR said there could be no doubt of that, and, in further defence of the purchase clause, said it would protect the public against a recurrence of what took place when the water companies were bought up. In some cases water companies got three times the amount of their capital expenditure. Negotiations were proceeding with other companies in addition to those mentioned, but no further actual agreements had been arrived at.

Mr. C. PELHAM, the secretary of the Board of Trade, made a statement as to the purchase clause, but would not express any opinion officially. He did not go into the witness chair. He said that the Board of Trade had seen the promoters and had suggested certain amendments to the clause which would make it workable. At the same time the Board was not prepared to express any opinion as to the policy of the clause, as they had heard no evidence for and against it, and, consequently, had nothing to guide them. The only guide which the Board had in the matter was

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the recommendation of the Joint Committee that bulk undertakings should not be purchasable by the local authorities. That recommendation had been given effect to as regards power schemes generally. As to the price, the terms proposed by the promoters were certainly far more favourable than the terms of the 1888 Electric Lighting Act. He knew of no precedent for the price being fixed by the future expenditure, and mentioned the case of the purchase of the bridges by the old Metropolitan Board of Works, when the price was fixed by the capital invested. That principle had also been adopted in the Bill promoted by the Government in regard to the Port of London. The Board of Trade was not, however, prepared to express an opinion as to whether that was the right method of fixing the price. It ought to be made quite clear that the depreciation fund at the time of purchase should go over to the purchasing authority. It was certainly reasonable that a power distribution company should have a longer time than that given to an ordinary company working under the 1888 Act. As to the desirability of having the clause at all, he could not at present give any opinion.

After further evidence from Mr. FALCONAR and Mr. G. FARRER, of Messrs. Baring Bros., the case for the promoters was closed. The last witness said that his firm would be willing to finance the scheme.

Mr. FREEMAN, K.C., representing metropolitan borough councils, opened the opposition to the Bill.

Mr. C. H. WORDINGHAM was the first witness and criticised the Bill at length. He disputed the accuracy both of the capital outlay estimates and also those dealing with income and working costs. He contended that the assumptions on which the promoters' figures were based were incorrect. He did not think there would be an enormous demand for electrical energy at ½d a unit, and he considered that sufficient notice had not been taken of the development of the gas-engine as a source of power.

ELECTRIC WINDING MACHINES.*

BY PROF. PAUL HABETS, OF BRUSSELS.

(Continued from page 89.)

ELECTRIC MOTORS FOR HAULAGE: THEIR STARTING PROPERTIES.

The machines used for electric haulage are either three-phase asynchronous motors or continuous-current motors. The latter may be shunt-wound, or separately excited. Both types of machines possess a remarkable degree of self-regulation—*i.e.*, their speed only varies slightly with a considerable variation of load.† This property makes the machine very easy to manipulate. The driver need not trouble about the speed, as it never exceeds the normal speed much, even when the resisting torque is negative, in which case the motors turn into generators sending energy back to the station. Continuous-current series machines, although used for electric traction, are not suitable for haulage, as they run away when the load diminishes. The advantage of a better starting torque, which these machines can furnish, is, however, only relative, as motors of the other types can easily produce torques three or four times the normal one. Such torques are necessary, as the resisting moment at the end of the acceleration period is often double as great as the rate velocity moment. The starting of electric motors requires special contrivances, on the design of which the consumption of energy during acceleration depends. We have shown that during the acceleration period the motor must develop a torque given by curve A B′ (Figs. 2, 3, and 5) in the cases treated above. As the author wishes to discuss the starting properties of these motors more thoroughly, he thinks it would not be out of place to give a short account of their mode of working.

Three-Phase Asynchronous Motors.—The torque produced by a polyphase asynchronous motor is (1):

$$C = \frac{K^1 H^2}{r} \times \frac{\omega_1}{1 + \frac{\omega_1^2 L^2}{r^2}} = K^1 H^2 \frac{1}{\frac{r}{\omega_1} + \frac{\omega_1 L^2}{r}}.$$

K^1 is a coefficient; H the rotary magnetic field due to the inducing currents; ω_1 is the slip which is equal to the difference of the angular velocities (ω) of the rotary field and (ω^1) of the induced field or rotor; r the electric resistance of the rotor circuits; L their coefficient of self-induction. The angular velocity ω is equal to $\frac{2\pi f}{2p}$, where f is the frequency of the current and $2p$ the number of inductor poles. Under normal conditions, the velocity ω^1 does not differ more than 2 or 3 per cent. from ω, hence $\omega_1 = 0{\cdot}02$ to $0{\cdot}03\ \omega$. When the intensity of the field is constant, the torque will be a function of the slip only. In Curve I., Fig. 6, the ordinates represent the torque, and the abscissæ, which are reckoned positive to the left of the origin, O, represent the slip. When the slip is zero the torque is also zero; and if the rotor was driven at a speed ω^1 larger than ω, due to a negative resisting moment, the motor would become a generator and would oppose the resisting moment.

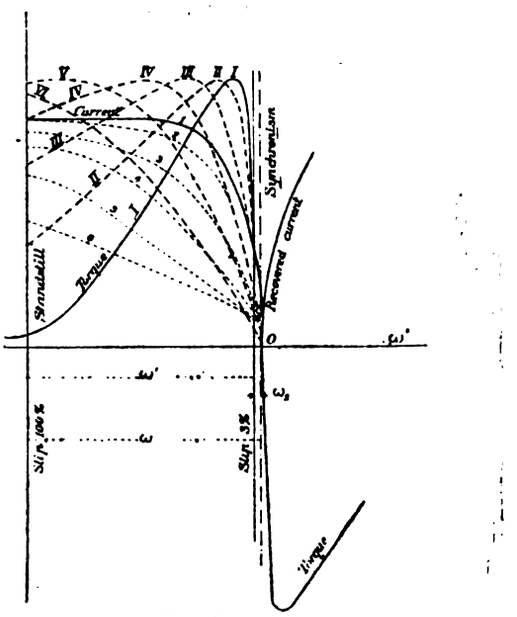

FIG. 6.

Curve I. also shows that in the neighbourhood of synchronism, the torque of the motor may vary between wide limits without causing much variation in speed. When ω_1 increases progressively from zero, the torque will also increase progressively, and becomes a maximum when $\frac{r}{\omega_1} + \frac{\omega_1 L^2}{r}$ is a minimum—*i.e.*, when $\frac{r}{\omega_1} = \frac{\omega_1 L^2}{r}$ or $\omega_1 = \frac{r}{L}$; the maximum torque will be $C_{max.} = \frac{K^1 H^2}{2L}$. The torque will now diminish as ω_1 increases progressively from $\frac{r}{L}$, and when ω_1 is equal to ω, then ω^1 will be zero and the motor will come to a standstill; we have then

$$C = \frac{K^1 H^2}{r} \times \frac{\omega}{1 + \frac{\omega^2 L^2}{r}}.$$

It will be noticed that the torque changes sign with ω_1—*i.e.*, it becomes a resisting moment when ω_1 is greater than ω. The maximum torque may attain a value three to four times greater than the normal torque corresponding to $\omega_1 = 0{\cdot}02$ to $0{\cdot}03\ \omega$. Curve 1 (Fig. 6) shows how the current varies with ω_1; it will be seen that at starting (standstill of rotor) the current is notably stronger than at the normal speed. In the case of powerful motors (above 5 h.p. or 7 h.p.) a current of such strength cannot be taken from the mains without causing an inadmissible fall of voltage, nor are the motors designed to carry such a current; the small torque which corresponds to $\omega_1 = \omega$ is not sufficient to start the rotor, especially if it has to drive a winding

* Paper read before the Institution of Mechanical Engineers (translated from the French).

† On condition that the difference of potential between the terminals of shunt or separately excited machines is constant.

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machine. For this reason we must adapt some contrivance by which we can increase the torque and reduce the current.

Starting Rheostat.—The only method which has been used with three-phase motors for driving haulage machinery consists in inserting variable resistances, r^1, in series with the three circuits of the rotor. We must therefore substitute $r+r^1$ for r in the formulæ, if r^1 is non-inductive. The maximum torque may thus be produced when the slip is $\omega_1 = \frac{r+r^1}{L}$, and by giving r^1 a value which will make $\omega_1 = \omega$, we will have the maximum torque at starting. These conditions are represented by Curves VI., 6. The resistance, r^1, inserted in the rotor circuits prevents the currents from rising too much, notwithstanding the large slip, ω_1, and hence the currents in the inductors will not exceed the normal strength. By reducing the resistance, r^1, successively, the torque and current curves change respectively to V., 5; IV., 4; III., 3; II., 2; and finally to I., 1, when the last resistance has been cut out. The use of a starting rheostat causes considerable loss of power during the period of acceleration. The current will be proportional to the resisting moment given by curve A B', and as the voltage (?) (*tension du reseau*) is constant, the

Liquid Rheostat at Preussen II. and at Grand Hornu.

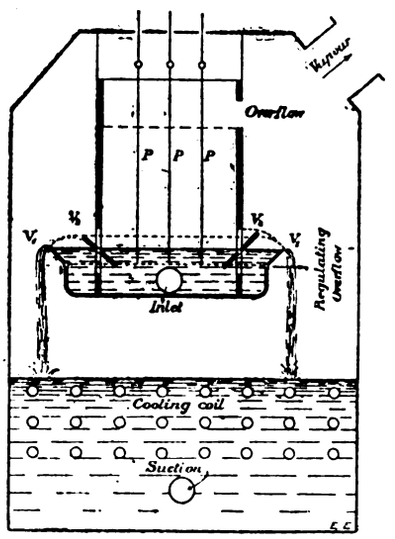

FIG. 7.

electrical energy absorbed will be equal to this moment multiplied by the angular velocity and the efficiency of the motor at such a charge. This loss will be less felt when the startings are less frequent; when the pit is very deep, the period of acceleration will be small compared with the period of constant speed. With regard to simplicity, this method is certainly superior to any other, and for this reason it is always adopted where three-phase motors are used for driving haulage machinery. The Allgemeine Elektricitäts-Gesellschaft of Berlin have designed a rheostat with liquid resistance, consisting of two vessels, the one above the other. The liquid is kept in motion by a small centrifugal pump driven by an electric motor of 2 h.p. to 3 h.p. The pump takes the liquid from the lower vessel and forces it back into the upper vessel, in which three metallic plates (one for each rotor circuit), electrically insulated, are suspended (Fig. 7). The upper vessel has an overflow, and the plates are only immersed to a depth corresponding to the required resistance. By manipulating the starting lever, which works the reversing switch and closes the inductor circuit, a stop-valve, V_2, will be closed; the level of the liquid in the upper vessel will therefore rise, and the plates will be more and more immersed. The rate at which the water rises can be regulated by a cock on the inlet pipe. The maximum speed of the machine is reached when the liquid has risen up to a second overflow, which is always open, and which causes the liquid to overflow continually from the upper vessel into the lower one. The circulation of the liquid prevents it from getting heated. When the lever of the reversing switch has been pushed home, to the right or left, according to the direction in which the machine is to turn, it may be moved back through a certain angle without breaking the circuit. In doing this the stop-valve is gradually opened so that the water can run out again, and the speed will be reduced as desired. The circuit will not be broken until the lever is turned back into its vertical position; as the level of the liquid is falling steadily, the current, as well as the speed, of the motor will be gradually reduced; the interruption, therefore, will not be sudden. The immersion of the plates may be further limited by an overflow, V_1, so as to reduce the speed when persons are carried up and down. When the pit or the ropes are to be examined, the speed may be still further reduced by regulating V_1. The conditions, when using starting resistances, are very unfavourable to the electric brake; one cannot count on recovering the energy, but one must try to utilise the energy stored in the moving masses as much as possible, and to let the cage arrive at the mouth of the pit with a much reduced speed which will only require the brake for holding the cage. The intermittent working of haulage machinery and the increased energy wanted for starting a three-phase motor with the rheostat causes sudden and irregular demands on the generators at the power station. The latter machines are to be designed accordingly large enough and supplied with sufficiently heavy flywheels. If this is not the case, the result will be a fall of speed and voltage which will be felt all over the area of distribution; this is the case at Preussen, and even at the coal mines at Grand Hornu, where the generating plant comprises engines, one of 2,100 h.p. with 75 tons flywheel, and one of 4,200 with 100 tons flywheel. This engine is to be worked with three winding machines. Only one is at work at present with the 2,100-h.p. engine. The electrical energy delivered varies from 300 kw. to 900 kw., and the fall of voltage is about 10 per cent. Direct driving of winding machinery by asynchronous motors requires generators capable of standing a considerable overload, and the installation of very powerful sets at the power station. This means an increased expenditure for extra boilers, steam-engines, and alternators; but, on the other hand, the use of three-phase machines is much simpler and much less costly than transforming alternating currents into continuous currents.

Continuous-Current Motors.—The fundamental equations for continuous-current motors are (1):

$$i = \frac{E-e}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$p = i\,e = i\,n\,N\,\Phi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$c = \frac{i\,n\,\Phi}{2\,\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\omega^1 = 2\,\pi\,\frac{N}{60} = \frac{2\,\pi}{60}\left[\frac{n\,\Phi\,E - 2\,\pi\,r\,C}{n^2\,\Phi^2}\right] \quad . \quad (4)$$

$$\omega^1 = \frac{2\,\pi}{60} \times \frac{E - i\,r}{n\,\Phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where i is the current passing through the armature;
E the difference of potential between the terminals;
e the counter E M F.;
r the resistance of the armature;
p the mechanical power given off;
n the number of inductors on the armature;
Φ the total number of magnetic lines through the armature;
N number of revolutions per minute;
ω^1 the angular velocity of the armature.

Shunt motors and separately excited motors possess somewhat similar properties, at least, when they are supplied at a constant difference of potential. In separately excited motors the flux, Φ, is constant, save for the slight reduction due to armature reaction. The torque (3) in this case is proportional to the current, i. When the motor is supplied with a constant current, its torque is also constant, and its speed (4) is proportional to the difference of potential between the brushes. By varying the difference of potential we could work the motor with a constant

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torque at different speeds, provided that the current through the armature is kept constant. Under these circumstances the mechanical characteristic of the motor—*i.e.*, the curve which represents the torque as a function of the speed—will be a straight line parallel to the axis of abscissæ (Fig. 8). The machine may then be started with any desired torque by progressively increasing the difference of potential between the brushes. If we maintain the constant difference of potential, the current in the armature will always be strong enough to produce a torque which can overcome the resisting moment (3); the speed varies with the torque; when the torque is zero the speed will be

$$\omega^1 = \frac{2\pi}{60} \times \frac{E}{n\Phi}.$$

This is the maximum theoretical speed which the motor can attain when running with no load; the current in the armature is then zero, and the counter E.M.F. is equal to the difference of potential between the bushes. On account of the losses of energy due to hysteresis, eddy currents, and mechanical friction, the torque of the motor will become zero before the current and at a lower speed. When the resisting moment becomes negative, tending to drive the motor at a speed greater than $\omega^1 = \frac{2\pi}{60} \times \frac{E}{\Phi n}$, then the counter E.M.F., e, will be greater than E; the current in the armature will be reversed and will flow from the motor back into the mains; and the motor becomes a generator and acts as a brake by transforming the mechanical

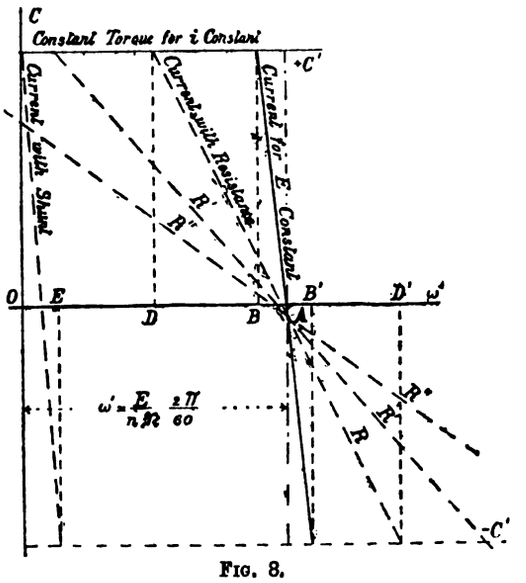

FIG. 8.

energy which it receives into electric energy. As soon as there is a resisting moment the speed will fall below $\frac{2\pi}{60} \times \frac{E}{n\Phi}$, and the current absorbed by the motor will be just sufficient to produce a torque equal to the resisting moment. The relation between ω' and C is represented by a straight line (4) passing through the point corresponding to $\omega^1 = \frac{2\pi}{60} \times \frac{E}{n\Phi}$, and inclined slightly towards the axis of ordinates (Fig. 8); the ohmic resistance of the armature, r, is small, and hence $\frac{2\pi r}{n^2\Phi^2}$ is also very small. The speed is therefore practically constant for all loads. It varies between the values O B and O B' for loads between + C' and − C' (Fig. 8). Separately excited motors supplied at constant difference of potential possess, therefore, the same self-regulating properties as three-phase motors. The same is the case with shunt motors, which behave, when supplied at a constant difference of potential, like separately excited motors. When a shunt motor is supplied at a constant voltage, the field current as well as the flux will be constant, and the motor will, therefore, behave like a separately excited machine. It is, however, not always possible to keep the flux constant; for instance, when starting the motor, the mains will be almost short circuited through the armature, whose resistance is very small, and this causes a momentary fall of potential across the terminals, resulting in the field current, and, therefore, also the flux, being reduced. For this reason a resistance must be inserted in the armature circuit to prevent the armature current from exceeding three or four times its normal strength. The field current, and, therefore, also the flux, will remain constant, as they are not affected by the resistance. We now reduce the resistance gradually, as the speed of the motor and, therefore, also the counter E M.F. increase, and in this manner a constant armature current as well as a constant torque may be maintained. Under these conditions a shunt motor will behave like a separately excited machine supplied with a constant current. Continuous-current motors may be started without much loss of energy, and we will now examine the different methods which have been used for this purpose.

1. *Starting Rheostat.*—This method is used when a shunt motor is connected across a pair of mains between which a constant difference of potential is maintained. A buffer battery may also be inserted across the same mains. The field current is thus constant. A variable resistance, R, is inserted in series with the armature. If the difference of potential between the brushes be E^1, the power absorbed in the resistance will be $(E - E^1)\ i = i^2 R$. During the period of acceleration, the resistance, R, is reduced progressively and the current, i, and, therefore, also the torque, C, may be kept constant; this requires that $E^1 - e$ must also be kept constant. The speed cannot be kept quite constant independent of the load with the resistance, R, inserted. This resistance increases the ohmic resistance of the armature. The relation between the torque, C, and the speed (4) will be found by substituting $r + R$ for r. This relation is represented by a straight line through the point corresponding to $\omega^1 = \frac{2\pi}{60} \times \frac{E}{n\Phi}$, and the inclination of the line towards the axis of ordinates will be the greater, the greater R is. The straight lines, A R, A R', A R'', etc. (Fig. 8), which correspond to increasing values of R, show that the greater the resistance is the more will the speed increase in proportion to the torque. This method of starting a shunt motor causes the same loss of energy as we found with three-phase motors.

2. *Series-Parallel Method.*—When using two motors for driving the winding machinery, the starting may be done by the series-parallel method, the same as used for regulating the speed of electric tramcars. It consists in starting the two motors by connecting them in series; the difference of potential across each armature, if no resistance is inserted, will be $\frac{E}{2}$. The normal speed will thus be reduced to half; when later on the motors are connected in parallel and the total difference of potential, E, is applied across the armature, the full speed will be attained. For the purpose of preventing jerks, while switching over from series to parallel, a kind of rheostat (controller) must be used. This method of starting gives a more satisfactory efficiency than the preceding methods, but the two motors together cost more than one motor of the same total power, and the circuit controller is complicated. This principle has been adopted by Messrs. Siemens and Halske at the Thiederhall Mines, at Thiede, near Brunswick. By using electric sources with variable pressure, the voltage between the brushes may be varied. For this purpose we may either use a battery of accumulators split up into sections, or a special generator, or an auxiliary dynamo.

3. *Batteries in Sections.*—A battery of accumulators, which is inserted across the mains, is split up into sections; the latter are, however, connected in series so as to make up a total voltage equal to the pressures between the mains. During the period of acceleration the brushes of the motor are connected across one or more sections of the battery, the number of sections being increased as the speed of the motor rises; the normal speed will be attained when all the sections are switched on. The motor may be reversed by reversing the connections between the brushes and the poles of the battery (the current in the armature will thus be reversed), and the different sections of the

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battery will then be equally discharged, provided that their number is even. The motor will have as many normal speeds as there are sections—for instance, four sections will give normal speeds equal to quarter, half, three-quarters, and full speed. For the purpose of avoiding jerks when switching a new section into the motor circuit, a rheostat must be used. The total resistance, R, required for each battery section must be equal to the resistance of the armature; R is, however, subdivided into smaller resistances, which are cut out progressively as the speed of the motor increases. The economy of the system as compared with that of the armature rheostat is only obtained by great complications, which was shown only too clearly in the case of the winding machine at pit No. II. Zollern, installed by Messrs. Siemens and Halske.

4. *Special Generator.*—In this system the haulage motor is separately excited by a constant current, and the difference of potential is varied, and therefore also the speed, by regulating the E M F. of the generator which supplies the motor by means of a field rheostat; the loss of energy is almost nil. But as one cannot use a buffer battery, the generator must be able to stand all the variation of the load, and the engine which drives the generator will be running on no load during the stoppages. The work of the engine might be equalised by providing it with a large flywheel, which could store up the energy during the stoppages of the haulage machines, or the engine might drive another generator, which, in connection with a buffer battery, could supply a circuit at constant pressure. It is, however, always necessary to have reserve sets at the power station, and this makes the undertaking costly. The use of a special generator is not practical unless the haulage machinery is close to the supply station This system has been adopted by the Allgemeine Elektricitäts-Gesellschaft in 1895 at the Hollertzug mines, and recently for two machines at the Alexandre pits of the Arnim Collieries at Planitz, near Zwickau, in Saxony. The system of a special generator may be worked more economically by adopting high-tension three-phase currents. In this case, the special generator is driven by an asynchronous motor, and the two machines are installed close to the haulage machinery; by using high-tension currents, the distance from the power station is not of much importance.

(To be continued.)

OLDHAM ELECTRICITY ACCOUNTS.

The accounts of the Oldham Corporation electricity department for the year ended March 25, 1905, show a total expenditure on capital account to that date of £269,155. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc, are appended.

General Balance Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	244,479	8	11
Sundry creditors	2,588	18	10
Balance at credit of sinking fund account	7,972	8	9
Balance at credit of reserve fund account	9,459	0	0
Deposits	140	10	0
Balance due to treasurer on general account	34,768	8	0
	£299,408	14	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	269,155	2	10
Stores on hand	3,197	19	0
Sundry debtors	8,707	6	4
Balance at debit of net revenue account	916	17	7
Balance in treasurer's hands	17,431	8	9
	£299,408	14	6

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	9,591	8	9
Distribution of electricity	1,042	18	5
Rents, rates, and taxes	1,961	15	4
Management expenses, salaries, etc.	940	8	8
Law expenses, commission, etc.	121	18	2
Insurance	74	0	8
Bad debts	59	0	4
Balance carried to net revenue account	14,446	11	1
	£28,238	1	5

Cr. Income.	£	s.	d.
By sale of current per meter	11,614	0	6
Public lighting	200	0	4
Traction purposes	15,686	15	6
Rental of meters and indicators	247	9	5
Sale and repairs of lamps and carbons	53	7	8
Rental of land and fines	17	12	8
Income tax deducted from chief rents paid	16	5	8
Income tax—interest on loans	402	9	8
	£28,238	1	5

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			3,682,250
Quantity sold: Private consumers by meter	877,925		
Quantity sold: Public lamps	19,202		
Quantity sold: Traction purposes	2,509,884		3,407,011
Quantity expended in distribution			60,281
Quantity used on works			198,944
Total quantity accounted for			3,666,236
Quantity not accounted for			16,014
Number of public lamps			20
Total maximum supply demanded (kilowatts)			2,205

DOVER ELECTRICITY ACCOUNTS.

From the accounts of the Dover Corporation electricity department for the 15 months ended March 31, 1905, it appears that the total expenditure on capital account to that date amounted to £167,016. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc, are appended.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	8,187	16	6
Distribution of electricity	613	18	3
Repairs and maintenance of public lamps	233	4	7
Rent, rates, and taxes	500	19	10
Management expenses, salaries, etc.	845	0	9
Law charges and insurance	256	11	6
	10,637	11	5
Balance carried to net revenue account	10,161	13	7
	£20,799	5	0

Cr. Income.	£	s.	d.
By sale of current by meter	17,715	5	0
Rental of meters	458	7	2
Public lighting	1,833	4	9
Sundry trading	658	10	8
Pupils' premiums	70	0	0
Rents receivable	53	2	6
Discounts	40	14	11
	£20,799	5	0

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital received	150,000	0	0
Sundry creditors	3,776	10	8
Capital and Counties Bank	16,053	5	8
Balance at credit of net revenue account	1,476	11	9
Sinking fund account	2,237	0	0
Reserve fund account	1,231	9	4
	£174,773	17	5

Cr. Assets.	£	s.	d.
Capital expended on works	167,016	11	7
Stores in hand	1,721	15	9
Sundry debtors for current supplied	4,698	1	6
Other debtors	1,035	15	2
Works in progress at cost	279	7	10
Cash in hand	22	5	7
	£174,773	17	5

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			1,591,851
Quantity sold: Public lamps	133,921		
Quantity sold: Traction	399,620		
Quantity sold: Private consumers by meter	764,520		1,296,061
Quantity used on works			24,531
Total quantity accounted for			1,322,592
Quantity not accounted for			269,259
Total maximum supply demanded (kw.): Lighting			410
Total maximum supply demanded (kw.): Traction, etc.			300

Number of public lamps: 40 arcs, 407 incandescents.

PERSONAL.

Mr. J. J. Schofield has been appointed junior assistant at the Huddersfield electricity works.

The Handsworth District Council have decided to appoint Mr. Nixon as electrical engineer at a salary of £350.

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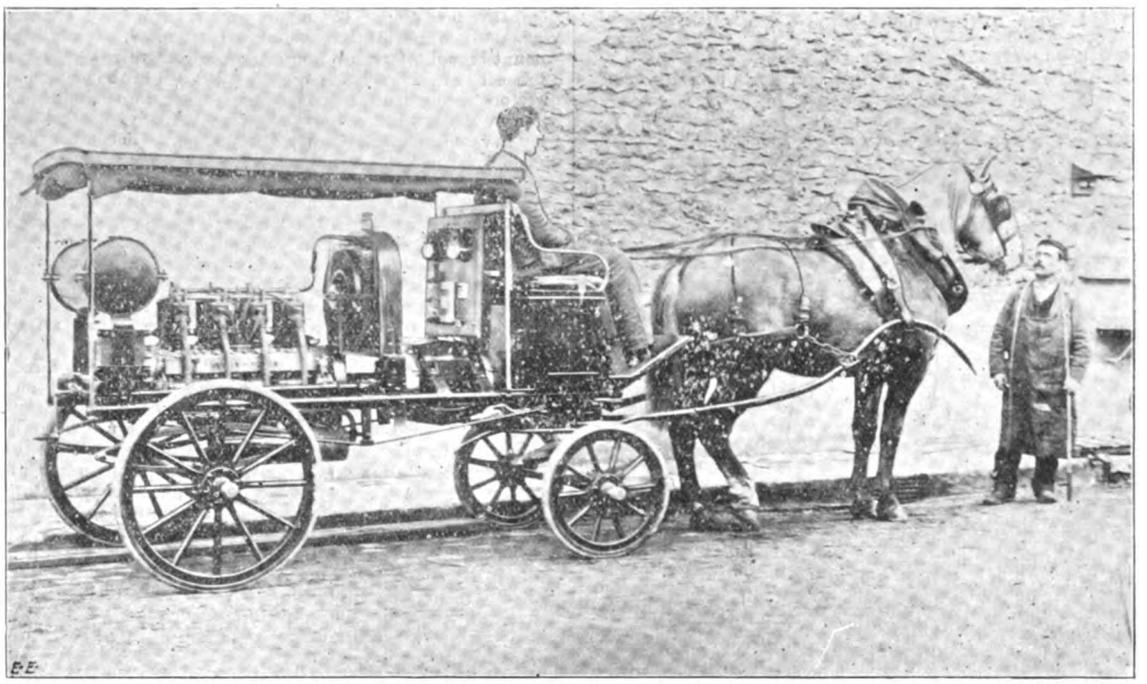
TRADE NOTICES AND NOVELTIES.

A Useful Motor-Dynamo Combination.

Through the courtesy of De Dion Bouton Limited, 10, Great Marlborough-street, Regent-street, W., we are able to illustrate herewith one of their compact motor-dynamo combinations. This is a 15-h.p. four-cylinder plant, replete with water and petrol tanks, radiator, fan and switchboard, and mounted on a horse-drawn vehicle made with tubular frame. The whole forms

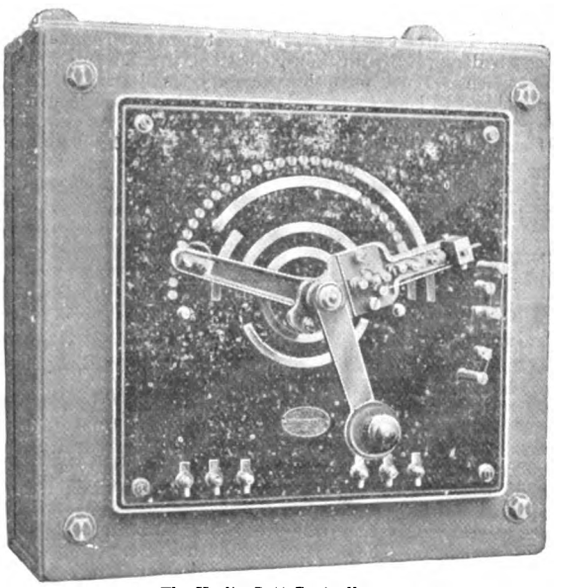


De Dion Bouton Portable Motor-Dynamo Combination.

a self-contained portable electric power installation developing 10 kw., specially suitable for use in connection with military work, travelling exhibitions, etc. The dynamo is specially light, aluminium parts being used wherever practicable. An electric department, where dynamos, motors, accumulators, dry batteries, etc., are made forms an important portion of the De Dion Bouton factory, a large demand being experienced, we understand, for motor-dynamo combinations for lighting country houses, motor-propelled vehicles, etc.

A New Controller.

Accompanying is an illustration of a new controller—the Verity-Gott—which Messrs. Veritys Limited, Deansgate, Manchester, are putting on the market. These controllers are

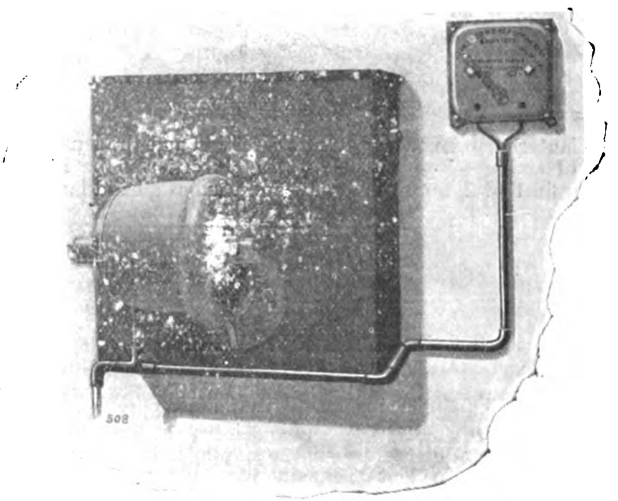


The Verity-Gott Controller.

made either for obtaining a long range of speed by supplying a motor with two voltages, or may similarly be used with series-parallel machines. They are particularly suitable for fine adjustment in the speed of boiler-feed pumps, machine tools, printing machines, etc. They give, it is claimed, a uniform increase of speed throughout a long range, and there is no excessive sparking at the change-over point. Both armature and field regulation on both voltages is provided, the change from one to the other being performed imperceptibly by the continuous rotation of the hand lever. The controllers are usually designed to give about 60 different speeds. A test recently made on a 30-h.p. motor gave the following actual speeds with the armatures in parallel: 180, 200, 230, 240, 250, 260, 270, 285, 300, 305. At the figure 305 the controller brought the armatures into parallel, and the speed then registered was 308, practically the same as the final speed on the series connections. The speeds then advanced in the same regular increments until the maximum speed (616) was reached. During the test there was no flashing at the brushes of the motor, or jumping in speed when changing from series to parallel or *vice versâ*, which operations were repeatedly carried out.

Electric Blower.

We note that James Keith and Blackman Company, Limited, 27, Farringdon-avenue, E.C., now supply a useful electric motor and blower combination for application to smiths' fires, furnaces, etc. The present system, it is pointed out, of arranging a smith's shop with one large blower for all the fires is very inefficient. The blower has to be large enough to blow all the fires at once, and to give the highest pressure required at any time on any fire, with additional pressure for blowing through a length of air-pipe. In consequence the power required to



Electric Motor-Blower Combina n

drive the blower is very heavy, and remains heavy even when a large proportion of the fires are shut off; also any repairs to the blower, motor, or engine driving means shutting down the entire shop. To meet these and other objections, the combination under notice has been designed for fitting direct to the tuyer of each forge. The power required is very small

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being from 100 watts for light work to 300 watts for heavy work, and as no power is used when the fire is not being blown, the average power will be from 50 per cent. to 33 per cent. of above. Moreover, the blast being started, stopped, and controlled by a switch, is under much better control than when regulated by a valve. The general form of the apparatus is shown by the accompanying illustration. One casting forms the casing of the blower and the field of the motor. The air propeller is of aluminium, and the weight of the revolving part is very small. The motor is series wound to run at a speed of 600 r.p.m., and it will stand switching directly on to full speed without injury.

The "University" Lamp.

Credit must be given to Messrs. Mayer and Meltzer, 71, Great Portland-street, W., for the introduction of many useful

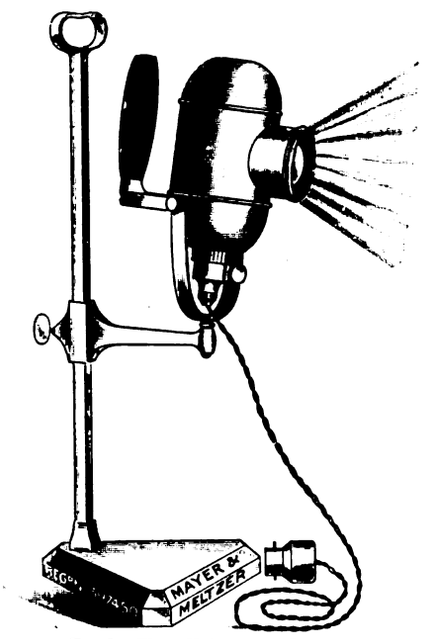
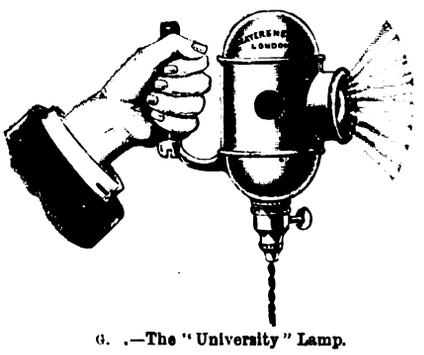


FIG. 1.—The "University" Lamp.

appliances for medical work. One of particular interest to us is their "University" examination lamp for hospital use and the consulting-room. This lamp, which we illustrate in Fig. 1, shows a clear disc of light without any image of the filament.



G. .—The "University" Lamp.

The lantern can be turned in any direction and the lens thrown out of action for ophthalmic work. It can also be lifted, as shown in Fig. 2, out of its cradle and used as a hand lamp.

LEGAL INTELLIGENCE.

UNDERGROUND WIRES.

Mr. Paul Taylor on Wednesday sat as arbitrator in a dispute between the Postmaster-General and the Borough Council of St. Marylebone in reference to the payment of certain costs incurred by the Council in making good certain roadways in their district, which had been broken up by the postal authorities for the purpose of laying underground telegraph wires. The Post Office authorities had applied for permission to lay down other wires, but this had been refused by the Borough Council pending the settlement of the latter's claim. The Postmaster-General thereupon availed himself of the powers conferred on him by the Telegraphs Act of 1878, and the disputed point was referred to Mr. Paul Taylor.

Sir Robert Hunter represented the Postmaster-General, and Mr. Bodkin appeared for the Borough Council.

Mr. Paul Taylor decided that the wayleaves applied for by the Postmaster-General ought to be granted by the Council, irrespective of any dispute as to the cost of previous operations. He also pronounced in favour of the Postmaster-General's claim in respect of the proposed erection of a pole for telegraphic purposes just outside Lord's cricket ground.

COMPANIES' MEETINGS AND REPORTS

BRITISH ELECTRIC TRACTION.

The ninth ordinary general meeting of the shareholders was held on Monday, Sir Charles Rivers Wilson, G.C.M.G., C.B., chairman of the Company, presiding. The report and statement of accounts for the year ended March 31 last, which were adopted, showed, omitting the amount brought forward from the preceding year, a net profit for the 12 months of £239,027, as against £219,818 in the previous year. The directors recommended the payment of the same dividend upon the ordinary shares as in the previous year—namely, 6 per cent.—although they have had to pay nearly £15,000 more debenture interest, and about £900 more dividend on preference share capital. This left £16,000 to be carried forward, as against £33,000 in the preceding year. The dividends and interest received upon investments amounted to £146,163, or about £10,000 more; but the investments amounted to £237,000 more. The balance-sheet shows a large reduction of liabilities. Last year the Company owed their bankers in respect of temporary loans sums amounting to £200,000, and they had had deposited with them by associated companies the total sum of £65,000. The whole of the loans have been repaid, and the deposits have been reduced to £19,250. The amounts due from associated companies have been reduced during the past year from £1,116,361 to £782,325.

The CHAIRMAN said satisfactory arrangements had been made for guaranteeing to the Bombay Tramways and Electricity Co. £600,000 of preference capital and £600,000 of debenture capital, and the transfer to the new company would be completed within this month. The Metropolitan Electric Tramways Co. was progressing favourably in the development of the tramway and light railway enterprise in the northern suburbs of London, and also in connection with the electric power supply business which was now controlled by the Metropolitan Tramways Co. The Company's Power Act covered over 300 square miles in Middlesex, Hertfordshire, and Essex, a district which would probably in the near future show a very considerable development for industrial purposes. The directors thought that well-designed electrical tramway undertakings had nothing whatever to fear from competition by motor omnibuses.

Mr. J. CHARTIER was of opinion that the dividend had not been fully earned, and he was surprised, he said, that the directors took £200,337 worth of consols at an average of over 98 per cent. He moved an amendment to reduce the dividend from 6 per cent. to 2 per cent.

The CHAIRMAN said that they had earned the dividend, and something more, enabling them to make a substantial carry forward.

The amendment was not seconded, and the report was adopted.

Sir Charles Rivers Wilson was re-elected a director of the Company.

GENERAL ELECTRIC.

The ordinary general meeting was held on Monday, Mr. G. Byng (the chairman of the Company) presiding, when the report, given in our last issue, was adopted.

The CHAIRMAN said they had received a fair amount of orders for large machines, such as contracts for Cardiff, South London, Woolwich, Fulham, Manchester, and Dublin. As regards the latter, the new 1,500-kw. set supplied during last year had turned out a great success, whilst the old contract had at last been satisfactorily completed. The Company had supplied with their generators, through sub-contractors, engines which did not pass the necessary tests, and, as main contractors, they had been compelled to undertake the reconstruction of these engines, and the plant had been taken over. As regards other manufactures, such as telephones and bells, electric light fixtures and accessories, there had been increasing output, but generally with lower prices and more difficult to sell. The payment of a dividend at the rate of 5 per cent. for the year was agreed to.

The retiring director, Mr. H. Bevis, was re-elected, and a vote of thanks to the chairman and directors concluded the meeting.

NATIONAL TELEPHONE.

The thirty-sixth ordinary general meeting of the National Telephone Co. was held yesterday week at Hamilton House, E.C., Sir Henry Fowler, M.P. (the president), in the chair.

The CHAIRMAN said that the last half-year had been a satisfactory one. The income had amounted to £1,086,507, against £985,274 in the corresponding half-year of 1904. The Post Office royalty was over £100,000. The working expenses during the half-year had been £630,251, as against £563,060 twelve months ago, which left a profit of £355,618, as against £331,472, showing a net increase of £24,146 in the half-year; adding the sum brought forward, an available sum of £365,759 remained. The debenture and other interests were £97,143. The directors proposed to pay the same dividends as before on the preference shares and preferred and deferred stocks, which will absorb £148,917, and to carry to reserve £110,000. The capital expenditure during the half-year had been increased. They had spent on construction of exchange and private stations and upon other capital expenditure during the half-year £477,156, on land and buildings about £6,000, or a total of £534,320. The staff had increased from 12,902 to 14,647, and the unexecuted orders from 9,706 to 10,842. The business was rapidly outstripping

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their available capital. The number of telephone message in 1904 over the system recorded in the usual way had been 995,671,664, or 10 times the number of inland telegrams in Great Britain and Ireland during that period. The average receipt by the Company for those messages was 0·43d.

The report was adopted, and the dividends declared for the six months ended June 30 as follows: 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent per annum on the preferred stock, and 5 per cent. on the deferred stock.

The retiring directors (Mr. Charles Swain Agnew, the Right Hon. Lord Harris, Mr. George Hunter Robertson, and Sir Albert Kaye Rollit, M.P.) were re-elected.

LISBON ELECTRIC TRAMWAYS.

The ordinary general meeting of the shareholders of the Lisbon Electric Tramways was held on Wednesday. Mr. Ludwig Breitmeyer presided in the absence of Sir Charles Euan-Smith.

The CHAIRMAN said that the favourable forecast of their chairman at the last annual meeting had been amply fulfilled. They had carried 3,000,000 more passengers, their cars had covered some 700,000 more car miles, and yet the cost of running the power-house remained at the same figure as before. The usual necessary provision of £20,000 for depreciation had been made, bringing this account to £40,000. The directors had also created a special reserve accident account, and a reserve account against the fluctuations of the exchange, with £10,000 and £5,000 respectively. After providing these sums, and paying the 6 per cent. dividend on the preference shares, the balance on hand amounted to £17,197, which sum it was proposed to carry forward to next year's accounts.

The report was adopted.

A motion was subsequently passed removing Mr. Alfred Parrish from the board of directors.

EAST LONDON RAILWAY.

Lord Claud Hamilton presided at Tuesday's meeting of the shareholders. He said that in the future the East London line would have to be electrified, but he thought they had done well to wait and see the results of experiments on other lines. In this they had followed the example of the Great Eastern Co., whose directors felt that there had not been sufficient experience to enable them to judge whether the best system of electrification had yet been found. Both were poor companies, and could not afford to risk expenditure until this had been settled.

NERNST ELECTRIC LIGHT.

At a meeting of the shareholders on Monday a resolution for a sale of the Company's patent rights for Nernst lamps, as well as the right to the British royalties, to the Allgemeine Elektricitäts-Gesellschaft for the price of £24,000 was passed. The resolution will have to be confirmed at a subsequent meeting, but we understand that there is every possibility of it being carried into effect.

BARCELONA TRAMWAYS.

An extraordinary general meeting of the Company was held on the 21st inst., Mr. J. B. Concanon in the chair. An agreement between the Company and the Société Financière de Transports et d'Enterprises Industrielles, Brussels, for the sale of the Company's undertaking, was confirmed. It was stated that ordinary shareholders will receive at least £14. 10s. per share.

DIRECT UNITED STATES CABLE.

The fifty-sixth ordinary general meeting was held on Tuesday at Winchester House. Mr. E. M. Underdown, K.C., presided. The report (given in our last issue) was adopted, and the payment of the dividend and bonus mentioned, both free of income tax, making, with the three interim dividends already paid, a total distribution of 3¼ per cent. for the year ended the 30th ult., was agreed to.

DEUTSCHE-UBERSEEISCHE ELEKTRICITAETS-GESELLSCHAFT.

Dr. Salomonsohn presided at the meeting on July 18 at Berlin. A resolution was passed practically doubling the capital of the Company to £7,050,000 in order to purchase the Chilian Electric Tramway and Light Co. at Santiago. The Company will receive in exchange for 9,768,000 marks in stock £598,738 in 6 per cent. preference shares of the Chilian Co. quoted at 80 per cent., and, in addition, £386,000 in ordinary shares of the same company gratis. Mr. Ludwig Breitmeyer, a partner of Messrs. Wernher Beit and Co., was elected a member of the Board of supervision.

EASTERN TELEGRAPH.

The report for the six months ended March 31 shows a revenue of £676,256. Deducting £179,330 for the ordinary expenses and £53,253 for expenditure relating to maintenance of cables, depreciation of spare cable, and income tax payable abroad, a balance of £443,662 remains, to which is added £35,631 brought from the preceding half-year, making a total available balance of £479,294. After providing for income tax payable in England, interest on loan, etc., and for two quarterly dividends on the preference stock, there remains a balance of £386,147, out of which £10,000 has been placed to the reserve fund for maintenance ships, £195,000 to the general reserve fund, and an interim dividend of 1¼ per cent. on the ordinary stock, amounting to £50,000, has been paid. The directors now recommend a final dividend on the ordinary stock for the year ended March 31, 1905, of 1¼ per cent., and a bonus of 2 per cent., amounting together to £130,000, free of income tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year. It is proposed to carry forward the balance of £1,147 to the next account. As the receipts from Indian traffic for the three years ended June 30, 1905, have reached the average "standard revenue" stipulated for under the guarantee agreement with the Indian Government, it had been decided to reduce the rate between Europe and India from 2s. 6d. to 2s. per word, which reduction will be brought into operation on Aug. 1, and from the same date the tariff between Great Britain and Aden will be reduced from 2s. 6d. to 2s. per word. An arrangement has also been concluded with the Egyptian Telegraph Administration for a reduction of tariff between Europe and Egypt (1st Region) from 1s. 5d. to 1s. per word, which will also come into operation on Aug. 1.

The sixty-sixth half-yearly ordinary general meeting was held on Wednesday, Sir John Wolfe Barry, K.C.B., in the chair. The report was adopted.

CITY AND SOUTH LONDON RAILWAY.

The report for the half-year ended June 30, 1905, shows receipts from all sources amounting to £76,164, the cost of working was £35,134, leaving a profit of £41,030. Adding the balance brought forward, the net revenue account totals £42,924. After providing for debenture stock interest, and transfer to renewal fund, a balance of £30,199 remains available for dividend. The directors recommend a dividend of 5 per cent. per annum on the preference stocks (1891, 1896, and 1901), and a dividend at the rate of 2 per cent. per annum on the consolidated ordinary stock for the half-year, leaving a balance of £1,041 to be carried forward. The number of passengers (exclusive of season-ticket holders) carried during the period was 8,662,588, a decrease of 561,399; receipts (including season tickets) totalled £71,802, a decline of £4,585. The dry weather and the competition of the London County Council electric tramways has, it is stated, adversely affected the traffic. The directors determined in May last to make a considerable reduction in the fares charged on the railway to meet the London County Council competition, and an increase of passengers has taken place, but not sufficient so far to do more than compensate for the reduction made. The contract for the construction of the extension to Euston was let in March last, and the sites for the stations have all been acquired, the shafts for the lifts are down to their full depth and the tunnels have been commenced. The directors hope that the line will be opened for traffic before the end of next year.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The result of the working for the half-year ended June 30 last is as stated: receipts, £86,400, against £85,096 in 1904; and expenses, £51,500, against £45,624. Adding the amount brought forward (£2,085), the balance available is £36,986. The increased expenditure is due partly to the higher wages bill and partly to exceptional repairs to rolling-stock, etc. After allowing for interest on debenture stocks, preference dividends, and setting aside £4,000 to meet the half-year's contributions to the renewals fund, debenture sinking fund, and accidents insurance fund on the same scale as those made in 1904, a balance of £10,239 remains, allowing for the payment of the same interim dividend as last year (1s. 6d. per share), with a carry forward of £2,739. Considering the uncertainty as to the effect on the Company's traffic of the approaching electrification of directly competing lines, the directors have decided not to pay a dividend until after the final accounts for the year have been completed.

DISTRICT RAILWAY.

The report for the half-year ended June 30 last shows the total receipts for the half-year have been £206,601, against £212,771 for the corresponding half of 1904, or a decrease of £6,169. The working expenses have been £114,879, against £115,155 for the corresponding half of 1904, being a decrease of £276. The revenue account shows a profit of £91,722, against £97,615 earned in the corresponding half of 1904, being a decrease of £5,893. The report says the work of electrification is now practically completed. The power-house is in working order. The sub-stations are completed, and the whole of the cables are laid throughout the Company's system. Electric trains are now running between Ealing and Whitechapel, and from Harrow to Mill Hill Park, and from Hounslow to South Acton. A service is also running between High-street, Kensington, and Putney. Further electric trains will from time to time, as cars are delivered, be brought into running into substitution for the steam service. Satisfactory progress has been made with the reconstruction of the new stations at High-street, Kensington, and South Kensington. The widening of the Company's line between West Kensington and Hammersmith is practically finished, and an arrangement has been made to grant to the Great Northern, Piccadilly, and Brompton Railway Co. a joint user of such widened lines at a yearly

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rental of £12,000 as from Jan. 1 last. The car-sheds and repairing shops at Mill Hill Park are completed. Extensive sidings have been laid down at Mill Hill Park and Gloucester-road. An arrangement, which it is believed will be for the mutual advantage of both companies, has been made with the Great Western Railway Co. for the construction of an interchange station at Ealing. With a view to provide the balance of the moneys required for electrical equipment and to meet other obligations, it is proposed to sell surplus freehold lands and properties of the Company to the value of £250,000. The directors propose to form a surplus land company, the capital of which will, in the first instance, be offered to the shareholders. Since the last meeting Mr. C. A. Spofford has retired from the Board, and the Right Hon. Lord George Hamilton, M.P., and Mr. W. H. Brown have been elected directors.

CENTRAL LONDON RAILWAY.

The report for the half-year ended June 30 shows receipts from all sources amounting to £185,876, an increase of £915, and the working expenses to £95,674, an increase of £549, leaving a balance of £90,202. The number of passengers increased by 68,038, and the number to whom cheap return tickets were issued, workmen and others, was 3,051,196, a decrease of 30,174. The average receipt per passenger was 1·86d., the same as in the half-year ended June, 1904. After providing for interest on debenture stock, etc., a balance of £94,886 remains, including £22,112 brought forward. The directors recommend dividends on the undivided ordinary and on the preferred ordinary stock at the rate of 4 per cent. per annum. After reserving £10,606 the proportion of dividend applicable to the deferred stock, which is not payable until the result of the year's working has been ascertained, there remains £34,886 to be carried forward.

BAKER STREET AND WATERLOO RAILWAY.

The accounts of the Company to June 30 show that during the half-year the capital expenditure amounted to £367,189. The estimated expenditure for the current half-year is £600,000. In view of all the circumstances, the progress made with the works during the half-year had been satisfactory. The Company's Bill, which was before the shareholders at the Wharncliffe meeting in February last, has passed through the committees of both Houses of Parliament.

LIVERPOOL OVERHEAD RAILWAY.

The accounts for the past half-year show a balance of £7,883, out of which the directors recommend the payment of the preference dividend, but nothing on the ordinary shares, leaving £4,336 to be carried forward. A year ago the ordinary shares received 1¼ per cent. per annum and £4,052 was then carried forward.

DUNDEE TRAMWAY AND CARRIAGE.

The last report notes a considerable diminution in the receipts of the Company, but owing to all-round economy the net profit is not much under the previous year's. The revenue amounted to £10,087 and expenditure to £8,227, making the net profit £1,860. An interim dividend of 1s. 6d. per share was paid in December, and a similar dividend is now recommended, making 7½ per cent. for the year. It is recommended that £500 be placed to contingent fund, making it £4,000, and that £270 be carried forward.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The last report shows a net balance of £23,289, to which must be added the sum brought forward, £1,621. It is proposed to pay a dividend on the preference shares at the rate of 2 per cent., leaving £12,911 to be carried forward. The electric lighting department earned a net profit of 276,597dol. during last year, against 179,723dol. earned in the year 1903. The tramways earned 678,197dol., against 232,857dol.

DUBLIN UNITED TRAMWAYS.

The report for the half-year ended June 30, submitted at the ordinary meeting on 25th inst., showed a profit of £45,355, out of which it is proposed to pay a dividend for the half-year at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares, leaving £5,000 to be added to the reserve fund and £5,255 to be carried to next account. Extensions of the tramways from Rathmines to Dartry-road and from Dolphin's Barn to Rialto Bridge, South Circular-road, were opened for traffic during the half-year.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH).

It will be remembered that at an extraordinary general meeting of the shareholders of the Blackpool Electric Tramways (South), at the beginning of this month, resolutions were passed that the Company be wound up voluntarily, and that the shares held in the Blackpool, St. Annes, and Lytham Tramways Co. be divided among the shareholders. The debenture holders object to this proposal. At a meeting of shareholders on Monday it was decided not to proceed at present with the winding up of the Company and the appointment of a liquidator.

NEW COMPANIES REGISTERED.

City and Suburban Motor Omnibus Co., Limited.—Capital, £10,000. Object: to carry on the business of motor omnibus proprietors, etc.

J. K. Conway and Co., Limited.—Capital, £1,000. Object: to carry on the business of dealers in gas and electrical appliances, fittings, accessories, and materials, machinery manufacturers, etc.

De Forest Wireless Telegraph Syndicate.—Capital, £120,000. Object: to adopt an agreement with S. S. Bojesen, and to carry on the business of owners of wireless and other telegraph systems, patents, and concessions, etc.

Peterborough Motor 'Bus Company, Limited.—Capital, £5,000 in £1 shares. Object: to carry on the business of proprietors of motor omnibuses, other public or private conveyances of all kinds. Registered office: 4, Orcas-street, Peterborough.

Chemin de fer Electrique d'Ostende-Blankenberghe et Extensions.—Registered at Brussels. Capital in 5,000 preference shares at £20 each, 25,000 ordinary, value not stated. Object: construction of electric tramway from d'Ostende-Blankenberghe.

Southend-on-Sea and District Motor Omnibus Co., Limited.—Capital, £10,000. Object: to carry on the business of proprietors of motor omnibuses and other public or private conveyances of all kinds. Registered office: 105, Broadway High-street, Southend-on-Sea.

Yates and Thom, Limited.—Capital, £240,000 in £1 shares. Object: to acquire and carry on the business as Yates and Thom of ironfounders, boiler makers, mechanical and electrical engineers, machine and tool manufacturers, etc. Registered office: Canal Engineering Works, Blackburn.

Bruné-Turchi Telegraphic Co., Limited.—Capital, £30,000. Object: to acquire inventions or rights relating to telegraphic or telephonic processes or instruments, or to the production, treatment, storage, application, distribution, and use of electricity, in particular; to acquire certain inventions and patents owned by E. Bruné and C. Turchi relating to simultaneous telephony and telegraphy, etc. Registered office: 31, Lombard-street, E.C.

Liens Registered.

Kent Electric Power Syndicate, Limited, London, E.C.—Charge registered, July 18, for £750. Secured on the undertaking and all the assets, present and future, including any uncalled or unpaid capital.

New General Traction Co., Limited, Westminster.—Particulars registered July 15, under Sub-section 4, Section 14, of the Companies' Act, 1900, relating to a series of 5 per cent. debentures, created Feb. 8, 1905, for £18,700. Trustees: Captain F. Pavey, Foley House, Portland-place, W., and Baron Emile B. d'Erlanger, 20, Bishopsgate-street Within, E.C. Charged on 19,070 fully-paid shares of £10 each in the Norwich Electric Tramways Co., 10,267 fully-paid shares of £10 each in the Coventry Electric Tramways Co., 12,262 fully-paid preference shares of £1 each in the Douglas Southern Electric Tramways, Limited, and by way of floating charge on the assets, present and future, other than the above-mentioned property.

United Electric Tramways of Monte Video, Limited.—A trust deed, dated July 12, 1905, to secure £500,000 debenture stock, created Oct. 28, 1904, has been registered. Property charged—90 debentures of 4,700dol. gold each, and 560 fully-paid shares of 1,000dol. gold each, in La Sociedad Comercial de Monte Video, any debt that may be incurred by the said company to this company in respect of moneys advanced to them out of the proceeds of the debenture stock of this company, issued or to be issued, in accordance with the terms of the said trust deed, etc. Trustees: Major W. E. E. Gordon, M.P., 4, Chelsea-embankment, S.W.; the Hon. C. G. Hay, M.P., Basildon House, Moorgate-street, E.C.; and H. A. Trotter, 7, Mincing-lane, E.C.

APPOINTMENTS VACANT.

Engineer-in-Charge, Bermondsey. Salary, £2.

Assistant Engineer about 25 years of age, with good knowledge of mechanical engineering. Applications to G M 532, Messrs. Deacon's, Leadenhall-street, London, E.C. See advertisement in last issue.

Practical Engineer to supervise the equipment of a complete electrical tramway in India. Applications to Box No. K 10, *Electrical Engineer* Office. See advertisement in last issue.

Assistant Buyer in electrical engineering works in Midlands. Applications to Box G 49, *Electrical Engineer* Office. See advertisement in last issue.

Youth (smart). Applications to the Electrical Co., 121-125, Charing Cross-road, W.C. See advertisement in last issue.

Mechanical and Electrical Engineer. Salary, 30s. per week. Applications to R. N., *Electrical Engineer* Office.

Junior Assistant Electrical Engineer, Burnley electricity works. Salary, £119. 12s. per annum. See advertisement.

Pupil, Stratford Urban District Council electricity department. See advertisement.

Chief Draughtsman, also Assistant Draughtsman. Applications to T. K., care of Davies and Co., advertising agents, Finch-lane, Cornhill. See advertisement.

Premium Pupil. Applications to Electricity Works, Canterbury. See advertisement.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Warrington. — Tenders are required for cables. Tenders by Aug. 11.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Turnu-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct-coupled steam set.

Brussels.—The Government Telegraph Department require tenders for 14,700 pine telegraph poles. Specification 76 may be obtained from their office at Brussels. Tenders by Aug. 9.

Paris.—The Post and Telegraphs Department require tenders for tubes for telephone and telegraph cables. Specifications from the above office, First Bureaux, 103, Rue de Grenelle. Tenders by Aug. 7.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10,000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Calanas (Spain).—The Municipality require tenders for the installation and working for 10 years from Jan. 1, 1906, of the electric lighting of the town. Tenders by July 27 to the Alcalde of Calanas, province of Huelva, Spain.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Ebbw Vale (Mon.).—Tenders are invited for the following, for the Ebbw Vale Urban District Council: (Section A) cables; (B) overhead lines; (C) street lamps and fittings; (D) meters. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders to the Clerk of the Ebbw Vale Urban District Council by 12 noon on Aug. 5.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2¼ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23. See advertisement.

RESULTS OF TENDERS.

Watford.—The tender of Babcock and Wilcox, at £41, has been accepted for chequer plating at the electricity works.

Hampstead.—The tender of the St. Helen's Cable Co. has been accepted for the supply of high-tension, three-core house service and single cable for 12 months from Aug. 1.

Hackney.—The Borough Council have accepted the tender of Messrs. Le Grand and Sutcliff, of 125, Bunhill-row, London, E.C., for an artesian well and air-lift pumping plant, at £1,370. 16s.

Battersea.—The Lighting Committee recommend that the tender of W. T. Glover and Co. be accepted for the supply of the necessary cable to connect No. 8 turbo-generator set with the main switchboard for £88. 15s. 11d.

Stoke Newington.—The Council have accepted the tender of the Reason Manufacturing Co. for the supply of meters; and for the erection of an electrical transformer station the tender of Patman and Fotheringham, at £3,273.

Hammersmith.—The Guardians have accepted the tender of W. J. Fryer and Co., Bravington Works, Paddington, for a complete wiring installation for the electric lighting of their new workhouse and infirmary at Wormwood Scrubbs: electric wiring, £4,580; transforming apparatus, £1,051.

Acton.—The District Council have resolved to purchase an additional transformer from the British Transformer Co. at a cost of £136, and for the low-tension switchgear in connection with the motor-generators purchased from the Metropolitan Co. the tender of Messrs. Cowans, at £276, has been accepted.

Switchgear, etc.—Messrs. Ferranti Limited, Hollinwood, Lancashire report the following contracts: Cardiff, motor-generator switchboard; Burnley, and Newcastle and District Electric Lighting Co., continuous-current switchgear extension; Metropolitan Electric Supply Co., Willesden, 3,000-kw. 11,000-volt switchgear extension; 10 alternate-current and continuous-current switchboards for private installations; Heriot-Watt College, Edinburgh, three 10-kw. alternate-current transformers; Mauritius, two 20-kw. three-phase transformers.

Cardiff.—The Asylum Committee have accepted the tender of D. Firth and Co., Manchester, to do the wiring and general electrical installation work at the new asylum at Whitchurch. It will be remembered that the original tender was for £7,198, but on the suggestion of the committee a cheaper scheme was prepared, and all the firms who had tendered were asked to give fresh prices. Messrs. Firth were the lowest of 16 tenders. The nearest local firm to the successful tenderers were Clay Bros. and Co., of Cardiff, whose original price was £7,850, and whose second quotation was £6,964.

Loughborough.—The following tenders for a year's supply of stores, etc., have been accepted by the Committee: (1) oils, Valvoline Oil Co.; (2) engine-room stores, G. Hatch, Limited; (3) cables and (4) cable accessories, W. T. Henley's Telegraph Works Co.; (5) house service meters, British Thomson-Houston Co.; (6) switches and fuses, Marples, Leach, and Co.; (7) 440-volt motors and starters, Brush Co.; (8) 220-volt motors and starters, Crompton and Co.; (9) ironmongery, sundries, etc., W. Armstrong and Son; (10) house service fuses, W. T. Henley's Telegraph Works Co.; (11) turbine-generator brushes, Brush Co.

London, E.—The Stepney Borough Council have received the following tenders for supply and delivery of meters, etc.: Meters up to a capacity of 10 amperes—Reason Manufacturing Co., £320 (accepted); Chamberlain and Hookham, £320; Ferranti Limited, £326. 5s. Meters above a capacity of 19 amperes—Ferranti Limited, £297. 18s.; Chamberlain and Hookham, £306. 12s. 6d.; Reason Manufacturing Co., £314. Meters above a capacity of 10 amperes—Ferranti Limited (accepted). Combined meter and demand indicator—Reason Manufacturing Co., £770. 4s. 6d. (accepted); General Electric Co., £877. 12s. Demand indicators only—Reason Manufacturing Co., £347. 17s. Carbons—F. Henrion, 79, Mark-lane, E.C. (accepted). Storage tanks—Newton, Chambers, and Co., £687 (accepted).

Fulham.—The following tenders have been received for the supply and construction of extension of cables, feeders, etc.:

W. F. Dennis and Co.	£1,779	7	6
Johnson and Phillips's Electric Cable Works	1,780	4	8
Electrical Co.	1,905	7	6
British Insulated and Helsby Cables (stoneware ducts)	2,000	8	9
Ditto (fibre ducts)	2,064	18	9
Western Electric Co.	2,043	19	6
Ditto	2,115	19	6
W. T. Henley's Telegraph Works Co. (fibre ducts)*	2 075	3	0
Ditto (stoneware casing)	2,012	3	0
Callender's Cable and Construction Co.	2.104	2	6
W. T. Glover and Co.	2,132	8	0
St. Helens Cable Co.	2,209	0	0
Ditto	2,315	15	0
Siemens Bros. and Co. (fibre conduit)	2,362	10	0
Ditto (stoneware conduit)	2,295	0	0

* Recommended for acceptance.

Paris.—None of the tenders for copper wire covered with india-rubber and cotton dipped in paraffin, which were called for July 12, were accepted by the Post and Telegraphs Department. There were five lots, and no reasons are given except that in Lot 1, which probably holds good for the rest—namely, that the prices were above the maximum fixed. We give the results as they appear in the current number of *La Metallurgie*. The figures represent francs per kilometre: A 1 conductor, model 336, No. 1, 20 kilom.—De la Mathe 145, Sté industrielle des téléphones 139, Grammont 130, the India Rubber 129; Cie générale de constructions électriques 125 le kilom. A 2 conductors, model 336, No. 2, 100 kilom.—De la Mathe, 258·90, Sté industrielle des téléphones 259. Grammont 260, the India Rubber 259; Cie générale de constructions électriques 255. Ditto, 200 kilom.—De la Mathe 258, Sté industrielle des téléphones 249, Grammont 252, the India Rubber 256; Cie générale de constructions électriques 262. Ditto—De la Mathe 257·50, Sté industrielle des téléphones 249, Grammont 245, the India Rubber 256, Cie générale de constructions électriques 265·50. A 3 conductors, model 336, No. 3, 100 kilom.—De la Mathe 393, Sté industrielle des téléphones 389, Grammont 380, the India rubber 388, Cie générale de constr. méaniques 399, Alliot et Roi 400.

Metropolitan Asylums Board.—The tenders of the following firms for a year's supply of electrical accessories have been accepted: Pryke and Palmer; General Electric Co., 69-71, Queen Victoria-street, E.C.; Electrical Co., 131-125, Charing Cross-road, W.C.; Goossens, Pope, and Co., 5, Arthur-street, New Oxford-street, W.C.; McGeoch and Co.; Sunbeam Lamp Co., Park-road, Gateshead-on-Tyne; Veritys Limited, 31, King-street, Covent garden; Armourduct Manufacturing Co., 6, Farringdon-avenue, E.C.; Berliner Telephone Manufacturing Co., 200, Upper Thames-street, E.C.; Berry and Skinner, 75, Upper Thames-street, E.C.; British Insulated and Helsby Cables, Helsby, near Warrington; Johnson and Phillips, Electric Light Works, Charlton, Kent; London Electric Wire Co., Playhouse-yard, Golden-lane, E.C.; W. T. Henley's Telegraph Works Co., Blomfield-street, London-wall, E.C.; Edison and Son United Electric Light Co., 36 7, Queen-street, E.C.; Frankenburg and Sons, Greengate, Salford; Sun Electrical Co., 118-120, Charing Cross-road, W.C.; Tucker and Co., Sampson-road North, Birmingham; Baxter and Caunter, 86, Charing Cross-road, W.C.; G. Braulik, 217-218, Upper Thames-street, E.C.; Brush Electrical Co., 106-112, Belvedere-road, S.E.; Connolly Bros., Vale Mills, Blackley, Manchester; Davis, Kent, and Stewart, 17, Berners-street, W.; H. Greene and Co.; Siemens Bros., 12, Queen Anne's gate, Westminster, S.W.

London County Council.—The Highways Committee have received nine tenders for the supply of the high and low tension switchgear

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required for the four sub-stations at Battersea, Clapham, Streatham, and Wandsworth respectively as follows:

Edison and Swan United Electric Light Co., London...	£8,427	0	0
General Electric Co., Manchester*...	10,129	12	0
Electric Construction Co., Wolverhampton...	10,317	10	0
Siemens Bros. and Co., London...	10,568	10	0
A. Reyrolle and Co., Hebburn-on-Tyne...	11,421	19	0
Dick, Kerr, and Co., London...	12,042	6	3
Kelvin and J. White, Glasgow...	12,335	6	0
British Westinghouse Electric and Manufacturing Co., London...	12,705	7	0
British Thomson-Houston Co., Rugby...	13,178	6	0

* Recommended for acceptance, with power to sublet to the undermentioned firms (or to such other persons or firms as might be approved by the engineer under the contract), as follows: (1) to Ferranti Limited, Hollinwood, the manufacture of the alternating-current ammeters, voltmeters, and wattmeters, (2) to the British Westinghouse Electric and Manufacturing Co., London, the manufacture of the starting resistances and pillars, and (3) to W. T. Henley's Telegraph Works, London, the supply of the cables. The Edison and Swan United Electric Light Co. withdrew because the sub-tenderers found it necessary to increase their prices.

The same committee have received 18 tenders for the supply of the low-tension switchboards required for the Battersea and Wandsworth sub-stations of the London County Council tramways, as follows:

Evered and Co., Birmingham*...	£1,347	10	0
Edison and Swan United Electric Light Co., London...	1,439	16	3
J. Fowler and Co. (Leeds), Leeds...	1,732	0	0
J. G. Statter and Co., Birmingham...	1,732	9	0
General Electric Co., London...	1,855	7	6
L. Robinson and Co., Thames Ditton...	1,982	18	0
J. E. Spagnoletti and Co., London...	2,008	10	0
Electric Construction Co., Wolverhampton...	2,053	10	0
B. Thomas, Manchester...	2,055	18	6
British Westinghouse Electric and Manufacturing Co., London...	2,101	1	0
C. Hodges and Co., London...	2,157	14	0
Consolidated Electrical Co., London...	2,226	0	0
Siemens Bros. and Co., London...	2,344	0	0
A. Reyrolle and Co., Hebburn-on-Tyne...	2,382	9	6
Walsall Electrical Co., Walsall...	2,564	4	6
British Thomson-Houston Co., Rugby...	2,701	14	0
Kelvin and J. White, Glasgow...	2,853	9	6
Baily, Grundy, and Barrett, Cambridge...	3,148	5	6

* Recommended for acceptance, with power to sublet to the undermentioned firms (or to such other persons or firms as may be approved by the engineer under the contract), as follows: (1) to Evershed and Vignoles the manufacture of the ammeters and voltmeters; (2) to Elliott Bros., London, the manufacture of the recording instruments; and (3) to B. Thomas, Manchester, the manufacture of the circuit breakers.

Tenders were also received for electric lighting service in the ranger's house, Blackheath:

Wright, Methuen, and Co.*...	£174	2	0
Ward Bros., London...	175	0	0
Tamplin and Makovski, London...	176	7	6
Hooper, Neary, and Co., London...	187	5	0
F. J. Coleby and Co., London...	187	10	0
A. H. Marshall and Co., Leytonstone...	189	0	0
E. Probert and Co., London...	189	0	0
Lea and Warren, Kettering...	190	0	0
Sweet Bros., London...	200	0	0
W. Dickinson, Bexleyheath...	222	10	0
Jackson Bros., London...	239	11	0
Salisbury Electrical Engineering Co., London...	245	10	0

*Recommended for acceptance.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Ashton.—The Guardians' new hospitals are to be lit by electricity.

Battersea.—The Council propose to extend the electric lighting to Nine Elms Ward at a cost of £15,000.

Croydon.—The General Post Office contemplate the opening of telephone exchanges at Purley and Kenley.

Sunbury.—The National Telephone Co. have obtained permission to place their wires underground in Thames street.

Islington.—The electricity department of the Borough Council visited Portsmouth for their annual outing last week.

Cardiff.—We understand that a loan of £600,000 is to be raised in which provision is made of £228,587 for electric lighting purposes.

Westminster Electric Supply Co.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 13 per cent. per annum.

Bedwellty.—A company is being formed for the purpose of making an application to Parliament to supply the urban district of Bedwellty with electrical power.

British Promotheus Co.—The works of this company will be closed from Aug. 2 to 12 next (inclusive) for the purposes of an annual holiday and stocktaking.

Metropolitan Electric Supply Co.—The directors have declared an interim dividend of 5s. per share on the £5 ordinary shares, being at the rate of 10 per cent. per annum.

Huddersfield.—During this month 15 new consumers and 874 lamps have been connected.

Malton.—The Urban District Council have decided to give the electric light a trial for street-lighting.

Johnstone Extension.—Strong efforts are being made by Howwood and Lochwinnoch residents to induce the Paisley District Tramway Co. to extend their system to these districts.

County of London Electric Supply Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 4 per cent. per annum, less tax, payable on Aug. 21.

Durham.—The County Council will be asked at the next meeting to consider the promotion of a Bill in Parliament with the object of establishing a system of electrical service in the county.

Chertsey.—The engineers of the Chobham and Windlesham electric lighting scheme have decided not to place overhead wires along the public roads, and have completed their plans for laying mains.

Selby.—The Electrical Distribution of Yorkshire Co. intend to apply for a provisional order, under the Electric Lighting Act, authorising them to supply electric power within the urban district.

Hayward's Heath.—The Rural District Council have invited the promoters of the Hayward's Heath Electric Supply Co. to attend a special meeting of the Council and discuss the question of a supply.

Watford.—The electrical engineer's last report shows that the number of consumers connected to date is 410. It is proposed to construct and equip two sub-stations similar to those at present in use.

Case-Hardening.—We have received from Messrs. W. H. Palfreyman and Co., 17, Goree-piazzas, Liverpool, an interesting little pamphlet describing how the best results in case-hardening may be obtained.

Waterloo and City Railway Co.—The directors recommend a dividend at the rate of 3 per cent. per annum for the half-year ended June 30, carrying forward £658. The dividend at June, 1904, was at the same rate.

Llanelly.—A public meeting of ratepayers was held at the Llanelly Market Hall last week to discuss the Council's proposal to adopt a scheme of electric lighting. After discussion the meeting adjourned for a fortnight.

Diamond Cutting.—Mr. Leopold A. Claremont, managing director of Claremont Limited, in a letter to the *Daily Telegraph* says that it was a London firm who first applied electromotive power to the purpose of diamond polishing.

Rawtenstall.—The Board of Trade have approved the system to be adopted by the Town Council for the supply of electrical energy. Plans and estimate are before the Local Government Board, with an application to borrow £12,000.

Portland.—The National Provincial Electricity Corporation intend to apply for a provisional order to empower them to supply electricity for all purposes within the urban district. Steps are also to be taken for the purpose of applying for a provisional order on behalf of the Council.

Ossett.—A ratepayers' meeting was held on Monday to consider the advisability of erecting an electricity station, and a resolution was passed to the effect that if the Board of Trade refused to extend the time of the provisional order, a scheme not to exceed £4,000 might be promoted.

Retford.—The Town Council have been served with a notice by a London firm of intention to apply for parliamentary powers to supply electricity in the borough. In 1899 the Town Council received a provisional order to supply electricity within the borough, which has since been cancelled.

Torquay.—It has been arranged to accept the offer of the Dolter Co. for their engineers to consult with the borough electrical engineer as to the feasibility of carrying out the scheme of extension of the present station, the approximate cost of which it is roughly estimated would not exceed £6,000.

London Electric Supply Corporation.—The units sold for the half-year ended June 30 last amounted to 6,130,461, of which 4 039 970 units were for power purposes, producing a total revenue of £62,886, as compared with 4,494,220 units sold in the corresponding period of 1904, producing £64,776.

Queen's Hall Orchestra.—This year's promenade concerts at Queen's Hall will be held from Aug. 19 to Oct. 27. We have seen an attractive list of orchestral compositions which are to be performed for the first time in London by the Queen's Hall Orchestra, under the conductorship of Mr. Henry J. Wood.

Norton.—An agreement has been arrived at between the Urban District Council and the Northern Counties Electricity Supply Company whereby the Council agree to waive their right to the provision of a generating station in Norton, and the company undertake to at once commence to lay down a cable from Malton.

Leith.—Last week Judge Craig laid the last brick of the chimney stalk at the extension of the electric lighting station. Messrs. John Dennis and Co., Dalkeith, were the contractors. There are over 101,000 lamps connected with the station, which is now able to supply all the energy required for the working of the electric tramways.

Bridlington.—The Town Council propose to apply for sanction to borrow £4,500 (in addition to £1,500 for which application has already been made) for necessary extensions in connection with the electric lighting scheme, as the demand for current has been greatly in excess of anticipations, though ample provision has been made for extensions.

Anglo-American Telegraph Co.—The directors have resolved, after placing the sum of £5,000 to credit of the renewal fund, to declare an interim dividend for the quarter ended June 30, 1905, of 14s. per cent. on the ordinary stock and £1. 8s. per cent. on the

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preferred stock, leaving a balance of about £1,250 to be carried forward.

West Ham.—The accounts of the Corporation tramways for the year ending March 31 last show a gross profit for the year of £23,198. Of this sum £9,020 is absorbed by interest on the undertaking, and the net profit is £14,418. Of this sum the Corporation has placed £7,418 to the sinking and renewal fund, and have carried £7,000 to the relief of the rates.

Sale of Plant.—The Aston Manor Corporation invite tenders for the purchase and removal of the following apparatus: 280 (approx.) Electrical Company's tariff clocks, mechanically wound, 30 days; 100 Aron time switches (Wilson system), electrically wound, with warning coil; and 25 Schuckert time switches, electrically wound. For particulars see advertisement column.

Wrexham.—The Corporation have again demonstrated that the combination of refuse destructor with electricity works can, under able management, be worked successfully. We are informed that Mr. Sillery, the electrical engineer, has reported that the Meldrum destructor had worked continuously for 12 months without stoppages and without incurring a cost of one penny for repairs.

Fulham.—Messrs. Allen and Norris are about to build some 400 flats in the vicinity of Woodlawn-road, and have arranged to have them wired for electric lighting. The Council having decided to adopt prepayment meters, and to make a charge of 4d. per unit for current consumed, 25 meters for penny-in-the-slot are to be obtained from the British Thomson-Houston Co. at a cost of £103. 2s. 6d.

Faversham.—The electrical engineer reported at the last Council meeting that, on the basis of the expenditure of last year, the cost of the street electric lighting for the ensuing year would be £22 for each of the 10 arc lamps and £4 for each of the other lamps. A notice was tabled to the effect that, owing to the cost of the arc lamps, the question of substituting for them some other kind of electric lamp be considered.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Yorkshire (West Riding) Electric Tramways Co.'s £275,000 4½ per cent. first debenture stock, and to allow the Edmundson's Electricity Corporation's further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 70,001 to 80,000, to be quoted in the official list.

Grimsby.—Mr. W. A. Vignoles, the borough electrical engineer, in his last report states that as the result of the year's working the committee had made £895 profit, which could be voted to the relief of the rates. The undertaking is only four years old, yet the engineer estimates next year's profit at £1,500, while if a proposed agreement with a probable large consumer is completed, the undertaking would in about three years be able to repay the whole of the money received from the rates.

Loughborough.—The Town Council have decided on the recommendation of the electrical engineer, Mr. W. H. Allen, to reduce the price of current to the following: private house and shop lighting, 4d. per unit; factory and workshop lighting in bulk, 3d. per unit; current for motors, radiators, fans, and all heating and cooking apparatus, except between 5 and 11 p.m., 1d.; current for ditto between 5 and 11 p.m., 3d. per unit. These reductions will come into operation as from July 1, 1905.

Woolwich.—Application is to be made to the London County Council for an advance of £5 610 for a further scheme of street-lighting by electricity. An electric lighting scheme has been adopted, subject to an estimate being passed by the Finance Committee, and the sanction of the London County Council being obtained to the borrowing of the amount required—for Woolwich parish, £4,387. 11s 10d.; Eltham parish, £415. 16s. 6d.; estimated cost of side street lighting, £805. 14s. 6d.—a total of £5,609. 2s. 10d.

Lighting Big Ben.—In the House of Commons last week Mr. Lough asked Lord Balcarres what was the cost of lighting "Big Ben," and what was the estimated saving by colouring one or more of the dials green, as opposed to red. Lord Balcarres said the cost of lighting the dials of the clock electrically amounts to £242 for the year. The green light is incidental to the lamp used experimentally, and the cost of current, if it was adopted permanently, would be reduced some 35 per cent. A red colour, being impracticable, has never been used.

London Gazette.—A first and final dividend of 1s. 10½d. in the £ has been declared in the estate of James William Hunter, electrical engineer and motorcar dealer, 8, Norwood-road, Leeds, and trading with Albert Chapman as the Yorkshire Motorcar and Electrical Engineering Co. The partnership between Austin Isherwood and George Richardson Burnett, carrying on business as electricians, electrical engineers, and contractors, at 37, Surrey-street, Sheffield, under the style of the Sheffield Electric Bell and Telephone Co. has been dissolved by mutual consent.

Private Bills.—The following Bills have been read a third time in the House of Lords and passed: Metropolitan and Great Central Railway Companies, Gosport and Fareham Tramways, Hastings Tramways, South Lancashire Tramways, North Metropolitan Electric Power Supply, Metropolitan Electric Tramways, Dublin United Tramways, Charing Cross, Euston, and Hampstead Railway, Baker-street and Waterloo Railway, Edgware and Hampstead Railway, South Barracas (Buenos Ayres) Gas and Coke Company, Great Northern Railway (Ireland), Great Northern, Piccadilly, and Brompton Railway (No. 1), and the Shropshire, Worcestershire, and Staffordshire Electric Power Bills.

Burnley.—An inquiry has been held into the application of the Town Council for sanction to the borrowing of £16,194 for the purposes of electricity undertakings. Major Norton, the assistant town clerk, stated that the total amount sanctioned for the purposes of the undertaking was £85,844, the actual amount raised was £78,524, and the outstanding debt was £64,319. During the last three years the profits of the electricity undertaking, after paying interest and sinking fund charges, for the year ending March 31 last amounted to £8,307; for 1904, £5,123; and for the year 1903 to £3,552. The acting electrical engineer, Mr. Starkie, gave figures showing how the electricity works had developed, mentioning the electrification of the tramways. He considered that with the new extensions and additions the town would be fairly well equipped for some time to come.

London County Council.—At Tuesday's meeting of the Council tenders for the manufacture, supply, and delivery of one five-ton and one 2½-ton overhead electrically-driven travelling crane were referred to committee for consideration and report. It was agreed to lend the Poplar Borough Council £10,818 for electric light purposes. The Highways Committee recommended that expenditure on capital account, not exceeding £30,000, be sanctioned in respect of the construction of the foundations and the erection of the chimneys for the second portion of the Greenwich electricity generating station; and that the drawings, specifications, and estimate of £28,000 for the construction of the foundations and the erection of the chimneys for the second portion of the Greenwich electricity generating station be referred to the Works Committee with a view to the execution of the work without the intervention of a contractor.

Hampstead. — The Lighting Committee recommended last Thursday week that, with the commencement of the New Year, the charges for electric current to private consumers for lighting be 6d. per unit for the first hour's average maximum demand per day, and 1½d. per unit for all current consumed beyond that quantity during each quarter for the winter quarters, and a uniform charge of 1½d. per unit for the summer quarters, instead of 6d. per unit for the first hour and 2½d. for the remainder during the whole year as previously. They further recommended that the question of making any alteration in the meter rents stand over for the present, and that no alteration be made in the present charges for heating and power. An amendment, that the whole matter be referred back to the committee, with instructions to bring up the full reports of the officials and the whole of the information placed before the committee, was carried.

Wigan.—The Wigan Corporation Bill has passed the House of Commons after amendment in committee. Under it the Corporation sought, amongst other powers, to acquire provisional orders for electric lighting in the districts forming the Wigan Poor-Law Union. This district is already included in that of the Lancashire Electric Power Co., who accordingly offered strong opposition to the above proposal. After hearing evidence on both sides the Select Committee of the House of Commons allowed the Wigan Corporation to take over the electric lighting order of Ince, but refused the power sought to supply electricity elsewhere with the poor-law union. The evidence in opposition to the Bill showed that a good deal of power was likely to be required by the collieries within the area. The committee was evidently convinced that this class of work should be done by the Lancashire Electric Power Co. rather than by a municipal body.

Charing Cross Electric Athletic Association.—The members of the above association held their first annual sports on their ground at Acton on Saturday, July 22, 1905, before a large gathering of friends. The cup presented by the president (W. F. Fladgate, Esq.) for the highest number of points scored was won by Mr. W. B. Schroder, Mr. H. Davies being second. After the sports Mrs. J. Gatti presented the prizes, and a most enjoyable day ended with a dance on the lawn, in which a great many took part. Amongst the results we note: 100 yards—(1) H. Davies, (2) W. B. Schroder, (3) H. Miller; veterans' race—(1) J. Usher, (2) J. Eness, (3) H. J. Payne; 440 yards' handicap—(1) F. Wallington, (2) A. Nicholls, (3) T. Jones; long jump—(1) C. R. Oldfield, (2) W. B. Schroder; one-mile championship—(1) H. J. Henbrey, (2) W. Webb, (3) A. Patter; two-mile walk—(1) T. O'Gorman, (2) G. Connor, (3) F. Palmer, (4) E. Suffling; high jump—(1) H. Davies, (2) F. A. Smith.

Birmingham.—Mr. Ellaway, in moving the adoption of the report of the Electric Supply Committee, pointed out that while the probable requirements of energy for tramway purposes during 10 years was estimated at 7 500 kw., provision was only asked for the installation of 3 600 kw., leaving a margin of 4,000 kw. to be added as occasion arose. The additions proposed were necessitated by the scheme of the Tramway Committee for the extension of the tramways, involving the laying of about 31 miles of entirely new lines. The additional equipment at Summer-lane provided for the installation of 1,500 kw. of direct-current supply, and 1,500 kw. of alternating-current supply. With regard to the three sub-stations already sanctioned, the intention was to build them only at present to about half their ultimate size, but the committee were now satisfied that it was the wiser and more economical plan to now erect them to their full size. To the £10,500 for the building of the three stations they now added a further £16,000. The cost of the high-tension lighting cable connecting Summer-lane to Saltley was £6,000, and they asked for £10,000 for lighting mains and feeders for opening up the district. They would, of course, only spend the latter sum as they got applications for a supply. The total sum required for the extensions was close upon £100 000. The report was approved without discussion.

Newcastle.—Mr. Ernest Hatton in a recent report says the net receipts over the expenditure for the present 200 arc lamps, at an annual cost to the Lighting Committee of £2,980, amounted to £317, which sum allowed for ample depreciation on the equipment. The report shows that during the year ended March 31, 1905, 8,581,301 units were produced and distributed as follows: units used in power station, 273 325; at pumping station, 380,575; leaving a net balance for disposal of 7,927,401 units. The total cost of production was £33,541, including all capital charges, rents, rates, etc., or 1·015d. per unit; 328,393 units were now used for the present 200 arc lamps. It is proposed to increase the number for a further 160 arc lamps,

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making a total of 360 arc lamps. This will necessitate a further expenditure on cables, etc., and new lamps of £4,500. The total cost of this additional supply, providing 8,194,008 units, will be £33,753, or a total cost of ·989d. per unit. As it is proposed to reduce the price paid per lamp from £15. 10s. to £12 per annum, the total revenue derived from the 360 arc lamps will be £4,320, and the expenditure, including additional maintenance on the increased number of lamps, together with the additional capital charges, will be £4,239 per annum, leaving a net balance of £91, in lieu of £317 now derived from the present installation of 200 lamps, at a total expenditure to the Lighting Committee of £2,960.

Govan.—In his report on the working of the Govan electricity department for the year ending May 15, 1905, Mr. Theodore Parsons states that nearly all the contemplated extensions are now completed. The new engine-room has been completed, and the overhead crane, 750-kw. steam dynamo and condensing plant and piping erected, and the 600-kw. steam dynamo shifted from the old to the new engine-room. Eighty-five long-hour arc lamps, with raising and lowering gear, have been erected, and various extensions to the mains have been made. The balance of profit is £411, which, with the balance carried over from last year, amounts to £727, which has been placed to the renewals fund account. The result is very satisfactory, as bad debts of £108 and buildings taken down, £407, were written off, and about £600 of income was lost due to the failure of one of the consumers, and £365 due to the new street lamps being late in erection. All the working costs show decreases except the oil, waste, etc., which have risen ·003d. per unit sold. The coal cost has gone down ·052d. per unit. The maximum load in kilowatts is only 100 higher than last year, which is due to the loss of a large consumer and to the fact that the new street lamps were not connected until after January, 1905. The cost of attending to street lamps has been reduced to ·555d. per unit, and should be still lower in the coming year. The applications for both light and power were higher than in any previous year.

Erith.—The annual report of the electrical engineer (Mr. G. E Heath) on the working of the electricity supply undertaking for the year ending March 31 last contains the following statistics: The connections made to the mains during the year were 3,771 8 c.p. lamps, 5,275 h.p. in motors, and the equivalent of 203 8 c.p. lamps in public lighting, the totals now being 17,359 8-c.p. lamps and 231·75 h.p. in motors. The street-lighting comprises 17 arc lamps, 34 32-c.p lamps, 458 two 8-c.p., and 84 half-ampere Nernst lamps. The total mileage of the cable laid during the year is 2 63 miles, made up as follows: ·44 miles of high-tension feeder, ·90 miles of low-tension distributor cable, and 1·29 miles of street-lighting cable, bringing up the total mileage of cable laid to 59 2 miles. Substantial reductions have been effected in each item with the exception of coal, resulting (notwithstanding an increased coal cost) in a net reduction of ·267d. per unit generated on the total costs, and ·323d. per unit sold. The standing charges have risen from £1,878 to £2 824. In view of the conditions above mentioned, a gross profit of £1,959 with a reduction in the generation costs of ·267d. per unit conclude a satisfactory year. The general statement accompanying the report shows the total capital expended to have been £51.648. 11s. 0½d.; gross revenue, £7,176. 3s. 9d.; gross expenditure, £5,151. 15s. 1½d.—gross profit, £2 024. 8s. 7½d. Average price obtained per unit: private lighting, 4 938d.; power, 1·586d.; street lighting, 1·669d. Interest and sinking fund, £2 821. 2s. 7d.; balance on year's working—deficit, £799. 13s. 11½d.—gross profit, £2,024. 8s. 7½d.

TRACTION.

Limerick.—An inquiry has been held into the proposed Limerick tramways scheme.

Dover.—The extension of the municipal electric tramways through the country district to River is expected to be opened for traffic in August.

Derby.—The extension of the electric tramway from the Market Head to the borough boundary on the Kedleston-road has been practically completed.

Colchester.—The Colchester electric tramways on July 28, 1904, complete their first year. Up to Thursday last week the total receipts had come to a little over £11,000.

Aberdeen.—All the tramway standards on the various routes of the city have been numbered so that the repairer can find the required posts easier, as most repairs are done at night.

Heywood.—The Tramways Committee have arranged that their proposed electric tramways, the construction of which is about to be commenced, will be worked at 4½d. per car mile.

Tramwaymen's Sports.—The annual sports in connection with the Southport Corporation Tramway Employés' Social and Athletic Society took place on Wednesday and Thursday of last week.

Auckland.—The Rural District Council will not oppose the application of the United Kingdom Tramway Syndicate for the prolongation of the time fixed for the commencement of the tramway scheme.

Wednesbury.—The work of reconstructing the tramways between Wednesbury and Darlaston is proceeding satisfactorily. It is expected that the cars will be running by the latter end of August or the beginning of September.

Ashton.—The Ashton Tramway Committee and the Stalybridge Joint Electricity Board have at last settled their difficulties, it is said, satisfactorily to both parties. On Monday through running commenced, the fares remaining as hitherto.

Brighton.—The Corporation have inaugurated a system of personally conducted touring cars, which twice daily leave the Aquarium terminus for a circular trip to the points of interest about Brighton. The journey covers about nine miles, and occupies nearly two hours.

Lewisham.—The Council have authorised the Special Tramways Committee to join with the committee of tradesmen in Sydenham and Forest Hill in a deputation to the London County Council to urge upon them the necessity for the early extension of the tramways in that district.

Watford.—The Herts County Council have sealed amended agreements with the Urban District Council of Watford and the Metropolitan Electric Tramways Co. with regard to the Watford light railways. We understand the Watford Urban District Council will supply the current.

The Edinburgh and Queensferry Tramways.—At the conclusion of the inquiry under the Private Legislation Procedure (Scotland) Act, 1889, into the draft provisional order on the Edinburgh and Queensferry tramways, the Commissioners intimated that they held the preamble not proved.

Cricklewood to Marble Arch.—Mr. B. B. Evans is making efforts to bring about a Marble Arch-to-Cricklewood tramway scheme. He will ask the Willesden and Hampstead Councils to have a conference to consider the questions of trams and widenings, and to test the feelings of neighbouring public bodies.

Wolverhampton and Cannock Chase Railway Co.—An inquiry has been held into the application of the Wolverhampton and Cannock Chase Railway Company for a light railway order. The chairman said the order would be recommended for granting, subject to the readjustment of clauses for the line to be run as a light railway.

Nelson.—The Burnley Corporation and the Colne and Trawden Light Railways Co. have agreed to cheap fares over their respective systems for parties of not less than 10, to be carried on ordinary service cars. The Nelson Council have approved of the arrangement, subject to the inclusion of cheap fares for similar parties between Nelson Centre and Townley, Manchester-road Summit, Rose-grove, and Padiham.

Liverpool Overhead Railway Co.—The accounts for the past half-year show an available balance of £7,883. 6s. 8d. The directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and carry forward a balance of £4,335. 11s. 6d. Last year at the corresponding period a dividend of 1½ per cent. per annum was paid on the ordinary shares and £4,052. 5s. 10d. balance carried forward.

Shildon.—The United Kingdom Tramways and Light Railways Syndicate propose to apply to the Board of Trade for a prolongation of the time limit in respect of the commencement and completion of the work of laying the proposed tramways. We understand that the Urban District Council have passed a motion to the effect that the proposed extension of time be objected to unless the syndicate were willing to pay the Council a wayleave of £50 per mile per annum.

Birmingham.—The Tramway Bill promoted by the Corporation relates to the building of depôts, the construction of new lines, etc., which will cost about £1,000,000. It is expected that all the existing lines, with the exception of the cable route, will be electrically equipped by the time the leases expire in 1906. The time-limit for the construction of the new lines is five years, as large street widenings are necessary. The electrical equipment is estimated to cost £600,000.

Falkirk.—Good progress is being made with the construction of the tramways, both in the burgh and in the county. A consignment of cars has arrived at Grangemouth per s.s. "Donavon" from Dunkirk. The cars are in parts, and on arrival in Falkirk will be put together and the motors connected with them fitted in. They are large, roomy, and comfortable looking, and artistic in design and finish. They have been supplied by Messrs. Bruce Peebles and Co., Edinburgh, the principal contractors for the tramway.

District Railway.—Electric trains commenced to run on the Putney Bridge to High-street, Kensington, section of the District Railway on Sunday last. For the present there will be no through electric service from Putney to the City, but passengers on the Putney line may, by changing at Earl's Court, complete the journey in one of the electric trains running between Ealing and Whitechapel. The Richmond section will be the next electrified section to be opened. The electric trains to Wimbledon will be started in a week or two.

Huddersfield.—The Council have adopted a report, in which the Tramways Committee recommended that the manager be given sole control over the employés of the tramway department, with power to dismiss or suspend, and that the manager be instructed to post up a notice that henceforth any motorman found abusing his equipment in definance of the regulations will be summarily dismissed. All ticket inspectors are in future to be fully qualified motormen, and their duties will include the supervision of the motormen as well as the conductors.

Poole.—The Railways Committee have reported the receipt of a letter from Mr. J. J. Norton calling the attention of the Council to the obligation resting upon them of constructing a light railway through Parkstone under the Poole and District Light Railway Extension Order, 1902. The town clerk will apply to the Board of Trade to extend the time for executing the works for a further period of two years; and after having obtained the concurrence of the Branksome Urban District Council, will ask the Bournemouth Corporation whether they are willing to undertake the construction of the line, subject to plans, etc., and method of construction being approved by this Council and the Branksome Urban District Council. Similar steps will be taken with regard to the proposed extension to the Sandbanks district.

Tramway Construction Contracts.—We understand that Messrs. J. G. White and Co., who are now making an issue of capital, have just secured a contract, amounting to upwards of £400,000, for the complete construction of tramways, etc., at Para, Brazil. If the report of the Traffic Commission is acted upon, it will, no doubt, give an impetus to tramway construction in London. Messrs. White were the

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pioneers of the conduit system of electric traction in London, and they have carried out works amounting to over £400,000 for the London County Council during the last few years. They are at present carrying out a large contract for the London United Tramways, and will also be entrusted with the conversion to electric traction of the Bombay (India) tramways system. With the large amount of contract work already in hand, amounting to over two million pounds, and the bright outlook for the future, the continued success of the company appears very promising.

Portsmouth.—The balance sheet of the Corporation tramways for the year ending March 31 shows the undertaking to be increasingly prosperous. The total receipts amounted to £100,973, of which £91,705 was from fares, £1,093 from advertising on the cars, and £5,564 for the sale of current to the light railway company. The total expenditure for maintenance and repairs was £44,165, so that there was a gross profit of £56,807, equivalent to rather more than 8 per cent. on the capital outstanding. From this total £18,696 has to be deducted for interest charges, £15,930 for the sinking fund, and £934 for income tax. This brings the net profit down to £21,246, to which has to be added the sum of £712 dividends on investments, so that the available surplus is £21,959. The committee have spent £5,608 upon the Somers-road and Circle improvements, and £2,107 for workshop and other improvements, and for balancing various outstanding capital charges for which money was not borrowed. These two payments reduce the balance to £14 243, and the committee propose to add this to the reserve fund, which will then amount to £37,236.

Light Railways in the Potteries.—The Light Railway Commissioners have held an inquiry into an application of the North Staffordshire Railway Co. for an order authorising them to work certain mineral branches of their system as light railways. The lines in question were—(1) branch from Apedale Junction to Apedale Ironworks; (2) from Knutton Junction to Pool Dam Canal Wharf, Newcastle; (3) from Normacot to Adderley Green; (4) from Botteslow Junction to Adderley Green; (5) from Longport Junction to Tunstall Junction; (6) from Tunstall to Newfield; (7) from Chatterley Junction to Talk-o'-th'-Hill; (8) from Chatterley Junction to Chesterton; (9) the Grange branch at Burslem; (10) from Stretton Junction to Hawkins-lane Junction, Hornicglow; (11) from Congleton Lower Junction to Congleton Brunswick; and (12) from Wheelock Station to Sandback. The Potteries Electric Traction Co. opposed the application as regarded Nos. 1, 2, 3, 5, 6, and 9. Mr. B. C. Brough appeared for the railway company, and Mr. Tildesley Jones for the electric traction company. The Commissioners announced that they were prepared to submit an order to the Board of Trade sanctioning the working of all the lines as light railways except Nos. 2, 5, and 6.

Tramway Damages.—At the Manchester Assizes on the 25th two verdicts were given against the Salford Corporation. One man obtained £90 damages. From the evidence it appeared that when riding on the outside of a Salford tramcar, he was struck by a loose trolley pole. In another case the plaintiff obtained £225 compensation for his personal injuries caused by a collision which was due to one of those obstinate carters of whose objectionable tactics every user of a tramcar is well aware. In giving his evidence, a car driver said that two coal-carts appeared in front of him and monoplised the road, preventing his car from proceeding. The wheels of both carts were over the metals. The witness repeatedly sounded his gong, but although the carters might readily have drawn off to the left, the obstruction continued. The driver of the second cart at length drew away, but the one in advance of him not only maintained his position, but turned and jeered at the witness, putting his thumb to his nose—"as youngsters would"—and laughing at him from under his horse's head. The man persisted in this behaviour, although called to and warned by his companion, and when he did lead his horse out of the way it was to the right instead of to the left. This brought him into collision with the car on the down line. The near shafts of the coal-cart struck the front part of the car (after Tobin had applied his electric brake), pinned Tobin's left arm against the steps, and broke the arm below the elbow.

London County Council.—On Tuesday £50,000 was voted in respect of the acquisition of lands and easements in connection with the construction of the tramway subway from Southampton-row to the Victoria-embankment. Next week the Highways Committee will recommend: (*a*) That the estimate of expenditure on capital account of £59,394, made up of the undermentioned amounts submitted by the Finance Committee, be approved in respect of the equipment of the tramways from the Strand, *via* the tramway subway, to Theobald's-road, and the reconstruction and equipment of the tramways in Theobald's road between the present tramway terminus and the authorised tramways in Rosebery-avenue near Gray's-inn-road—namely: rolling-stock, £33,000; trackwork, £19,870; cables, switchboards, etc., £5,024; lighting, etc., £1,500. (*b*) That the Highways Committee be authorised to make any necessary arrangements with the North Metropolitan Tramways Co. for the electric working as a through route of the tramways in the tramway subway between the Strand and Southampton-row, and of the tramways between Theobald's-road and the Angel, Islington; that an agreement be entered into to give effect to the arrangements; and that the seal of the Council be affixed to such agreement. An expenditure of £4,500 is proposed for the construction of a junction line at St. George's-circus between the tramways in Borough-road and Blackfriars-road. The report of the Highways Committee on the accounts of the receipts and expenditure for the year ended March 31, 1905, in connection with the Council's tramways undertakings south of the Thames is as follows: The London County Council tramways comprise the undertakings transferred to the Council by (*a*) the London, (*b*) the South London, (*c*) the South-Eastern Metropolitan, (*d*) the London, Deptford, and Greenwich, and (*e*) the London, Camberwell, and Dulwich Tramways Companies. The net capital expenditure in respect of the whole of these tramways amounted on March 31, 1905, to £2,623,692. 19s. 2d., of which £208,363. 11s. 7d. has been repaid out of revenue, the amount of the outstanding debt on that date being £2,415,329. 7s. 7d. During the year 1904-5 the net expenditure on capital account amounted to £499,454. 3s. 5d. This amount includes £102 884. 15s. for the purchase of the undertakings of the London, Deptford, and Greenwich Tramways Company and the London, Camberwell, and Dulwich Tramways Company, the remainder being in connection with the reconstruction for electrical traction of certain sections of the tramways. The net capital expenditure up to March 31, 1905, in respect of the reconstruction of tramways for electrical traction was £1,470,018. 13s. 2d. The total receipts from the undertaking during the year, and the working expenses, were as follows: Total receipts—electric traction £548,296. 7s. 1d., horse traction £133 799. 2s., total £682,095. 9s. 1d.; working expenses—electric traction £365,497. 12s. 6d., horse traction £134,323. 1s. 6d., total £499 825 14s; making the gross surplus on working—electric traction £182 798. 14s. 7d., horse traction £523. 19s. 6d. (deficiency)—total £182 259. 15s. 1d. Debt charges, amounting to £136,953. 17s. 9d. (including £576. 2s. 3d. in respect of the widening of Harleyford-street), and a charge of £3 261. 7s. 6d. for income tax, have been set against the sum of £182,269. 15s. 1d. above referred to, and a sum of £35,000 has been transferred to the renewals reserve fund, leaving a net surplus of £7,054. 9s. 10d. to be carried to the appropriation account. This compares with a net deficiency of £8,283. 14s. 2d. in 1903-4, when no amount was set aside for renewals. The total receipts have been £145,856 more than in 1903-4, notwithstanding the fact that Streatham cable tramways were closed during their reconstruction for electrical traction. The exceptionally fine weather during the summer no doubt accounted to a considerable extent for the increased earnings. The total amount of the renewals reserve fund established in connection with the undertakings was, at the beginning of the year 1904-5, £30 772. 4s. 9d. Dividends on investments and interest on the bank balance of the fund amounted during the year to £834. 17s. 9d. The uninvested moneys of the fund were temporarily used to defray the expenditure incurred in the provision of the four temporary generating stations at Loughborough Junction, Deptford, Streatham, and Bankside. The expenditure incurred under this head is £35,203 12s. 3d., of which sum £2,895. 12s. 5d. was charged against the revenue of the year 1903-4, while the remaining £22,307. 19s. 10d., instead of being charged over the whole period during which certain of the temporary stations are to be used, as was originally proposed, has been borne by the revenue of the year 1904-5. The balance of the fund carried forward to the current year is £56,607. 2s. 6d., an increase in the year of £35 834. 17s. 9d. No comparison of working expenses can be made with those of former years owing to the different circumstances obtaining. It may be stated, however, that the total operating expenses for electrical traction were £340,987. 11. 9d., or 7·49d. per car mile run, while the addition of the expenditure in connection with the provision of temporary generating stations mentioned above and other special items increases the revenue expenditure to 8·03d. per car mile run. The total expenses in connection with horse traction work out to 10·23d. per car mile run. We would, however, point out that the working expenses for electric traction have been considerably higher than they are exected to be when the permanent generating station at Greenwich is completed, and when the use of temporary car-sheds can be dispensed with. On the whole, therefore, we regard the result of the year's working, which is considerably more favourable than was anticipated in the annual estimates, as being very satisfactory. The following further facts may be of interest to the Council. The tramways system extends over a total length of about 46⅞ street miles, inclusive of the lines of the London, Deptford, and Greenwich Tramways Co., acquired in July, 1904, but exclusive of the derelict lines purchased from the London, Camberwell, and Dulwich Tramways Co. Of this total length about 26⅝ miles of double track have been reconstructed on the underground conduit system of electrical traction. Electric services on the lines were first started on May 15, 1903, and during the year 1904-5 several further sections of lines were opened for traffic, including the Brixton and Streatham lines and several new routes. The total number of passengers carried and the car miles run during the year were 164,818,560 and 14,081,397 respectively, or 31,679,475 and 2,544,863 more than in 1903-4. The sub-division of these figures between electric and horse traction is as follows: Number of passengers—electric traction, 126,255,230; horse traction, 38,563,280—total, 164,818,560. Number of car miles run—electric traction, 10,931,396; horse traction, 3,150,001—total, 14,081,397. Of the total number of passengers, 35·97 per cent. were carried at ½d. fares, 47·10 per cent. at 1d., 9·12 per cent. at 1½d., 5·01 per cent. at 2d., 1·18 per cent. at 2½d., and 1·62 per cent. at 3d. The average fare per passenger was ·97d., as against ·93d. in 1903-4. During the year an innovation has been made by the use of roof-covers for some of the electric cars, 81 of which were equipped up to the end of the year 1904-5, while others are being fitted. These roof-covers have been much appreciated by the public, and the earnings of the cars have been considerably increased. The tramways stud at the beginning of the year numbered 1,872, and 295 horses were added upon the transfer of the London, Deptford, and Greenwich Tramways Co.'s lines. Owing principally to the institution of electrical traction on some of the lines, however, the stud has been reduced by 847 horses, which have been sold by auction at an average price of £21. 12s. 4d. each. The low average price realised is due to the fact that nearly 400 of the horses sold, which had been recently transferred to the Council from one or other of the companies, were of an inferior standard, and had to be replaced from the Council's own stud by a much better class of horses, which would otherwise have been disposed of. In addition to the horses sold, 20 horses have died and eight cart horses have been bought, so that the stud on March 31, 1905, numbered 1,300 car horses and eight cart horses. The average cost per week for provender and litter has been 7s. 6·28d. per horse, as against 8s. 3·09d. in 1903-4. The permanent way has been well maintained, and the machinery, plant, and rolling-

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stock have been kept in thorough order and repair. In consequence of complaints as to the noise caused by the running of the tramcars on the Tooting section of the Council's electric tramways, it has been found that the rail joints have in many cases worked loose, and a trial is to be made of the Thermit system of welding rail joints. It has been arranged that 200 rail joints be welded on this principle at a total cost of about £240.

PROVISIONAL PATENTS, 1905.

JULY 17.

14660. Improvements in or relating to vapour electric lamps. Francis Harrison, 157, Grange Park-road, Leyton, Essex.

14663. Improvements for central battery telephone transmitters. Joseph Henry Scales, 94, Stockwell Park-road, Brixton, London.

JULY 18.

11970a. Improvements in electric couplings. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London. (Date applied for under Patents Rule 9, June 7, 1905.)

14713. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14714. Improvements in and relating to electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14715. Improvements in vapour electric rectifiers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14736. New electric switch for recording, indicating, and controlling main switches by magnetic coils. Charles Isaac Adams and Walter Brand, 8, Crescent-gardens, Bath, England.

14749. Improvements in electric stop motions for looms. Pierre Vindrier, 6, Bank-street, Manchester.

14751. Improvements in electric dynamos and motors. Cenek Macku, 6, Bank-street, Manchesters.

14770. Improvements in and relating to telegraphic instruments and the like. Alberto Gentili, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, July 19, 1904, being date of application in Italy.) (Complete specification.)

14780. Improvements in or relating to apparatus for electric welding. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The Clinton Wire Cloth Company, United States.) (Complete specification.)

14785. Improvements in connection with frogs and switches and crossings for the overhead conductors of electric tramways and railways. Isaac Everson Winslow, 47, Lincoln's-inn-fields, London.

14788. Improvements in or relating to wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

14803. Improvement in telephone shells. William Robert Sine and Jacob Sigmund Rosenthal, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 19.

14837. Improvements in or connected with trolleys of overhead electric railway vehicles or locomotives. Robert Wilson Dunn, 15, Water-street, Liverpool.

14847. A continuous covering for electric tramway or railway conduits. Thomas Dewhirst and Robert Burn, 50, Old Broad-street, London.

14879. Improvements in and relating to safety devices for electric motors and the like. The Johnson-Lundell Electric Traction Company, Limited, and John Harper Robertson, 7, Southampton-buildings, Chancery-lane, London.

14889. Improvements in submarine electric cables. Paolo Coridori, 31, Bedford-street, Strand, London. (Complete specification.)

14898. Improvements in the manufacture of filaments for incandescing electric lamps. Jack Crawford Randell, Olun House, Surrey-street, Strand, London.

JULY 20.

11971a. Improvements in and relating to electric current rectifying systems. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (The General Electric Company, United States. (Date applied for under Patents Rule 9, June 1, 1905.)

14905. Disinfector appliance for telephone transmitters. Erbine Curtis Phillips and Fred Earle Shedd, 20, High Holborn, London.

14955. Improvements in the production of long stable electric arcs. James Yate Johnston, 47, Lincoln's-inn-fields. (The Badische Anilin und Soda Fabrik, Germany.)

14959. Improved sparking coil with multiple winding for ignition and like purposes. Société d'Electricité "Nilmelior" and Auguste Michel, 322, High Holborn, London. (Complete specification.)

14964. Improvements in electric hoists and conveyers. Joseph Gershom Childs, Hawthorn-road, Willesden Green, London.

14971. Improvements in and relating to electric switches. Norman Hamilton, 83, Cannon-street, London.

14972. An improved process of obtaining a substance particularly adaptable for making incandescent electric lamp filaments thereof. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14973. Improvements in mercury vapour electric apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

14978. Improvement in electric switch. Gustave Leopold Herz, 19, Holborn-viaduct, London. (Date applied for under Patents Act, 1901, Oct. 7, 1904, being date of application in United States.) (Complete specification.)

JULY 21.

15002. Improvements in and relating to electrically-controlled variable-speed gear. Henry Vincent James, 3, Brown-street, Market-street, Manchester.

15017. An improvement applicable to the trolley poles of electric cars. James Stewart Finney, 4, St. Anne's square, Manchester.

15022. Receivers suitable for use in wireless telegraphy or telephony. John Greene Balaillie, 143, Ham Park-road, Forest Gate, Essex.

15045. Improvements in electric train-control systems. August Sundh and Axel Magnusen, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 16, 1905, being date of application in United States.) (Complete specification.)

15055. An improved process for extracting metals from ores and other metalliferous material by electrolytic means and apparatus therefor. Ganz and Co., Eisengiesserei und Maschinen-Fabrike Act.-Ges., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Aug. 26, 1904, being date of application in Germany.) (Complete specification.)

15067. Improvements in and relating to the regulation of alternating-current dynamo-electric machines. The Allgemeine Elektricitäts-Ges., 83 Cannon-street, London. (Date applied for under Patents Act, 1901, July 22, 1904, being date of application in Germany.) (Complete specification.)

15071. Improvements in protective devices for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15074. Improvements in or relating to means or apparatus for regulating the difference of potential between portions of alternating electric current distributing systems. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

JULY 22.

15084. Improvements in means for enclosing electric switches and pushes, and other apparatus requiring manipulation in a medium from which they must be protected. Christopher Alvey Peck, 6, Bank-street, Manchester.

15091. An improved type of house service fuse-box for the supply or distribution of electricity. Thomas Henwood and Frank Camillo Norman Bergh, 14, Pelham-square, Brighton.

14101. Magnetic tubular hammer. Henry James Dale, 166, Pentonville-road, London.

15121. Improvements in and relating to electric sparking coils. Douglas Elyard Brown, 1, Queen Victoria-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 10.

1904.

15703. Means for electrically controlling phonographs and cinematographs in combination. Soc. L. Gaumont et Cie. (Date applied for under International Convention, July 17, 1903.)

15942. Alternating-current electric meters. Union Elektricitäts-Ges. (Date applied for under International Convention July 18, 1903.)

17743 Trolley turners or devices for moving the trolley poles of electric cars. Bamber.

17869. Electric controllers British Thomson-Houston Company Limited. (General Electric Company.)

18012. Processes of oxidation and reduction effected in an electrolytic bath. Imray. (Farbwerke vorm. Meister, Lucius, und Brüning.

19478. Regulators for electric circuits. British Thomson-Houston Company, Limited. (General Electric Company.)

19885. Electric motor controllers. British Thomson-Houston Company, Limited. (General Electric Company.)

26527. Electric ignition apparatus for internal-combustion engines. Eckstein and Coates.

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19886. Electric railway systems employing sectional conductors. British Thomson-Houston Company, Limited. (General Electric Company.)

19891. Devices for protecting electric railway signalling systems from excessive current. British Thomson-Houston Company, Limited. (General Electric Company.)

19993. Shunts for electrical measuring instruments of the moving-coil type. Evershed and Vignoles, Limited, and Vignoles.

24692. Means for ascertaining the power factors in alternating-current systems. Grammont. (Date applied for under International Convention, Nov. 24, 1903.)

1905.

2328. Apparatus for heating water electrically. Shoenberg.

4541. Micro-telephones. Elektromilitära Aktiebolaget. (Date applied for under International Convention, March 8, 1904.)

5455. Spark gaps for electric discharges. Thompson. (Ges. für drathlose Telegraphie m. b. H.)

5827. Field systems for continuous-current electric meters. Busch. (Date applied for under International Convention, March 22, 1904.)

9540. Dynamo-electric generators and motors for power transmission. Simonds. (Date applied for under International Convention, May 5, 1904.)

10685. Ventilating arrangements of dynamo-electric generators and motors. Siemens Bros. and Co. (Siemens-Schuckertwerke G. m. b. H.)

11860. Electric target-setting apparatus. Boult. (Phönix Elektrotechnische G. m. b. H.)

12263. Electrolytic ship-bottom cleaner. Frazier.

12291. Process for the electrolytic production of lustrous metallic coatings upon metals. Classen.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5½-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2⅞-2⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	86-88
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	92-95
—— 4½ per cent. 2nd Debenture Stock	100	..	77-80
Callender's Cable, Debentures	100	..	106-108
—— Ordinary	5	..	10-11
—— 5 per cent. Pref.	5	..	5-5⅜
Crompton and Co.	3	..	1½-2
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1¼-1⅜
—— "A" Shares, 01-017,139	5	..	2-2½
—— 5 per cent. Debentures	100	..	89 94
—— 4 per cent. Deb. Stock, Red.	100	..	83-88
Electric Construction, Nos. 1 to 112,100	2	..	⅜ ⅜
—— 7 per cent. Cumulative Pref.	2	..	1⅜-2¼
—— 4 per cent. Perp. 1st Mort Deb.	100	..	93-96 xd
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-101
W. T. Henley's Telegraph Works, Ordinary	5	..	11½-12½
—— 4½ per cent. Preference	5	..	5⅜-5⅝
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	31-33 xd
—— 5 per cent. Bonds	100	..	101-103
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	11⅜-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11½-12⅜
—— 4½ per cent. Debenture Stock, Red.	100	..	116-118
Bromley (Kent) Electric Light and Power Co.	5	..	5⅜-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	103-106
Brompton and Kensington, Ordinary	5	..	9½-10⅛
—— 7 per cent. Preference	5	..	9-10
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9 9⅛
—— Nos. 60,001-80,000	5	..	8⅜-9⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12⅛-13⅜
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	6⅞-7⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5⅛-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	104-106
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4 13/16 5 1/16
—— ditto (1903) 40,001-80,000	5	..	4 13/16-5 1/16
Chelsea Electricity Supply	5	..	6 6½
—— 4½ per cent. Debentures	100	..	108-110
City of London, Ordinary	10	..	10½-11½ xd
—— 6 per cent. Cumulative Pref.	10	..	13-14 xd
—— 5 per cent. Debenture Stock	100	..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	105 105
County of London Electric Supply, Ordinary	10	..	7⅛-8⅛
—— 6 per cent. Cum. Pref.	10	..	11⅝-12⅜
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6¼ xd
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	105½-107½ xd
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	101-104
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	7⅜-8½
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Deb. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅜-⅞
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	11½-12⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10⅛
London Electric, Ordinary	3	..	1⅛-2⅛
—— 6 per cent. Pref.	5	..	4½-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-102
Metropolitan Ordinary, 100,001-300,000	5	..	9⅛-10
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	99-101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0.9	5	..	7⅜-8⅛
—— do., 57,0 0-75,000	5	..	7⅜-9⅛
—— 5 per cent. Pref., 1-57,009	5	..	6 6⅛
—— do., 57,0 0-75,000	5	..	6-6⅛
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	..	6¼-7
—— 4 per cent. Debenture Stock	100	..	98-100 xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2½-3
—— 4 per cent. Debenture Stock	100	..	78-82
South London, Ordinary	5	..	3½-4
South Metropolitan Electric Light and Power, Ord.	1	..	⅜-⅞
—— 7 per cent. Cum. Pref.	1	..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	..	106-109
—— ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13¼-14¼
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97-99
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅝-4⅞
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5⅛-5⅜
Westminster, Ordinary	5	..	11½-12⅛
—— 5 per cent. Cum. Pref., 110,191-138,251	5	..	6⅛-6⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5⅞-6⅛
—— Ord.	5	..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	104-106
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-13⅞
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	99-102
—— 4½ per cent. Red. Deb. Stock	100	..	98-103
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3¼-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	92-96
British Columbia Electric Railway Co., Ord. Def.	100	..	105-108
—— Ord. Pref.	100	..	98-101
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	102-105 xd
—— 4 per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	..	98-101 xd
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	8⅜-9⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	121-123
—— 4½ per cent. 2nd Deb. Stock	100	..	97-99
Buenos Ayres and Belgrano Trams	5	..	3-3⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	6 7/16-5 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	105-107
—— Prov. Cert., all paid	100	..	101-104
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	96-98
Calcutta Tramways, 1-102,268	5	..	8⅝-9⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	106-108
Cape Electric Tramways, Nos. 1-480,000	1	..	1⅛-1⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4¾-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	102-104
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13½-14½
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13½-14⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5	..	2⅜-5½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8⅜
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	98-101
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	102-104
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	9/32-11/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	104-106
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104 108 xd
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	104-106
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	½-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	1⅜
—— 5 per cent. Cum. Pref.	10	..	9½-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8½-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,152 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	91-93
—— 4 per cent. Pref.	100	..	101-103
—— ,, ,, deferred	100	..	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	120-123
—— ,, ,, ,, '86	100	119-122
—— ,, ,, ,, '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3½-4½
—— 4 per cent Mortgage Debentures, Red., 1-1,700	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-100
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111-112
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	102½-101⅛
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas. s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 15	1,578	1,819	- 241	- 403A	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 22	866	864	+ 2	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 23	1,088	1,335	- 248	- 439	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 22	337	338	- 1	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 19	1,123	1,083	+ 39	+ 649	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	,, 20	1,901	1,950	- 49	+ 1,652	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 22	1,267	1,471	- 204	- 397	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 23	2,077	2,014	+ 63	+ 1,046	40	38	March 31	96,765	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 19	1,596	1,165	+ 430	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 22	4,659	4,880	- 210	- 2,516	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 23	1,339	1,168	+ 170	+ 958A	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 21	5,471	5,430	+ 41	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 24	1,127	1,103	+ 24	—	10 60	10·60	March 31	—	—	—	—	—	—	
Burton Corporation	,, 23	347	392	+ 45	- 454	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2 068	6·76
Cardiff Corporation	,, 15	2,188	2,223	- 35	+ 648	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 24	235	253	- 22	- 403	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 22	5,932	6,087	- 155	- 577A	6	6	,, 31	347,538	44,875,547	1,281,214	1·86	65 10	57,931	35·80
City and South London Railway	,, 23	2,228	2,316	- 88	- 139A	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 4	286	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 20	617	556	+ 61	+ 696	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 21	267	255	+ 12	+ 197	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	,, 31	11,250	2,853,200	284,743	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 21	167	153	+ 14	— A	6½	6½	Dec. 3	6,353	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 21	4,314	4,427	- 113	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 21	1,311	1,324	- 13											
Dundee City Tramways	,, 19	897	899	- 2	—	22	21	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 22	920	811	+ 109	+ 1,123	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 22	12,572	11,593	+ 573	+ 6,764A	144½	143	May 31	756,480	196,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	June 7	302	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	July 12	1,797	1,812	- 45	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 24	1,494	1,379	+ 115	—	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 22	2,233	2,170	+ 62	—	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 19	134	154	- 20	—	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 19	303	358	- 49	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 22	6,232	5,971	+ 261	—	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 15	11,329	11,795	- 466	+ 9,219	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 23	1,684	1,894	- 210	— A	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 15	16,408	14,709	+1,699	+43,398	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 20	153	219	- 65	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 22	13,443	13,152	+ 2·6	+10,581	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,299	6·99
Nelson Corporation	,, 22	147	137	+ 10	+ 241	—	2½	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 22	3,872	3,665	- 207	—	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 23	1 737	1,280	+ 457	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 22	2,436	2,493	- 59	- 356	—	29	,, 31	95,702	19,625,323	197,499	1·17	11·63	—	—
Reading Corporation	June 29	670	647	+ 23	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	396,547	1·24	9·24	1,102	7·32
Rotherham Corporation	July 20	466	505	- 39	—	9½	7½	,, 31	23,563	5,251,472	593,054	1·07	9·53	2,612	7·49
Salford Corporation	,, 17	6,155	4,384	+1,771	+ 5,193	70½	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	,, 22	343	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 23	4,991	4,860	+ 131	+ 4,113	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 19	1,072	1,074	- 2	- 224	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	,, 5	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 14	1,044	743	+ 301	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 16	1,567	1,554	+ 13	+ 387	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 19	196	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 22	950	1,041	- 91	+ 446	11·86	10 5	,, 31	38,768	7,412 881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	,, 13	342	332	+ 10	+ 175	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 20	1,791	1,127	+ 604	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 19	902	806	+ 96	—	—	7½	,, 31	—	—	—	—	—	—	—

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. A Half-year's figures.

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NOTES.

Tramways and Light Railways Association.—The *Official Circular* for July contains some useful information concerning light railway orders and a copy of Mr. Bigwood's Vehicles Lights Bill regulating the carrying of rear lights by all vehicles, which Bill was only lost by one vote, and will be reintroduced at a favourable opportunity.

Miniature Electric Lighting Undertaking.—Bridgetown, situate a few miles from Dulverton, Somerset, claims to be the smallest village in England supplied with the electric light. A local wheelwright laid down a plant to supply his own premises. His neighbours expressed a desire for similar illumination, so the wheelwright added to his plant, and is now supplying electricity to others in the village. The population is less than 100.

The Institution.—The issue dated July of the *Journal* of the Institution of Electrical Engineers contains "Stand-by Charges and Motor Load Development," by Mr. A. M. Taylor, with discussion; "Telephone Traffic," by Mr. H. L. Webb, with discussion; "Wireless Telegraphy Measurements," by Messrs. W. Duddell and J. E. Taylor, with discussion; "Low-Tension Thermal Cut-Outs," by Messrs. A. Schwartz and W. H. N. James (Manchester); "Notes on Heating and Sparking Limits in Variable-Speed Motors," by A. H. Bate (Birmingham); and "Commutation in a Four-Pole Motor," by J. K. Catterson-Smith.

"Liberty" a Barrier to "Wireless."—Bartholdi's statue of Liberty, which is constructed of bronze, and surmounts the harbour at New York, is accused of being the obstacle to the reception of wireless messages. Considerable difficulty having been experienced in communicating with the American city, experts were deputed to investigate the cause, and they concluded that the statue acted as a mammoth receiver. If this be correct, it raises a curious position, for the statue at once symbolises the freedom of the Great Republic and imposes a barrier upon science and commerce. It will be remembered that the Eiffel Tower has been similarly regarded with suspicion.

The Metric System.—The secretary of the Decimal Association has received a letter from the general council of chambers of commerce of the Commonwealth of Australia stating that at a meeting of that body held in Sydney in June last the following resolution was passed: "That this general council of the chambers of commerce of the Commonwealth of Australia views with satisfaction the increasing public interest in the metric system of weights and measures, and expresses the hope that it may very shortly be adopted for England and the Empire generally, and recommends that such legislation may now be framed in the Commonwealth as will enable us to at once follow the home country in this change."

Electric Light v. Gas.—The latest contribution to this long-standing debate comes from Loughborough, where electricity has scored a decided success. Hitherto the Market-place has been illuminated by gas lamps of 640 c.p., which apparently have served to accentuate the darkness. Three arc lamps, aggregating 5,700 c.p., have now been substituted at a less cost for lighting than that of the supplanted gas lamps. The arc lamps are of the Union Excello type, giving about 1,900 c.p. each. Midway between the arcs and the ground two 25-c.p. tantalum incandescent lamps are installed on each post, the idea being to burn the arcs till about 11.15 p.m. and then the incandescents only until about daylight, when they will be automatically switched off from the generating station. A similar arrangement has also been installed in Derby-square. A great improvement in the lighting of the districts has resulted, and this is emphasised by comparison with the dismal-looking gas lamps.

Parcels Traffic.—The case of the Manchester Corporation's parcels traffic was mentioned in the Chancery Division on Saturday in connection with interlocutory proceedings in the action instituted by the Attorney-General, at the instance of Messrs. Sutton and Co., to restrain the Corporation from collecting and delivering parcels. The Corporation have statutory powers to carry goods on their cars, and they have adopted the practice of collecting the parcels and delivering them to the consignee's premises, charging a commission for this service. Messrs. Sutton and Co. contend that this extension of the Corporation's carrying powers is *ultra vires*, and the result of the proceedings will doubtless be watched with much interest now that tramway undertakers are paying more attention to goods traffic as a source of revenue.

State Cables and Cheap Telegraphy.—Sir Sandford Fleming, of Ottawa, gave an address at the United Empire Club, London, last week, in which he advocated the formation of an Imperial intelligence department. Sir Sandford said there was a widespread desire to secure a comprehensive means of cheap telegraphy between all the great self-governing British States throughout the world in the interests of trade, shipping, social, and commercial intercourse, and especially in the interests of Imperial affinity and union. No argument had been advanced against the public policy of completing without loss of time the trunk line of telegraph cables, of which the Pacific Cable constituted the first great division, forming as it did a large portion of the whole system of State-owned cables at present projected. He proposed that the cable should be used for a portion of each day to transmit news at a comparatively low rate—10,000 to 12,000 words each week—to be published simultaneously in the chief centres of the Empire. He was assuming the co-operation of the Press in this work. This proposal would be found to harmonise with the suggestions formulated by Sir Frederick Pollock and his friends in the appeal they had made in favour of an Imperial Council combined with an Intelligence Department.

New South Wales Mines.—The annual report of the Department of Mines, New South Wales, for 1904 has just reached us. The information contained, while of great interest to mining engineers, only affects our readers as far as the application of electricity to mining is concerned. We find from the report that coal-cutting machinery has been introduced to a considerable extent into the collieries of New South Wales during the past year. The returns show that seven collieries are now using such machines, and that there is a keen rivalry between electricity and compressed air as the driving medium. Out of the six mines now using mechanical coal-cutters, four have adopted electrical driving and two are using compressed-air machines. The actual number of coal-cutters is 25, and of these 15 are driven by compressed air. The Sullivan electric heading machine and the long-wall machine of the same name seem to find most favour. We should like to see English firms obtaining more orders for this class of plant. Reference is made to the report of the Departmental Committee on the use of electricity in mines issued in England at the beginning of the year, and it is advised that the precautions mentioned in this report should be adopted in the collieries. We notice that the department have instituted an examination for electric motor drivers, on the result of which they issue certificates of competency. The report contains the questions set during the last examination, which show that a good working knowledge of electric machines and of their usual faults is required.

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Submarine Cables and Longitude.—The *Observatory* notes the result of a determination of longitude made by officers of the United States Coast Survey through the cable of the Commercial Pacific Company, which joins San Francisco to Manila in the Philippines. Since the laying of this cable completed the telegraphic circuit of the earth it became possible to measure by the ordinary method of telegraphic longitude the arc across the Pacific, and hence to complete the entire circle of the globe. Of necessity this must be equivalent to 360deg., or 24 hours of time, and the interest lies in noting how nearly the sum of the links which go to make up the whole approximates to this total, and thus obtaining some indication of the degree of accuracy which attaches to such operations. There are several routes across the Eastern hemisphere by which the ends of the Pacific cable might be joined, and taking one direct route, *vid* Madras, it appears that the "closing error" is less than a fifth of a second—that is to say, the sum of the various links exceeds 24 hours by only 0·174 second. Another interesting fact comes out. This Pacific cable consists of four sections divided by transmitting stations at Honolulu, Midway Island, and Guam, the total length of cable being 7,846 nautical miles. The time that a signal takes to traverse this length—excluding that occupied by reading and passing on the messages at the intermediate stations—is 0·648, not quite three-quarters of a second.

Test of a Curtis Turbine.—A test was recently carried out upon a 2,000-kw., 900-r p.m. Curtis turbine, built by the General Electric Company of America, the gentlemen entrusted with the proceedings being Mr. F. Sargent (Messrs. Sargent and Lundy, engineers, Chicago) and Mr. Lewis A. Ferguson (vice-president of the American Commonwealth Electric Company). All the instruments used were carefully tested and standardised during the trials, the electrical instruments being tested by representatives of the New York Testing Laboratory. The surface condenser showed practically no leakage. The following is a graphic summary of the results: Full load—Duration of test, 1·25 hours; steam pressure (gauge), 166·3lb.; back pressure (absolute), 1·49in. of mercury; superheat, 207deg. F.; load in kilowatts, 2,023·7; steam consumption per kilowatt-hour, 15·02lb. Half load—Duration of test, 0·916 hour; steam pressure (gauge), 170·2lb.; back pressure (absolute), 1·40in. of mercury; superheat, 120deg. F.; load in kilowatts, 1,066·7; steam consumption per kilowatt-hour, 16·31lb. Quarter load—Duration of test, 1 hour; steam pressure (gauge), 155·5lb.; back pressure (absolute), 1·45in. of mercury; superheat, 204deg. F.; load in kilowatts, 555; steam consumption per kilowatt-hour, 18·09lb. No load—Duration of test, 1·33 hours; steam pressure, 154·5lb.; back pressure (absolute), 1·85in. of mercury; superheat, 156deg. F.; steam consumption per hour, 1,510·5lb. It will be observed that a high degree of superheat was employed. The results taken all round are distinctly satisfactory, and go to confirm the claims made by the manufacturers as to the economy of the Curtis turbines.

Street Lighting in the City.—Our readers are acquainted with the general position of matters between the City of London Electric Lighting Company and the Corporation, and elsewhere in this issue some figures on the subject will be found. The company, who have carried out the illumination of main thoroughfares in the City for several years, were asked by the Corporation in March whether they would be willing to enter into a contract for lighting certain streets with improved lamps. The company asked for particulars of the improvements desired, to which the Corporation replied that a specification would be forwarded. This was not done, and on June 19 the company received an intimation that the Streets Committee had decided to substitute gas for the existing arc lamps, and requesting the company to have the latter removed. The unfairness of this proceeding, both to the company as a commercial concern and to electricity as an illuminant, is obvious. The company has incurred a substantial outlay for street lighting, and the change over to gas implies an annual loss of revenue amounting to over £1,200. As a test of the relative values of gas and electricity as illuminants, it is obviously fallacious to compare what may have been the best electrical apparatus at the time of its installation, nearly 15 years ago, with perfectly up-to-date gas plant. The company point out, moreover, that they did not have a free hand in the selection of either the standards, the lanterns, or the glass of the present electric arc lamps, all of which were settled by the late Colonel Haywood, the then engineer to the Commissioners of Sewers. Considering that the mains and other electrical plant are available, it would have been a comparatively small matter to substitute improved lamps, and as the company are showing a distinctly conciliatory attitude, it is to be hoped that the Corporation will reciprocate this sentiment by responding to the company's proposition for a conference.

The Embankment Scheme.—The ebullitions of public feeling at the actions of our legislators are not invariably a criterion of the sentiment of the community, as they are apt to prove but ephemeral outbursts on the part of a small, if noisy, section; but in the case of the London County Council's Bill to sanction the Embankment scheme the course adopted by the House of Lords in rejecting the measure appears to have aroused a widespread chorus of disapprobation both on the part of the public and the Press. In regard to the latter, this attitude is not confined to those journals which are accustomed to inveigh against every act of the Upper Chamber, but extends to the most Conservative organs. A meeting was held last week at the Surrey Masonic Hall, Camberwell, under the auspices of the local Conservative associations to protest against the course adopted by the Lords. A resolution condemning the action of the peers was altogether inadequate to meet the views of an irate section of the meeting, at whose instance a proposition that the Upper Chamber be abolished was submitted and carried. This step need not, perhaps, be taken very seriously, but it serves to illustrate how embittered the populace have become at the hasty action of the Lords. Had the measure been carefully gone through *seriatim*, and shown to be impracticable and inexpedient, the feeling of indignation might have been allayed; but to throw the Bill out after a brief discussion, when it had been extensively investigated and approved by a committee of the Commons, was rather in the nature of an affront to public opinion. Surely, when that conservative authority the City Corporation had felt constrained to yield its assent, if reluctantly, the scheme merited more detailed consideration than it received at the hands of their lordships. Accustomed to these rebuffs from Parliament in the matter of tramways along the Embankment, the County Council are still undaunted, and will probably bring up another Bill next year, when it will be interesting to observe how far the Lords will persist in their present course.

Hull Tramway Returns.—The balance-sheet which has just been issued for the electric tramway undertaking at Kingston-upon-Hull furnishes some valuable figures as to the cost of generation from the tramway station. In our issue for July 7 we reproduced a paper upon charges

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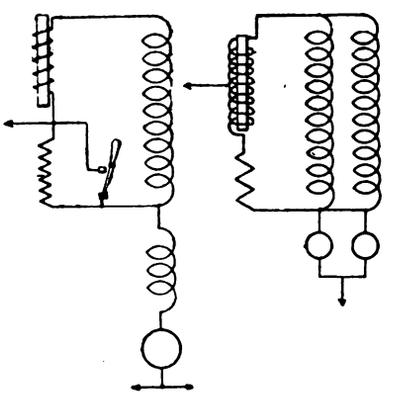
for supply from combined lighting and traction stations by Mr. J. H. Rider, which showed the figures various tramway undertakings throughout the country have to pay for their current. The argument was in favour of such combined stations, but it is interesting to get figures like those from Hull to show the costs for tramway supply from separate stations. During last year at Hull 3,696,700 units were delivered from the station to the line, and the maximum load on the station was 1,150 kw., which shows a load factor of nearly 37 per cent. The actual figures of costs were as follows: coal, 0·26d.; oil, waste, and water, ·03d.; salaries and wages, ·09d.; repairs and maintenance, 0·08d. This gives a total works cost of 0·46d. as compared with 0·64d. for the year ending March 31, 1904, and 0·94d. for the previous year. In order, therefore, to compare the cost of electricity as supplied to tramways at Hull with the figures in Mr. Rider's paper it is necessary to add the charges for interest and depreciation on the capital expenditure on the station, and also a certain proportion of the management expenses. The accounts are not presented in a form which enables this to be conveniently done, but we see that the capital outlay on the generating station for land, buildings, and plant was slightly over £51,000. The interest and sinking fund charges in Hull average 5·05 per cent., which on the above sum works out at 0·17d. per unit. It will be seen, therefore, that with interest and sinking fund the cost per unit delivered amounts only to 0·639d., and ample provision can be made for management expenses at the generating station and for depreciation on the generating plant without bringing this figure up to that paid in other towns of a similar size. Elsewhere in the accounts we find evidence that the car mileage in Hull is being extended with a corresponding increase in the passengers carried. The total cost per car mile now stands at 7·04d., the income being 9·29d. The increase in the service has slightly reduced this last figure, but the working expenses have come down to a greater extent. The undertaking has paid £11,500 to the city funds for the relief of rates, which is against the policy advocated by strict municipal traders. The tramway engineer at Hull is to be congratulated upon the results obtained from the past year's working.

Air Friction on Trains.—Any information as to the friction which has to be overcome in propelling trains at high velocities is of interest to electrical engineers who have this problem now before them. The high-speed trials carried on near Berlin gave useful figures from actual measurements made at high velocities in the open air. Some experiments made by Dr. A. F. Zahm at the Catholic University of America, at Washington, are described in the *Scientific American*. The chief object of the experiments was to measure the tangential force of air flowing swiftly over even surfaces. The type of surface was varied in order to find what the effect of surface friction was. The experiments were carried on in a laboratory, and, therefore, it was more convenient to move the air at high velocities than to move the object experimented upon. The procedure adopted was to suspend the surface to be experimented on by means of two steel wires in a tunnel through which air was forced at a known velocity. Suitable precautions were taken to ensure that the velocity of the air should be the same at all parts of the tunnel. The length of the surface was then varied in order to divide end friction from the tangential force on the sides of the suspended planes. The results obtained have led to the following conclusions: (1) the total resistance of all bodies of fixed shape and aspect is expressed by an equation of the form $R = a\,v^n$, R being the resistance, v the wind speed, a, n, numerical constants; (2) for smooth planes of constant length and variable speed, the tangential may be written $R = a\,v^{1\cdot85}$; (3) for smooth planes of variable speed, l, and constant width and speed, the friction is $R = l^{0\cdot93}$; (4) all even surfaces have approximately the same coefficient of skin friction; (5) uneven surfaces have a greater coefficient of skin friction, and the resistance increases approximately as the square of the velocity. It will be found that these conclusions agree in general form with those obtained by Froude for water. It can be deduced from the experiments that the friction on a long railway train may equal or exceed the true head resistance, while on a short train or single car the friction is comparatively inconsiderable. Now, though the head resistance may be very greatly reduced by sharpening the front and rear, the skin friction cannot be reduced appreciably by any treatment Hence it is apparent that the total air resistance of a long train or hull cannot be reduced very largely by any treatment, whereas the resistance of a single coach, like a street car or automobile, may be reduced several per cent. by use of suitable prow and stern.

Alternating-Current Motor Used on Direct-Current Circuits.—Two patents have recently been granted in the States to Mr. B G. Lamme respecting alterations in the type of the energy supplied to series-wound motors. When a motor of this description is operated by alternating current, it is desirable that the ampere-turns in the field winding should be relatively low but when it is operated by direct current the magneto motive force of the field current should be much higher in value. In order to provide means for automatically changing the value of the ampere-turns in the field-magnet winding of the motor, Mr. Lamme places in combination with the field coils suitable arrangements of resistances and reactances so as to allow a greater value for the ampere-turns in the field-magnet winding when the motor is operated by direct currents than when it is operated by alternating currents. The methods employed are indicated in the accompanying illustration, which we reproduce from



the *Electrical World* of New York. In one of these methods the field winding is divided into two parts, in parallel with one of which is placed a series circuit containing resistance and reactance. The current is introduced in the series circuit at such a point that when the current is unidirectional the major portion of it flows through both field windings, while when it is alternating only a small part of it flows through the shunted section of the field coil, as shown in the illustration. According to another method, the inventor places in parallel with the whole of the field winding a series circuit containing a resistance and an inductive winding. The current is introduced at a point along the inductive winding so chosen that the proper proportion of alternating current is forced to pass through the resistance and directly to the armature, while the greater relative value of the resistance allows only a small part of any unidirectional current to flow therethrough and forces the greater portion to pass

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through the field coil. The diagram indicates this arrangement when two motors are operated simultaneously, the field windings being connected in parallel with each other, and the armatures being also connected in parallel with each other.

The Electric Arc in a Vacuum.—In the June issue of the *Physical Review* (New York) Mr. C. D. Child describes some of his investigations at Cornell University on the electric arc in a vacuum and in hydrogen, using different substances as electrodes. The tests were of a somewhat extensive character, and it would occupy too much space to recapitulate them, but the author's conclusions are interesting. With graphite terminals it was found that with pressures less than ·7mm. the drop in potential at the anode became less than that at the anode, and that whenever a glow appeared at the anode the drop there increased from six volts to fifteen. Mr. Child states that there are reasons for believing that this glow is similar to that seen with "Canalstrahlen." At pressures of less than ·7mm. many of the ions appear to move along magnetic lines of force when in a magnetic field. With carbon terminals and with a pressure of ·1mm. the drop at the cathode was somewhat larger than that at the anode. With copper and iron it was found impossible to maintain an arc with pressures of less than about 1mm., unless there was an oxide of the metal on the cathode. Experiments were performed, using graphite for one of the terminals and various metals for the other. When the cathode was graphite the phenomena of the arc were practically independent of the nature of the anode. It was, however, impossible to maintain an arc on a 100-volt circuit with a pressure of less than 1mm. when the anode was graphite and the cathode any of the metals having a high melting point, such as platinum, iron, nickel, copper, or silver. It was very easy to do so when the metal was one having a low melting point, such as antimony, lead, or bismuth. With graphite terminals in hydrogen the drop at the anode was less than that at the cathode for pressures above 400mm., the total drop being much greater than with the arc in air. Between 400mm. and ·7mm. that at the anode was the greater. At pressures less than 10mm. the arc would start on a 500-volt circuit without bringing the terminals in contact, if they were comparatively warm. Under these conditions there were three distinct forms of the arc. With carbon in hydrogen the drop at the anode was much greater than at the cathode. With low pressures four forms of the arc were here observed. No current could be produced by an alternating E.M.F. of 220 volts between iron, copper, or graphite terminals at any pressures. From the experiments it would appear that no theory of the arc is complete which fails to consider the chemical action occurring in the arc. It would also appear that the temperature of the cathode does not alone account for the production of ions there, and their production depends very largely on the melting point of the metal used. The experiments also indicate that with pressures less than about ·8mm. the positive ions driven off from the anode ionise by impact the gas about the anode, while with less pressure this does not occur.

Trains and Tramway Competition.—At more than one railway company meeting during the last few days the wail has been heard that the electric trams are seriously diminishing the traffic on railway suburban lines. Presiding over the Great Eastern meeting, Lord Claud Hamilton stated: "The suburban passenger traffic, other than season-ticket holders, which they were accustomed to see increase by leaps and bounds, had gradually diminished, until in the past half-year they were faced with a falling-off of 1,674,000, representing £19,500, out of the total decrease in passengers of 2,050,014. The cause of this decline was partly bad trade, but it was attributable more to the competition of electric tramways and of the Great Northern and City 'Tube' Railway, and to the creation of additional railway facilities in other parts of London." His lordship proceeded to deprecate the introduction of the new tube to Waltham Abbey, urging, somewhat illogically, that it could have no prospect of success. No allusion was made to electrification. The South-Eastern Company are apparently reconciled to the loss of suburban traffic, and they, too, do not contemplate, at any rate for the present, a resort to the electrification of these lines. At the half-yearly meeting Mr. H. Cosmo-Bonsor announced that: "The number of third-class passengers had decreased by the large figure of 1,499,000, and in money of £13,000. They might attribute that entirely to what was called short-distance journeys, principally in the metropolitan area. The competition to which he had formerly alluded, electric tramways, had drawn a large number of short-distance passengers away from their line through the more convenient form of electric trams, and the principal districts in which they had suffered were Brixton, Peckham, and the neighbouring stations. They could not expect to compete satisfactorily with those electric trams. They, however, had a certain amount of consolation in the fact that the traffic was not particularly profitable, and they had also the consolation that when they came to appeal against the assessments in these particular districts they would be able to plead the competition that had been set up against them for a reduction in the amount of rates they have to pay." Reduced fares do not appear to have furnished a panacea in this instance, as, though the number of passengers shows an increase, the receipts are less. The London, Brighton, and South-Coast Railway also have to deplore a considerable falling-off in their suburban traffic, and the approaching electrification of their metropolitan line will afford an interesting example of the effect of this expedient. The East London Railway, who have also experienced the effects of tramway competition, maintain their policy of sitting on the fence, though the chairman intimated that the line would undoubtedly be electrified ultimately after there had been an opportunity of seeing how the third-rail system worked on the Metropolitan and District lines. The two latter companies, it may be noted, have informed the East London Company that they will cease running over the lines of the last-named company, their successors being the Brighton and South-Eastern Companies. At the meeting of the London, Tilbury, and Southend Railway it was stated that the electrical equipment of the section between the junction with the Whitechapel and Bow Railway at Campbell-road, Bow, and East Ham is finished, and that the District Company's electric trains will shortly be extended to East Ham. There is still a not unnatural disposition on the part of the railway companies to await events in the matter of electrifying their suburban lines, but indications are not lacking that a few years will witness a transition.

British Association.—The remaining contingent, which includes the official section, of the British Association are well on their way to Cape Town on the Union Castle Royal Mail steamer "Saxon" for the annual conference of the association, which, as our readers know, will this year comprise meetings at the chief centres of South Africa. The party includes Prof. G. H. Darwin (president-elect), Sir William Crookes, Sir Benjamin Baker, Sir William Wharton, Sir Richard Jebb, Mr. Alexander Siemens, Profs. J. Perry, W. E. Ayrton, Vernon Boys, D. H. Campbell, H. S. Carhart, and A. R. Forsyth, Major P. A. Mac

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Mahon, and others, several of the members being accompanied by their ladies. The subjects discussed will cover practically the entire field of scientific research. Prof. Darwin will deliver two presidential addresses, one at Cape Town and the other at Johannesburg. He proposes to review the general principles of evolution, with special reference to inanimate matter. Lord Selborne, the High Commissioner for South Africa, has consented to become one of the vice-presidents of the meeting, and other distinguished South Africans who will co-operate include Sir Charles Metcalfe, Sir David Gill, and the mayors of the chief towns. Another token of the interest taken in the proceedings by the South African Governments assumes the tangible form of a grant of £6,000 towards the official expenses, while the various railways are making substantial reductions to the party in general. Altogether the visit is expected to occupy over 70 days, a good half of which will be spent in travelling, but the admirable method of organisation promises to reduce fatigue to a minimum. All sorts of excursions, scientific and recreative, have been planned. In Section A the subjects will include a paper upon "The Leak of Electricity from Certain Heated Substances," by Prof Beattie, and the same author, in conjunction with Mr. Lyle, will present some "Observations of Atmospheric Electricity in South Africa." Other subjects to be dealt with by the professor are "The Magnetic Survey of South Africa" and "Electrical Conductivity in Relation to Chemical Action." Prof. Perry will contribute a paper upon "The Teaching of Elementary Mechanics," and another upon "The Strength of Winding Ropes in Mines," which will doubtless be appreciated by the large mining industries of those regions. A "Form of Dry Daniell Cell" will receive treatment at the hands of Mr. J. Brown. Section B (chemistry) will be presided over by Mr. G. T. Beilby, whose choice of subject has fallen upon "Gold," and Dr. H. Marshall will discuss "The Experimental Basis of the Dissociation Hypothesis." Colonel Sir Colin Scott-Moncrieff will preside over Section G (engineering), and the chief subject of his address will be irrigation, a theme of much interest to those concerned in South Africa. Sir Colin favours the Italian system of irrigation, which will come in for a high measure of eulogy. Sir Charles Metcalfe's views will doubtless be listened to with great attention, the subjects being the Rhodesian railways and the bridge over the Zambesi at the Victoria Falls, which are to be visited by the party. A paper by Mr. Byles will deal with "Ocean Turbine Boats," and at Johannesburg there is to be a joint meeting of this branch and Section C (geology) for the discussion of important papers on mining, while Prof Ayrton will deliver a lecture upon "Distribution of Power." Section L (educational science) will be under the able presidency of Sir Richard Jebb, who, in his address upon "University Education and National Life," will deal with the growing importance of university education as a factor in national development. The other sections, with which we are not directly concerned, also intend to discuss a great number of momentous questions, and the general indications suggest that the conference will be most successful.

The Liverpool Accident.—In view of the letter written by the signalman Boote acknowledging that the accident was due to an error on his part, it is sufficiently clear that the lamentable tragedy on Friday last on the Liverpool-to-Southport section of the Lancashire and Yorkshire Railway was attributable to the fallibility of the "human equation." The precise manner in which the disaster occurred, as detailed at the inquest, shows that engineering matters had no connection with the fatality, and it was quite immaterial that electricity was the form of traction; a brief attack of mental aberration on the part of the signalman was the cause of the ill-fated passengers being hurried to their doom. When the train to Southport approached Hall-road Station it passed the outer distant signal, which was controlled by a lever numbered 40. It then came to and passed the inner distant signal, which was controlled by a lever numbered 39. After that it came to the outer home signal, which was controlled by a lever numbered 38, and after that to the inner home signal, which was lever 37. All these numbers were consecutive. Then the train came to the cabin and on to the station, and proceeding on the down line to Southport, it went to where the cross-over points back the train, if so desired, from the down line to the middle siding. These points were controlled by a lever in the box which was numbered 23. The signalman went to No. 23 lever and brought it over. When it was in that position he could turn any train that was travelling on the down line into this middle siding. That was the position of affairs. This train, coming from Liverpool, passed the outer and inner distant signals, and it was entitled to pass them whether they were against it or not. If they were not against it, it would come on at ordinary speed. If they were against it, it would come on cautiously. This signalman went to No. 38 lever, but it would not come over unless lever 23 was the other way. Instead of ascertaining that that was the cause, he thought something had gone wrong with the locking gear, and although the outer home signal was against the driver the signalman went to the window and with a green flag brought on the driver, who was bound to obey the order of the signalman, with the fatal result that he was turned into the middle siding, where there was a stationary train. A good deal of criticism has been directed to the influence of the type of coach on the extent of the fatalities. The coaches were of the corridor pattern, and the upper part of one of the coaches of the stationary train was completely separated from the bogie, and precipitated some feet into the air, descending upon the unfortunate passengers in the wreckage of their own car. It has been suggested that in the case of the older pattern of carriage, with its division of compartments and more substantial structure, danger of this kind would have been greatly reduced. Another view of the matter, however, is that in the latter case the peril simply takes a different form, as with the older type of car "telescoping" was almost inevitable. Moreover, it may be noted that in this instance the destruction was restricted to the first car of the express, the passengers in the rear vehicles experiencing nothing beyond a shaking. As remarked above, this deplorable occurrence is shown to be practically a question of the personal element, and this is a factor that can only be specifically regulated up to a certain point; but it seems from this case as if there is room for still greater stringency in rules for the guidance of signalmen in cases of doubt. A question was asked in the House of Commons on Tuesday as to whether, having regard to the damage sustained by the first car, the Board of Trade would consider the advisability of introducing a regulation that cars of this type should be fitted with "some sort of buffer, empty carriage, or other mechanical contrivance in the fore part." Mr. Bonar Law replied that the suggestion would no doubt be dealt with by the inspector in his report after the inquiry, and would be considered by the Board. Such an expedient would mean the consumption of additional power for carrying the dead weight, and a buffer vehicle would need to be placed at the back as well as at the front of every train to afford protection. We are afraid that the waste of power and the engineering difficulties attending a lengthening of the trains will prevent the adoption of any such suggestion unless it can be proved to give absolute safety.

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A STUDY OF CIRCUITS CONTAINING RESISTANCE, INDUCTANCE, AND CAPACITY BY MEANS OF THE CIRCLE-DIAGRAM.

BY J. S DOW AND F CREEDY.

The method of the circle-diagram has within the last few years been found applicable to a very large part of the field of alternating-current theory. The following article is an attempt to apply this method to the study of circuits containing resistance, self-induction, and capacity. The constructions made use of do not appear to be given in text-books on the subject, and yet they allow of a treatment much more simple than the analytical one.

The symbols made use of will be as follows:

P.D., applied to circuit, in volts, E;
Capacity, in farads, K;
Self-induction, in henrys, L;
Resistance, in ohms, R;
Current, in impedance, capacity, and main circuit respectively, in amperes, I_1 I_2 I_0;
Frequency of supply, f. $p = 2\pi f$;
Inductive reactance, $x_1 = Lp$;

Capacity ,, $-x_2 = \frac{1}{Kp}$;

Total ,, $x = Lp - \frac{1}{Kp}$.

It may be advisable to begin by defining "reactance," an idea of which we shall make considerable use, but which is not universally employed. Just as the resistance of a circuit is the coefficient by which the current must be multiplied in order to get the P.D. consumed by it, and in phase with itself, so the "reactance" is the coefficient by which the current must be multiplied in order to get the P.D. consumed in quadrature with it. We will term the reactance positive when the P.D. consumed is leading, and the E.M.F. produced, therefore, lagging on the current.

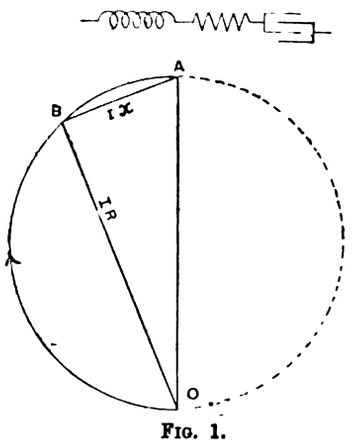

FIG. 1.

The E.M.F. produced by a current I in a self-induction L is ILp, lagging 90deg. on I. Hence a self-induction L produces a reactance $x_1 = Lp$ which is positive. Similarly, the E.M.F. produced in a capacity K is $\frac{I}{Kp}$, leading 90deg. on I. We, therefore, say that a capacity K produces a negative reactance,

$$-x_2 = \frac{-1}{Kp},$$

Thus the total reactance of a circuit containing both capacity and self-induction in series will be

$$x = x_1 - x_2 = Lp - \frac{1}{Kp},$$

which may be either positive or negative.

The circle-diagram is obtained immediately by considering the effect on the current in a circuit containing reactance and resistance in series of varying either of these quantities.

In Fig. 1, O A represents the P.D. applied, E. Then O B will represent in phase and magnitude the P.D. consumed in resistance, I R, and B A the P.D. consumed in reactance, I x, in quadrature with O B. Now, since O A is constant and O B perpendicular to B A, B will travel on the circle O A B however we vary the reactance and resistance, and B A will lead or lag on O B according as our reactance is positive or negative. We are now in a position to follow the change of the current in a circuit containing any combination of reactance and resistance produced by alteration of either of these two variables.

I. *Circuit Containing Resistance and Reactance in Series*—(*a*) *Constant Resistance.*—If we divide through by R, which is constant, the dimensions of Fig. 1 will be reduced R-fold, but the angles will remain the same. We thus arrive at

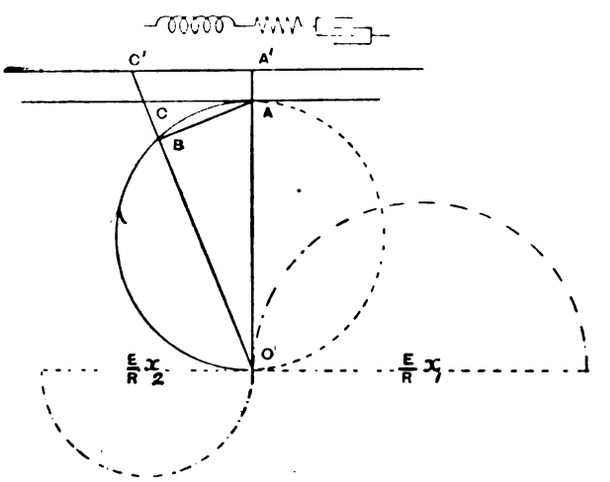

FIG. 2.

Fig. 2. O B is now the P.D. consumed in resistance divided by the resistance, and, therefore, represents the current I_1 in magnitude. Also the angle A O B will represent the angle of lag, for the tangent of this angle is still $\frac{Lp}{R}$. The *locus* of I_1 will, therefore, be the semicircle O A B, and its maximum value, corresponding to no reactance in the circuit, will be $\frac{E}{R}$, in phase with the P.D, which is represented by O A. (In the above we have assumed, for the sake of simplicity, that we are dealing with positive reactance only. If our reactance is negative, I_1 may also travel on the semicircle shown dotted.)

We can now deduce a simple construction, by means of which the current corresponding to any value of x may be found. Draw A C tangential to the circle O A B at A, and produce O B to meet it at C. Now, since the triangles A O C, A O B are similar,

$$\frac{AC}{AO} = \frac{AB}{OB} = \frac{x}{R}, \text{ and hence } AC = \frac{Ex}{R^2}.$$

A C is thus proportional to x, and the intercept A' C', on any line parallel to A C, will clearly be proportional to x also. We thus obtain the following construction: Set off the reactance along any line A' C' to a convenient scale. Set off the resistance from A' along a line A' O perpendicular to A' C', to the same scale. To *any* convenient scale set off O A, along O A', to represent $\frac{E}{R}$. Describe a circle on O A as diameter. Draw a line, O C', cutting the circle in B. O B will now represent the current corresponding to A' C', to the same scale as that to which $\frac{E}{R}$ is represented by O A. If, as assumed above, our reactance is entirely of a positive character, our construction enables us to find the current for any value of L if the frequency is constant, or for any value of p if L is constant.

Turning to the more general problem in which reactance may be either positive or negative, it is of interest to observe the variation in the P.D. across the self-induction and capacity respectively. If we have a constant inductive reactance and a variable capacity reactance, the P.D.

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across the self-induction (equal and opposite to the E M F. of self-induction) will be proportional to the current, and lead it by 90deg. Thus it will move on a semicircle of diameter $\frac{E}{R} x_1$, as shown in Fig. 2. Similarly, if we vary the inductance, the P.D. across the capacity will travel on the semicircle of diameter $\frac{E}{R} x_2$.

(*b*) *Constant Reactance.*—Reasoning as before, we see that if we now take A in Fig. 1 as our origin and divide through by x, which is constant, A B will represent the current in magnitude, but now not in phase, for the angle of lag is the complement of the angle O A B. We must, therefore, rotate the vector O A through 90deg., thus arriving at Fig. 3, in which A T represents the P.D., E. Therefore the angle B A T (which is equal to 90deg. – A O B) may now represent the angle of lag, and thus A B will represent the current in phase and magnitude. The *locus* of I_1 is,

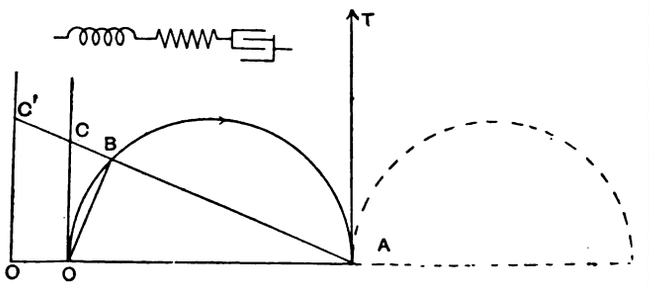

FIG. 3.

therefore, the semicircle A O B, and its maximum value $\frac{E}{x}$, corresponding to zero resistance, is represented by A O. Clearly an exactly analogous construction to that introduced in I.(*a*) may be applied here. If O′ C′ represent any resistance, R, A B, obtained in the same manner as before, represents the corresponding value of I_1 to the same scale as that to which O A represents $\frac{E}{x}$. A combination of these two constructions enables us to find the current for any resistance and reactance if both are varied.

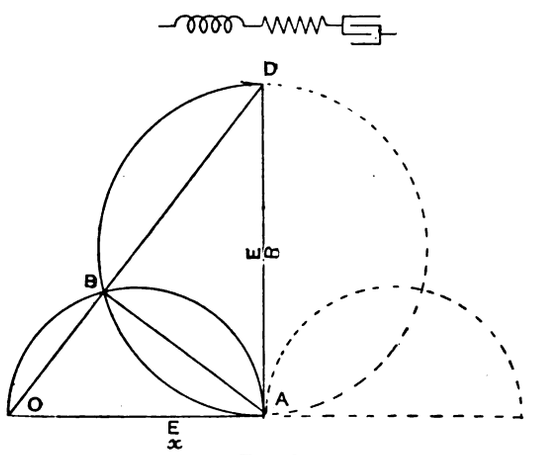

FIG. 4.

(*c*) *Resistance and Reactance both Variable.*—In Fig. 4 the current A B travels on the semicircle A B D, the diameter of which is $\frac{E}{R}$, for variable reactance, and on the semicircle A O B, the diameter of which is $\frac{E}{x}$, for variable resistance. Therefore, if both R and x have certain values given to them, the corresponding value of the current must be A B, which is drawn from the origin to the intersection of the two circles. This construction can be still further simplified.* O B and D B are both perpendicular to A B, and O D is, therefore, a straight line. The construction is, therefore, as follows: Set up A D = $\frac{E}{R}$. Draw A O = $\frac{E}{x}$ perpendicular to A D. Join O D. Through A draw A B perpendicular to O D. Then A B represents the current, corresponding to a reactance x and a resistance r both in phase and magnitude.

We now come to the consideration of circuits containing impedance and capacity in parallel. We shall find that the variation of self-induction, resistance, capacity, and frequency respectively give rise to four distinct cases

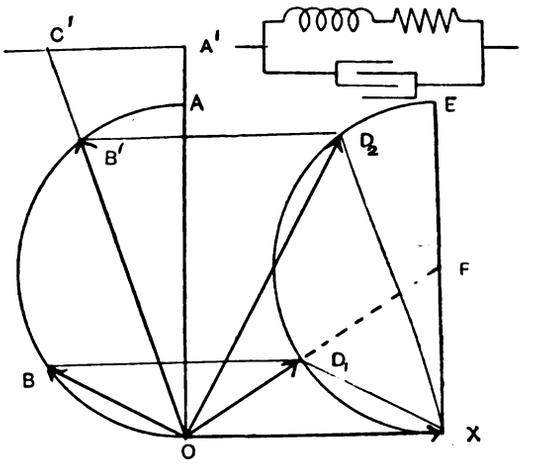

FIG. 5.

II. *Capacity and Impedance in Parallel.*—(*a*) *Variable Self-Induction.*—In Fig. 5, O A represents $\frac{E}{R}$ as before, and the *locus* of the choker current, I_1, is the semicircle A O B. O X perpendicular to O A represents the condenser current I_2 in phase and magnitude. Combining each value of I_1 with I_2, we get the *locus* of I_0, the current in the mains, which is

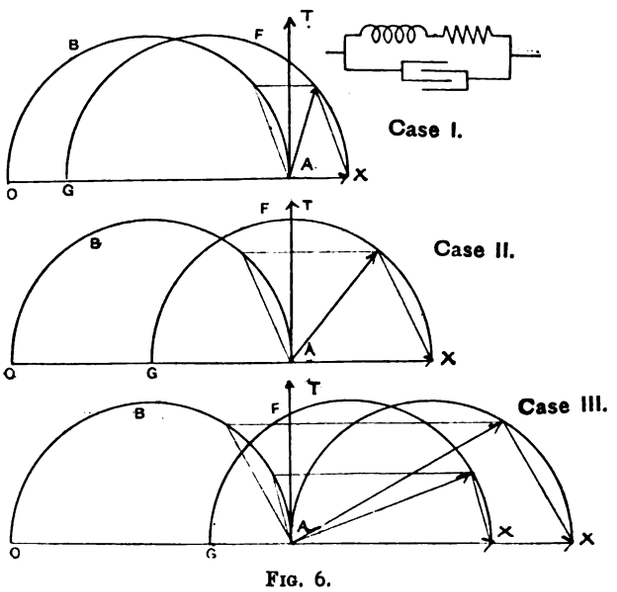

FIG. 6.

represented by O D_1, O D_2, etc. As O X is constant throughout, the *locus* of the points D_1 D_2 . . . is clearly the semicircle X E D, the diameter of which is $\frac{E}{R}$, and the centre, F, of which is removed a distance O X to the right of G, the centre of the circle O A B. From this figure it is evident: (1) That the main current will either lag, lead, or be in phase with the P.D. according as $I_2 = E K p$ is less than, greater than, or equal to $\frac{E}{2R}$. Therefore, if $2 K p R$ is greater than 1, the main current must always lead whatever value we give L. (2) That I_0 is a minimum when O D produced passes through F, and this is the case when the tangent of the angle of lead = $2 K p R$. The value of

* This simplification was pointed out to one of the authors by Mr. L. I. Solomon, a student at the Central Technical College.

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L corresponding to this is easily deduced direct from the figure, and is given by the well-known relation

$$L = \frac{1 + \sqrt{1 + 4KR^2p^2}}{2Kp^2}.$$

It is interesting to note that the minimum value of the main current must always lead on the P.D. It might have been supposed that the main current which supplies the losses in the choker would be least when in phase with P.D, but it must be remembered that an increase of L, while it puts the main current more out of phase, also decreases the choker current, and hence the choker losses. An application of the construction previously described would enable the value of I_0 for any value of L to be found.

(*b*) *Variable Resistance*.—Our diagram is now a modification of Fig. 3, arrived at in a similar manner to Fig. 5. In Fig. 6, as before, the semicircle A O B is the *locus* of I_1, and A T represents the P.D., E, applied to the circuit. Then, if A X represents the constant capacity current, I_2, I_0 will travel on the semicircle A F G, the diameter of which is $\frac{E}{L\,p}$, and the centre of which is moved a distance A X to the right. Three distinct cases now occur, and these are tabulated below:

		Value of I_0.	
		R = 0.	R = ∞.
Case I.—			
$EKp < \frac{E}{2Lp}$	I_0 may lag, or lead, or be in phase with E	Max.	Min.
Case II.—			
$EKp = \frac{E}{2Lp}$	Ditto, ditto	$I_0 = EKp$	$I_0 = EKp$
Case III.—			
$EKp > \frac{E}{2Lp} < \frac{E}{Lp}$	Ditto, ditto		
$EKp = \frac{E}{Lp}$	I_0 always leads, except when R = 0, and is then zero and in phase with E	Min.	Max.
$EKp > \frac{E}{Lp}$	I_0 always leads		

The chief point of interest brought out in this table are that the maximum and minimum values of I_0 occur when the resistance is either 0 or infinity. It is also to be noted that in case II. we have a constant main current for all values of R. Here, again, the application of the construction given in I (*b*) enables us to find the main current for any value of R.

(*c*) *Variable Capacity*.—This case appears to be the most usually considered of the four, probably because it is the simplest. Following our usual nomenclature, it is clear that if I_1 is presented by O B in Fig. 7, and O X_1, O X_2

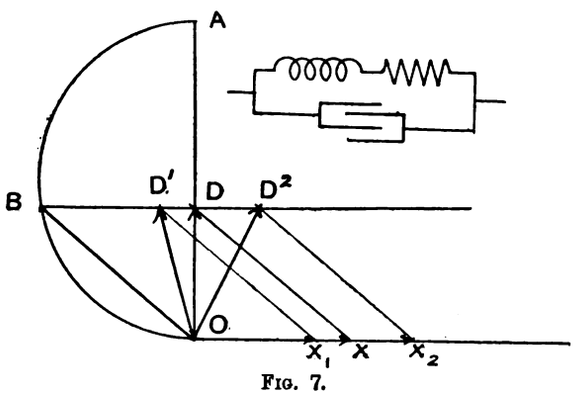

Fig. 7.

. . . represent the variable values of I_2, O D, representing I_0, must travel along the straight line B D_1. I_0 is, therefore, a minimum when O D is perpendicular to B D, and the condition for this is

$$\frac{E \cdot L\,p}{R^2 + L^2p^2} = EKp.$$

Hence the required value of K making I_0 a minimum is given by

$$K = \frac{L}{R^2 + L^2p^2}.$$

I_0 will then be in phase with the P.D. and equal to the "useful" current in the choker. Clearly, also, if K exceeds this value I_0 will lead, if K is less than this value I_0 will lag.

We now come to the last case—that of variable frequency. The problem is now complicated by the fact that a change of frequency affects capacity and inductive reactance in different ways.

(*d*) *Variable Frequency*.—As before, O A represents $\frac{E}{R}$, and A' C_1', A' C_2', . . . may now be taken to represent the frequency to any convenient scale. The *locus* of I_0 can now be found by the following construction: By joining C_1', C_2', . . . to O we get O B_1, O B_2, . . ., the corresponding values of I_1. Let O X_1 represent the value of I_2 corresponding to A' C_1'. Join C_1 x_1, cutting O A at P. Then the lines C_1' x_1, C_2' X_2, . . . drawn through

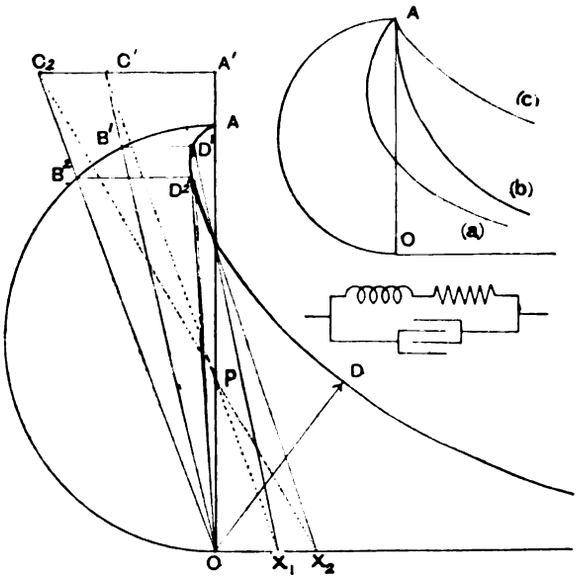

Fig. 8.

P_1 will cut O X in points X_1, X_2, . . . giving O X_1, O X_2, . . . , the corresponding values of I_2. Combining the corresponding values of I_1 and I_2 in the usual way we get the curve A D_1 D_n, which is the *locus* of I_0. The curve passes through the point A, and is asymptotic to the axis O X. The minimum value of I_0 will be O D normal to the curve, and this value of I_0 will lead on the P.D. The value of p for which I_0 is a minimum can be shown to be

$$\frac{1}{L}\sqrt{\frac{(L^2 + 2KLR^2)^{\frac{1}{2}}}{K}} - R.$$

This curve may, or may not, cut the axis O A. Clearly the same condition as in II.(*c*) will determine this. Hence I_0 will lag if $E\frac{Lp}{R^2 + L^2p^2}$ is less than I_2—*i.e*, if p is less than $\frac{1}{L}\sqrt{\frac{L}{K} - R^2}$. Now, if R is less than $\sqrt{\frac{L}{K}}$, this condition can be fulfilled, and we then get curve (*a*) in Fig. 8. I_0 will now lag for certain values of the frequency. If $R = \sqrt{\frac{L}{K}}$, we arrive at curve (*b*), which is tangential to O A at A. I_0 must now always lead except when the frequency is zero. Finally, if R is greater than $\sqrt{\frac{L}{K}}$, we arrive at curve C_1 and in this case also I_0 must always lead, for the only value of the frequency which brings I_0 into phase with the P.D. is zero.

We have now considered the alteration of the different variables for elementary combinations of reactance and resistance. In these constructions the usual assumption that we are dealing with sine waves has been adopted. The results would also require modification if iron losses in the choker, and dielectric hysteresis or leakage losses in the condenser, were taken into account.

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THE JOHNSON-LUNDELL REGENERATIVE CONTROL FOR TRAMCARS.

On Thursday last week the latest Johnson-Lundell-Lang regenerative double series-paralleling, automatic braking control system for electric tramcars was shown to a party of engineers at the Southall works of the Johnson-Lundell Company. The apparatus shown is a further development of the compound regenerative control system tested on the Newcastle tramway system in 1902. It is similar to that in so far as the general construction of the motors is concerned, but the method of control has been improved.

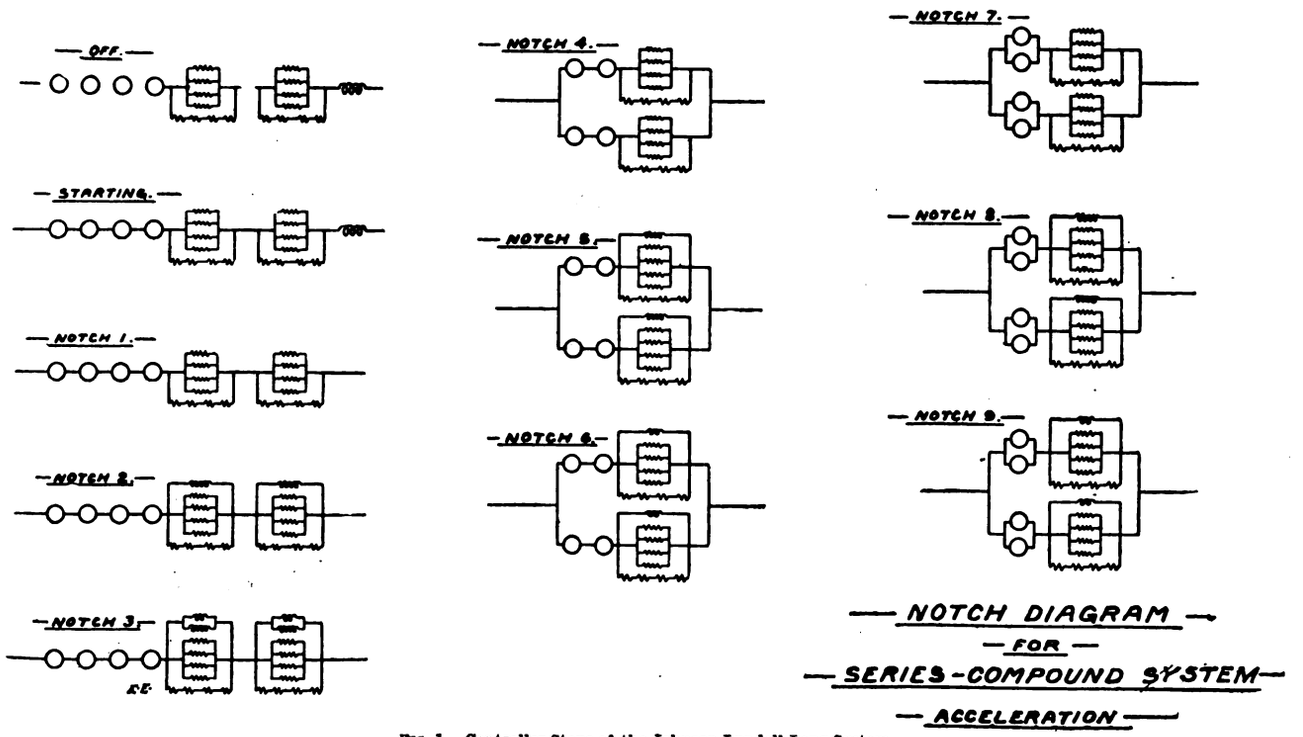

FIG. 1.—Controller Steps of the Johnson-Lundell-Lang System.

Coming now to the regenerative braking arrangements, it should be remembered that Mr. Lundell's original system was designed for compound-wound motors. In July, 1902, there was made in Newcastle elaborate tests of this all-compound regenerative system. These tests were made under the critical direction of Mr. H. F. Parshall, who, in

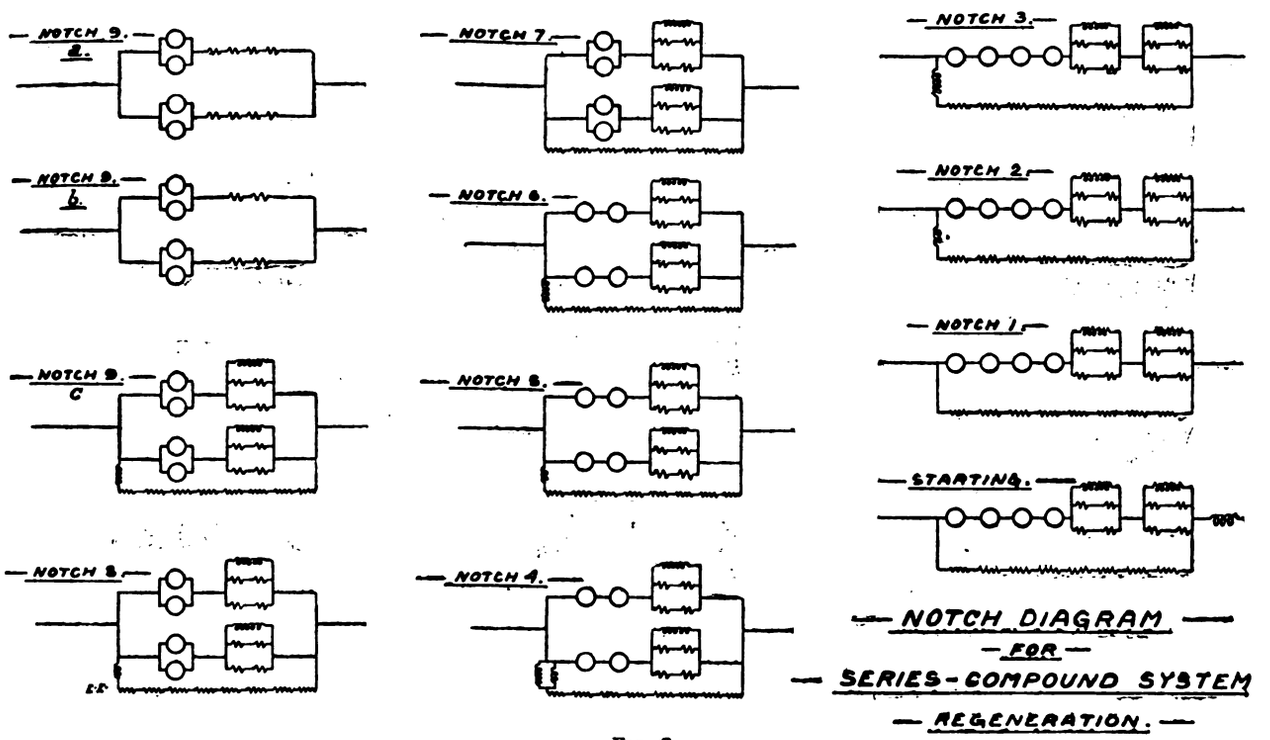

FIG. 2.

Thus there are still two motors employed per car, and each motor has a double-wound armature with two commutators. This enables the four armature circuits to be connected in series when starting, and all in parallel when running at high speeds. The advantage of this is that it increases the number of economical notches in the control and prevent loss of energy in resistance. As will be seen from the diagram of connections for the different notches of the controller, resistance is only used in series with the motors in the first position. This feature has been described before in our columns, and we shall not go into the details again except to mention that a saving of 15 per cent. is claimed from the abolition of main circuit resistances.

a subsequent explanatory note upon his report, observed that whereas the system was entitled to claim an input of some 15 per cent. less than that demanded by the single series-parallel system, and to a recovery through regeneration of about 25 per cent. of the input, the net saving over the standard system was, nevertheless, not more than 25 per

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cent. Mr. Parshall gave as a reason for this apparent inconsistency the fact that the shunt losses during the time of accelerating and running were about equivalent to the 15 per cent. saved by double series-paralleling the circuits. In the new apparatus this shunt loss has been avoided by a device designed by Mr. G. Lang, the engineer of the Johnson-Lundell Company. This is done by connecting the motors as series machine for acceleration and running, and by switching over certain coils to act as a shunt circuit when regenerating. Other series coils are still retained, so that the machines act as compound-wound

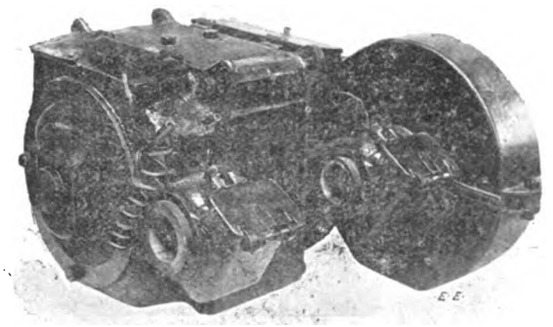

FIG. 3.—Tramway Motor with Laminated Field.

dynamos with the series coils opposing the shunt when they return current to the line. This is effected by suitably grouping the several windings in the required series or parallel relations through the medium of a third automatic controller, worked by pressing a button on the main controller handle. This third controller, or "field changer," is operated automatically by means of a solenoid so arranged as to oscillate its contact cylinder against the retractile force of a clock spring. The spring holds the cylinder in what may be termed its normal position, in which position it gives to the equipment its series or motor characteristic. When it is oscillated therefrom by the action of the solenoid, the

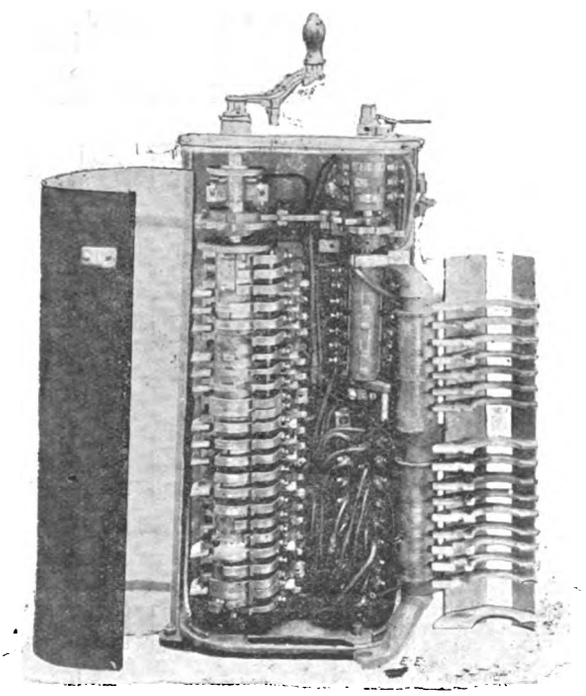

FIG. 5.—Controller.

equipment is given its compound or regenerative characteristic. The solenoid operating the field changer is controlled through contacts in the platform controllers, the circuit being closed by the driver's thumb pressing upon a button fixed in the top of the controller handle.

Fig. 1 shows the connections of the motors for the different positions of the main controller handle when accelerating. In studying these it must be noted that the zigzag lines represent field coils, the grouping of which can be altered, and the spirals represent resistances. Thus, while resistance is only put in the main circuit when starting, it is used to shunt the series field windings to regulate the speed on notches 2, 3, 5, 6, 8, and 9. If this controller handle is simply moved back after full speed is obtained, no regenerative action is set up by the series motor.

When, however, the button on the controller handle is pressed, the motors become compound machines, and the connections are as shown in Fig. 2. The motors are then caused to develop a braking effort from step to step as the handle is moved backwards, in the same graduated way as they developed the propelling effort in accelerating when the handle was moved forward. The compounding is so proportioned as to effect a gradual braking effort. The

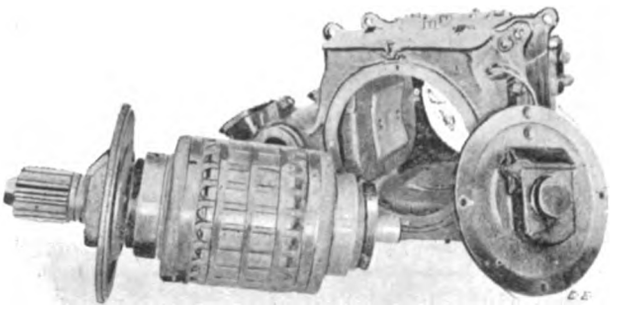

FIG. 4.—Motor with Armature Removed.

series ampere-turns acting in opposition to the shunt ampere-turns tend to decrease the braking capacity as the armature current rises, thus effectually preventing an excessive braking effort. The desired braking effort for each controller position is effected by varying the shunt ampere-turns; extra contact fingers on the platform controllers effect this variation of the ratio of series to shunt ampere-turns. These extra fingers are brought into play by means of the automatic controller; those effecting the changes of field strength for accelerating purposes being at the same time and by the same means put out of action. In this way not only has the efficiency of the system been materially increased through the elimination of the shunt losses indicated by Mr. Parshall, but there is also the advantage of having series-wound motors for acceleration. The confining of this compound working to the regeneration only enables the relative proportions of the shunt and series turns to be properly adjusted to give smooth braking which could not be done when the motoring was done with the same com-

FIG. 6.—The Johnson Brake Band.

pound machine. For the same reason it has now become practicable to operate the car with but one motor in case of need. A characteristic of Mr. Lang's method of field control of great value is that the field is always maintained by more or less series excitation, consequently the shunt coils are never subjected to the disruptive stress of an inductive discharge, and may be manipulated with as complete immunity from sparking as are ordinary series windings. This was apparent from the trials we witnessed, where no sparking whatever was to be seen on the automatic field-changing controller.

The motor used (Figs. 3 and 4) are of the usual four-pole

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type, and are suspended in the usual manner. They are, however, as has been indicated, fitted with armatures having divided windings and two commutators. The field magnets are of the laminated type instead of the usual castings. The series and shunt windings are so arranged as to require but little more winding space than is usually allowed for series windings alone. The platform controllers (Fig 5) are of the standard series-parallel type, and differ therefrom only in that they are fitted with the additional contacts required for double series-paralleling, and have fitted into their handles a button lever switch for operating the contacts which control the "field changer." The automatic controller, or field changer, is located underneath the car in an accessible position between the motors.

The braking function of the regenerative motors we saw ceases when the car speed falls to about two miles per hour. It then becomes necessary to bring into action a mechanical or other brake to stop the car and to hold it

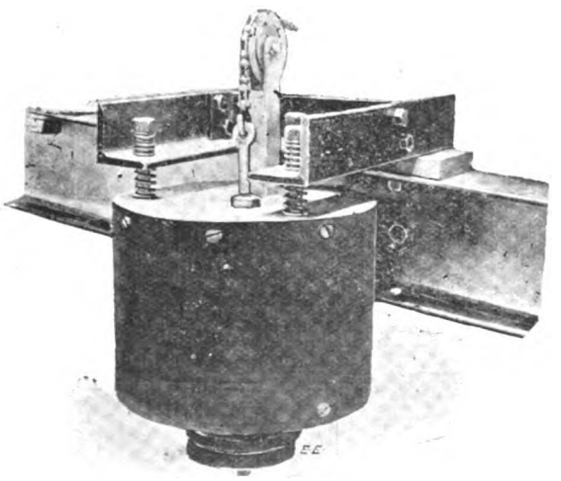

FIG. 8.—Solenoid for taking off Brakes.

when on a grade. This was done by a supplemental braking system, which has been invented and developed by Mr. Edward H. Johnson, and which, though purely mechanical, is, nevertheless, controlled electrically. The power to operate it is obtained from the car axle, as in the case of regeneration. Accurately speaking, this invention is not a brake, but rather a method of utilising the kinetic energy of the car to apply whatever brakes may be employed. It is equally applicable to wheel shoes or track slippers. The adaptation we illustrate is to the ordinary wheel-shoe system of a standard four-wheel tramcar, the entire braking mechanism of which is retained, and may, in addition to the special control to which it is subjected, be operated by hand in the usual way. To the end of the regular braking lever there is attached two stout steel-wire cables; these are led to one of the axles, and there attached to the respective ends of a specially designed resilient spiral friction band (Fig. 6), which band is given about five turns around a drum on the car axle. Normally this band is by its own resilience maintained in open form, and, therefore, free of the drum, and inoperative; but should a pull be exerted upon

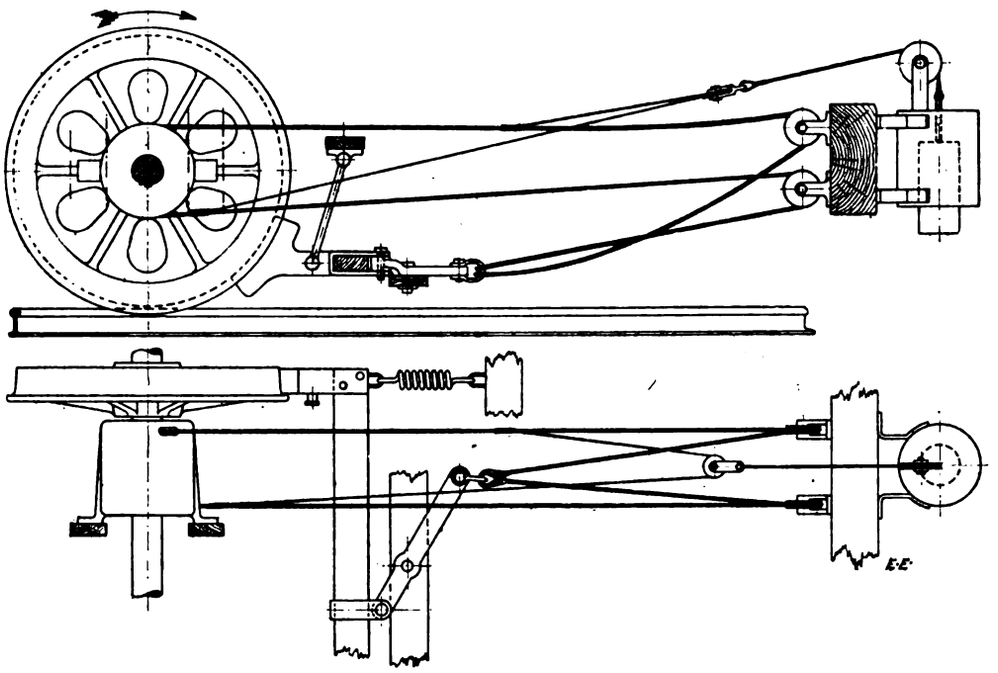

FIG. 7.—The Johnson Patent Braking System as applied to Ordinary Brakes on Car Wheels.

its two ends and its resilience overcome, it will wind up on the axle and exert a pull upon one or the other of the brake lever cables according to the direction of the axle rotation. The value of this pull will be the friction value of the five turns of the band derived from the pull or drag that is being exerted by the weight, or other force, employed to overcome the resilience of the spiral and initiate its winding action. Whatever excess this force may have over and above that required to overcome the spiral resilience becomes a drag on the "free" end of the spiral, and determines the value of the pull on the brake lever (Fig. 7). The form of force now employed for exerting this initial pull and subsequent drag is a weight; attached to this weight is a pulley, and around this pulley a small steel cable, the ends of which are attached to the respective ends of the spiral band. The weight becomes in turn the plunger of a solenoid which serves to hold it in suspense, thus relieving the strain on the spiral band and supplying the potential energising factor.

The solenoid (Fig. 8) is controlled by contacts in the platform controllers so located as to cause the weight to be lifted in advance of the starting moment of the motors, and maintained in suspense until the controller is again returned to the "off" position or should the current to the car be interrupted. In such event the solenoid, of course, loses its energising force and its plunger falls, thereby applying the brakes. In the event of the failure of the prime current supply from any cause, as, for instance, a stoppage of the power, a broken supply conductor, the loss of trolley contact, or any disablement of the equipment itself, the brakes promptly come on and the car is stopped. This is a valuable feature of the automatic braking system.

The results of the tests made on the circular track at Southall were satisfactory, everything working smoothly. It was admitted that a considerable amount of complicated apparatus was needed over and above the ordinary equipment. Commercial experience can alone decide whether the cost of maintaining this apparatus will be excessive. The working of the car is simple, and it is claimed that the failure of certain details will not prevent the motors being run as series motors. The regeneration is optional as far as the driver is concerned, but he obtains a braking

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action readily, as the controller is moved back, by the pressure of a button in the handle he is already gripping. It would seem, therefore, that it will be easier for him to work the car on economical lines, and the car driver may be relied on to work his car in a way most convenient to himself. We understand that a commercial trial for the system is being arranged.

A TRACTION MOTOR FOR CONTINUOUS AND ALTERNATING CURRENT.

In a recent issue the *Elektrotechnische Zeitschrift* described a car supplied by the Allgemeine Elektricitäts-Gesellschaft for the Niederschöneweide Ostend (Cöpenick) tramways. This car is equipped with motors of the Winter-Eichberg type, which can be driven either by continuous or alternating current. For compact systems of town tramways continuous-current working has been found best adapted, but where outlying branches or connecting links are concerned the advantages offered by alternating current become apparent, enabling, as it does, economies to be effected in the initial outlay and a reduction of the transformer losses. By working such branches or connecting links with alternating current it is possible to convey high-tension current to the feeding points, and there

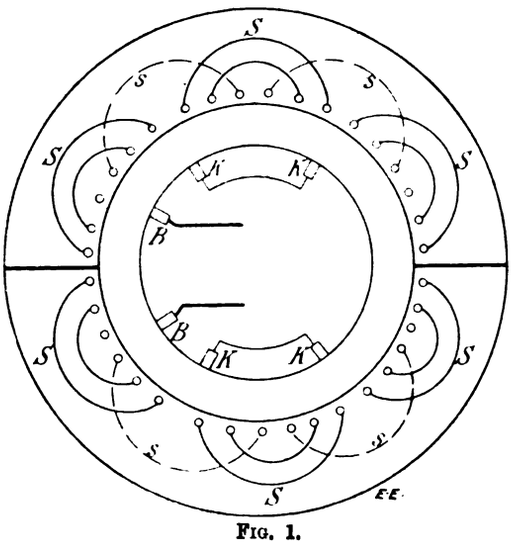

FIG. 1.

transform it down by means of static transformers to the pressure required for the motors. These transformers need no attendance, and have a considerably higher efficiency than converter stations. Or it is possible to convey the high-tension alternating current to transformers attached to the cars themselves.

On the tramways system in question continuous current was originally the only supply available, so that a transformer sub-station had to be provided. The line is usually worked with continuous current throughout its length. But to enable the experimental car to be driven also with alternating current, a small transformer station equipped with a motor-generator has been erected in a central position. The motor is supplied with current from the westerly portion of the overhead trolley wire, and drives an alternator which furnishes single-phase alternating current through transformers to the easterly half of the trolley line. The two halves of this line are divided by a short section of dead conductor. By regulating the speed of the motor-generator the frequency of the alternating current can be varied between 25 and 40 periods at from 400 to 640 volts pressure. The pressure of the continuous-current supply ranges from 500 to 550 volts. This experimental installation covers all the conditions which would obtain in the case of an interurban and urban tramways system, the small transformer station representing the town boundary, at which point the change from continuous-current to alternating-current working would take place in the ordinary way. In passing this point the driver has only to shift a lever on the controller from one position to another. Should he fail to effect the change at the right moment no damage would, however, result, the car in that case simply losing most of its driving force, and thus drawing attention to the omission. The car is equipped with two motors wound for a continuous-current pressure of 250 to 275 volts, so that with a line pressure of 550 volts they must be run in series. Hence for continuous-current working only series connection with resistance regulation at the controller is provided. The motors differ, however,

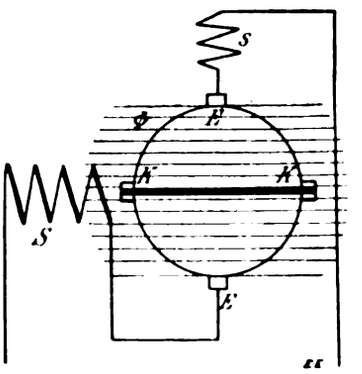

FIG. 2.

from ordinary continuous-current machines in that they have laminated fields to enable them to be worked with alternating current. They are six-pole machines of the Winter-Eichberg type.* The collector has six brushes, of which two are exciting and four short-circuiting brushes. The diagram of the winding is shown in Fig. 1, K being the short-circuiting and B the exciter brushes respectively. The coils S in the stator are the ordinary coils of the Winter-Eichberg motor, while the coils *s* constitute an auxiliary winding for the purpose of continuous-current working. Since the armature is provided with series drum winding, the compensating coils, *s*, do not require to be distributed uniformly over the whole circumference. This enables the casing to be arranged in the ordinary way for traction motors. Naturally it would be possible to dispense with the coils *s* by disconnecting the short-circuiting brushes when running with continuous current. But as this would introduce a further complication into the controller, Herr Eichberg preferred to compensate the action of the short-circuit current in the armature by means of the coils *s*. For the rest it may be observed that the turns in these coils correspond in number to those in the armature winding, but they carry a smaller volume of current, since less

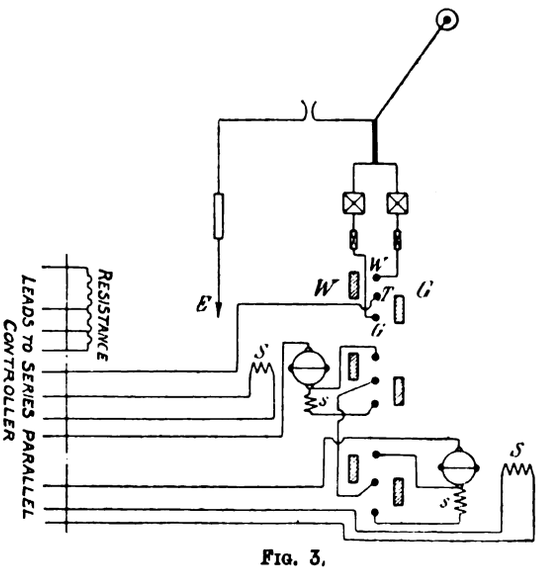

FIG. 3.

is taken when driving with continuous current than with alternating current. The effect of the coils *s* may be explained with the aid of the diagram (Fig. 2) which represents a two-pole arrangement. The only field which really passes through the armature is the active magnetic field, ϕ, represented in the diagram by horizontal lines. Were the coil *s* not provided, the armature would

* See full description, *Electrical Engineer*, vol. xxxiii., p. 357, etc.

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generate a vertical field which would induce a current between K K. As in Fig. 1, K K are the short-circuiting brushes and the exciter brushes are marked E E. S is the main winding in the stator and s the compensating coil required for continuous-current working. When running with alternating current the compensating coils are cut out at the controller. With continuous current, on the other hand, the brushes, E E, are connected in series with the compensating winding, it being in this way ensured that the compensating field is always exactly proportional to the armature current. Commutating poles are not used, despite which fact commutation both with continuous and alternating current is as sparkless when starting and running as with an ordinary continuous-current traction motor. The speed of the car is from 15 km. to 20 km. per hour when the continuous-current supply is used and from 25 km. to 35 km. per hour according to the periodicity, when the motors are receiving alternating current. This is in accordance with practical requirements, since a higher rate of speed is permissible out of town. Fig. 3 is a diagram of the connections in the car. Each circuit is provided with an automatic cut-out. It is, however, intended in future cars of the type to employ only one such device to serve both for the continuous and alternating current circuits respectively. The controllers resemble those of standard series-parallel type. Combined with each is a two-way switch, W G, which serves to change over from one system to the other as required. The windings s are also cut in or out through this switch. The armatures remain in series at all positions of the controller, while the stators may be connected in series or parallel through the main lever. A mechanical attachment actuated through the lever of the switch, W G, ensures that the stators are in series when continuous current is being supplied to the motors.

LABOUR SAVING FORMULÆ.*

In the Design of Direct-Current Dynamos, especially with regard to High Speeds.

BY JULIUS FRITH, A.M.I.E.E.

The use of formulæ by the elementary student is indefensible; it is only when actually engaged in the commercial design of machinery that it is allowable to take short cuts as labour-saving devices. There is one other argument for the use of formulæ, and that is, that by representing the complicated conditions that arise in the design of electrical machinery in some simple comprehensive manner, a clearer idea is obtained of the mutual relation of the various quantities involved, a truer perspective is gained, and the wood sometimes ceases to be hidden by the trees. For the sake of clearness we shall take multipolar generators, with as many circuits as poles—*i.e.*, parallel, or "lap" wound—and as many commutator bars as armature convolutions.

Let D = diameter of armature in inches;
d = diameter of commutator in inches;
n = number of convolutions and commutator bars;
b = thickness of a brush in inches;
P = number of poles and armature circuits;
l = length of armature between end plates in inches;
C = current per circuit in amperes;
A = total current in amperes;
V = terminal volts;
R = revolutions per minute.

The chief constants of a generator are, after the volts, amperes and revolutions per minute.

The KW. per 100 r.p.m. $= \frac{V A}{10 R}$;

the armature ampere-turns per inch diameter

$$= \frac{C \times n}{D} = \frac{A \times n}{P \times D};$$

the armature ampere-turns per pole

$$= \frac{C \times n}{P} = \frac{A \times n}{P^2};$$

the average volts per commutator bar

$$= \frac{V \times P}{n};$$

the peripheral speed of the commutator

$$= \frac{\pi d R}{12} \text{ feet/min.};$$

the peripheral speed of the armature

$$= \frac{\pi D R}{12} \text{ feet/min.};$$

and the reactance voltage of coil under commutation.

All these, with the exception of the reactance voltage, can be expressed quite simply in terms of symbols in the above list, and require no proof.

The formula for the reactance voltage is obtained from the following considerations:

Number of convolutions under commutation at one brush

$$= \frac{\text{thickness of brush}}{\text{pitch of commutator bars}} = \frac{b \times n}{\pi \times d} = N.$$

In one gap there are conductors under commutation from two brushes; the magnetising force of which = 2 N C ampere-turns.

If K = the lines due to one ampere-turn for each inch of slot parallel to the shaft, then lines set up due to commutation

$$= 2 N C K l = F.$$

The direction of the current is changed once only ($= \frac{1}{2}$ cycle) whilst passing under one brush, hence the frequency of commutation

$$= \frac{1}{2} \times \frac{\text{peripheral speed of comm.}}{\text{thickness of brush}} = \frac{\pi d R}{2 \times 60 \times b} = \sim.$$

Volts induced in each turn $= 2\pi \sim F \times 10^{-8}$,
i.e., reactance volts of the coil under commutation
$= C . K . l . R . n \times 0{\cdot}105 \times 10^{-8}$.

Now the armature reaction in ampere-turns per inch diameter

$$= \frac{C \times n}{D}.$$

Putting this value into the above equation,

Volts reactance
$= A.T. \text{ per 1in.} \times R . l . D . K . \times 0{\cdot}105 \times 10^{-8}$.

Now, for a machine to stand, say, 25 per cent. overload with fixed lead, the armature ampere-turns per 1in. diameter should not exceed 1,000, and the reactance voltage should not exceed 5. K, for parallel slots, can be taken = 28. From these

$$R \times l \times D > 240{,}000.$$

N.B.—It is interesting to notice that this is really a limit to the area swept out by an active conductor per second, which

$$= R \times l \times D \times \frac{\pi}{60} \text{ sq. in.}$$

Now by simple arithmetic the diameter of the armature

$$= \frac{\text{volts} \times \text{amperes}}{\text{ampere-turns per 1in. diameter} \times \text{volts per comm. bar}}.$$

Now, the volts between adjacent commutator bars should not exceed, say 10, *i.e.*,

$$\frac{V \times P}{n} > 10;$$

taking this in conjunction with armature ampere-turns per inch diameter not exceeding 1,000

$$\frac{A \times n}{P \times D} > 1{,}000,$$

and putting in the two limiting values we have

$$D < \frac{KW.}{10}$$

That is, if the kilowatt output exceeds 10 times the diameter of the armature, either the armature reaction or the volts per bar, or both, will exceed the limits given above.

*Paper read before the Institution of Electrical Engineers

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Putting these two results together we get

$$R > \frac{2{\cdot}4 \times 10^6}{KW. \times l}$$

and taking l as <10in., to be commercial, then

$$R > \frac{240{,}000}{KW.}.$$

From this expression can be drawn up a table of speeds for various kilowatts, beyond which that output cannot be obtained without overstepping one or others of the following limits:

Armature reaction, 1,000 ampere-turns per 1in. diameter.
Average volts per commutator bar, 10.
Reactance voltage of coil under commutation, 5.
Length of armature between end plates, 10in.

The numerical constants chosen are obviously merely arbitrary. Each designer can put in those values which he finds best accord with his own experience, without thereby altering the general conclusions arrived at.

This table would give 240 r.p.m. as the maximum speed for 1,000 kw. With these limitations the diameter for this would be

$$\frac{KW.}{10} = 100\text{in.}$$

The peripheral speed of the armature = 6,300ft. per minute. The machine would be 10in. long, it would have 1,000 ampere-turns per inch and 10 volts per bar, and volts reactance of 5, and would probably stand 25 per cent. overload with fixed lead if the design was in all other respects as perfect as possible.

The weight of copper on the armature, at 1,500 amperes per square inch and 1,000 ampere-turns per inch diameter,

$$= \frac{\text{diameter of armature} \times \text{length of 1 turn}}{47} \text{ lbs.}$$

The resistance of the armature

$$= \frac{D \times T}{10\ A^2} \text{ ohms,}$$

and the R C^2 loss in the armature

$$= \frac{D \times T}{10} \text{ watts,}$$

where T = length of one turn on armature.

So far the number of poles has been in the background, the diameter for a given output and speed being quite independent of the number of poles.

The total magnetic flux of the machine, however, is dependent on the number of poles, and with our assumption of 10 volts per commutator bar, the number of convolutions on the armature

$$= \frac{V \times P}{10}.$$

So that the total flux $= \frac{3 \times 10^{10}}{P \times R}$.

To accommodate this in round magnets at 15,000 lines per square centimetre and a waste field coefficient of 15 per cent., the diameter of magnet core

$$= \frac{45 \times 10^4}{P \times R} \text{ inches.}$$

Suppose we take 550 volts. As we have already taken 10 volts per bar, the number of commutator bars is $55 \times$ poles.

Now in practice what limits the number of poles is (*a*) the least permissible width of a bar, and (*b*) the greatest permissible peripheral speed for a commutator.

Just to fix our ideas let us take 0·2in. as the least *convenient* width for a commutator bar and 3,000ft. per minute as the greatest convenient peripheral speed for a commutator. Diameter of commutator becomes $3{\cdot}5 \times$ poles, and number of poles

$$= \frac{3{,}300}{\text{r.p.m.}}.$$

Taking our 1,000-kw. machine at 240 r.p.m., we find that it could have 14 poles as a maximum, and diameter of commutator would equal 49in.; say 50in.

Also the number of turns on the armature now first appears

$$= 55 \times 14 = 770.$$

The diameter of round magnets would be 11·5in.

Having now settled the diameter of the commutator, the next thing to settle is the length. This is ruled by considerations of heating.

The loss on the commutator results from two causes: (*a*) the contact resistance between the brush and the commutator and (*b*) the friction of the brush on the commutator.

The contact resistance of carbon brushes is in the neighbourhood of 0·03 ohm per square inch, and the coefficient of friction about 0·15. Allowing 2lb. per square inch pressure between the brush and the commutator, the total loss on the commutator for both these causes

$$= A\left(0{\cdot}06 \times \Delta + \frac{d \times R \times 3{\cdot}5}{1{,}000 \times \Delta}\right) \text{watts,}$$

where Δ = density in carbon brush in amperes per square inch.

The product of the current and the first term in the bracket gives the C^2 R loss, and the product of the current and the second term gives the friction loss, both in watts.

Next the density in the carbon brushes should be considered. As this machine is to stand 25 per cent. overload, this should not be more than 35 amperes per square inch.

The expression above then becomes:

$$\text{Total loss} = A\left(2{\cdot}1 + \frac{d \cdot R}{10{,}000}\right) \text{watts.}$$

At our assumed figure of 3,000ft. per minute peripheral speed, this expression becomes:

$$\text{Total loss} = 3{\cdot}24 \times A \text{ watts.}$$

We have now to consider the occult relation between the heat developed and the temperature rise. This can only ultimately be a matter of experience, as it depends entirely on the ventilation. For peripheral speeds of 3,000ft per minute with the armature revolving at 6,000ft. per minute near by, the figure of 15deg. F. rise per watt per square inch of commutator surface may be taken.

Allowing a temperature rise of 70deg. F. gives 4·7 watts per square inch.

And the necessary commutator surface = 3·24 A ÷ 4·7 square inches.

As we know the diameter, the length follows

$$= \frac{0{\cdot}22\ A}{d} \text{ inches.}$$

For our 1,000-kw. 550-volt generator the current = 1,800 amperes, the commutator diameter being 50in., the length is 8in., taking seven 1in. × 1in. brushes per pole.

The magnet winding is the next consideration. For the obtaining of the magnetising force required for the full load total flux, I have no short cut to offer; it must be done on the lines laid down by Dr. John Hopkinson.

The ampere-turns on each magnet pole required to compensate for the demagnetising effect of the armature are, of course, the armature ampere-turns per pole × sine half the angle of the gap (measured in electrical degrees). For a pole arc 75 per cent. of the pole-pitch this works out to

$$= 0{\cdot}383 \times \frac{A \cdot n}{P^2}.$$

If the total magnetising force required per magnet limb is = A T and the length of the mean turn = L inches, then the area for the cross-section of the wire for the shunt winding is given by the following (allowing the winding to reach a temperature of 60deg. C.):

$$\text{Area in mm.}^2 = \frac{A\,T \times L \times P}{V \times 2{,}000}.$$

Allowing 800 amperes per square inch, with the full volts on the shunt windings at a temperature of 60 deg. C., the convolutions per limb

$$= \frac{1{,}600 \times V}{P \times L}.$$

This gives a total length on all limbs of $45 \times V$ yards.

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Total resistance at 15deg. C.

$$= \frac{1{,}400 \times V^2}{AT \times L \times P} \text{ ohms.}$$

Total weight of copper $= \frac{AT \times L \times P}{2{,}500}$ pounds.

Total magnet loss at 60deg. C.

$$= \frac{AT \times L \times P}{1{,}600} \text{ watts.}$$

The winding space required—*i.e.*, the winding length on the spool × depth of winding (allowing 15 per cent. on the diameter of the wire for insulation, *e.g.*, No. 16 B.W.G., covered to 10 mils, single cotton).

$$\text{Space required} = \frac{AT}{480} \text{ square inches.}$$

Allowing a depth of 3in., winding length of spool

$$= \frac{AT}{1{,}440} \text{ inches.}$$

which = 0·7in. per 1,000 ampere-turns.

The sub-title of this paper would suggest turbo-generators, but the design of these falls under quite a different head from the ordinary "high-speed" steam-driven generator. The results arrived at in the present paper may, however, form a useful starting point for turbo-generator design, for it has been shown that the speed for a given kilowatt output is given by :

$$R = \frac{240{,}000}{KW.} \times \frac{\text{A.T. per 1in. diam.}}{1{,}000} \times \frac{\text{volts per bar}}{10} \times \frac{\text{reactance volts}}{5} \times \frac{10\text{in.}}{\text{length of arma.}} \times \frac{20}{\text{lines per A.T. per 1in.}}$$

Suppose we wish to make a 1,000-kw. generator to run at 1,500 r.p.m.; we know that if we keep the value of the constants at the figure associated with them in the above expression, then the speed can only be 240 r.p.m. If we wish the speed to be higher than this, some or all of the above constants must be sacrificed.

By the use of compensating windings and commutating poles, the armature reaction may be increased to, say, 1,200 ampere-turns per inch diameter; both the volts per commutator bar and the reactance volts will have to be doubled (hence the consumption of copper brushes so often referred to); the length of the armature parallel to the shaft will have to be increased to at least 15in.; the self-induction of the winding on the armature can be reduced to about half, or 10 lines per ampere-turn per inch of conductor, by the use of a smooth-core armature instead of a slotted core.

Summing up now what we have gained, we find the new speed for 1,000 kw.

$$R = \frac{240{,}000}{1{,}000} \times \frac{1{,}200}{1{,}000} \times \frac{20}{10} \times \frac{10}{5} \times \frac{10}{15} \times \frac{20}{10} = 1{,}536 \text{ r.p.m.}$$

so we have 36 r.p.m. in hand.

The diameter of the armature equals

$$\frac{KW. \times 1{,}000}{\text{A.T. per 1in.} \times \text{volts per bar}} = 38\tfrac{1}{2}\text{in.,}$$

making the peripheral speed 15,000ft. per minute.

I think I need not give further examples of how I mean these formulæ to be used; the purely labour-saving ones will commend themselves to those who require their use, and, I think, require no further explanation, but I shall be pleased to further elucidate any of them in the discussion.

ELECTRIC WINDING MACHINES.*

BY PROF. PAUL HABETS, OF BRUSSELS.

(Continued from page 132.)

For the purpose of storing the energy during the stoppages of the winding machinery, M. Ilgner uses a large flywheel mounted on the shaft of a motor-generator, the latter consisting of an asynchronous motor and a continuous-current generator. As the motor-generator is running continuously, the current from the supply station will not vary much. The mean power is also less than in the case of an asychronous motor driving the winding machinery direct. The continuous-current generator, as well as the haulage motor, are excited by a small continuous-current machine driven by an asynchronous motor. This system has been adopted by the Allgemeine Elektricitäts-Gesellschaft at the pits of St. Nicolas, at the collieries of Espérance and Bonne-Fortune, Montegnée, near Liége. The installation, together with the results of some trials, will be described in the following part of this paper. Messrs. Siemens and Schuckert have adopted the Ilgner flywheel system to the machine at pit No. II. Zollern. In this case the motor is a continuous-current machine.

5. *Auxiliary Starting Dynamo.*—In this system the armature of the haulage motor, M (Fig. 9), is connected in series with the armature of an auxiliary dynamo, D *a*, across the mains of a constant-pressure circuit, and a buffer battery can also be inserted; the fields of both machines are connected direct to the mains. The auxiliary dynamo is driven at a constant speed by the steam-engine, G G, working a set of dynamos. The field is regulated by a rheostat, and the E.M.F. generated in the armature opposes the pressure between the mains. When the difference of potential, E″, between the brushes is equal to the pressure between the mains, no difference of potential will be available at the brushes of the haulage motor, M, which will, therefore, be at a standstill. By reducing the resistance,

Auxiliary Starting Dynamo.

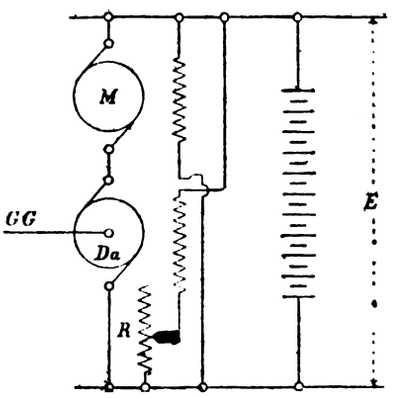

FIG. 9.

R, the difference of potential, E″, between the brushes of M will be E′ = E − E″; a torque will now be exerted by M which will be increased by reducing E″. When the motor, M, has attained its full speed, the counter E.M.F. in the armature of D *a* should be as near zero as possible, and E″ should only be sufficient to overcome the resistance of the armature. The dynamo, D *a*, works therefore as a motor, aiding the steam-engine; but when the resisting moment becomes negative, then the auxiliary dynamo will work as a generator, taking energy from the engine. The current will now flow against the pressure of the mains, and the energy generated by M, which has also become a generator, will increase, and therefore cause M to go slower. In this manner the auxiliary dynamo will keep the speed of M almost constant. The speeds as well as the startings are obtained without other losses than those due to driving the auxiliary dynamo. It is, however, inconvenient to have to regulate the field of the dynamo if this machine cannot be placed near the haulage motor. The auxiliary dynamo may be driven by a motor. The two machines mounted on the same shaft constitute a booster, which may be connected with the mains and the haulage motor in different ways, but can be placed close to the winding machine. This arrangement makes the winding machine more independent of the power station, which may be at a considerable distance from the pit.

6. *Starting Boosters.*—The booster, which we have just described, consists of an auxiliary dynamo with a field rheostat driver by a shunt motor which receives current from the mains. With regard to economy, the booster is

* Paper read before the Institution of Mechanical Engineers (translated from the French).

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inferior to an auxiliary dynamo driven by an engine, because the efficiency of the booster is less on account of the double transformation of energy. The cost of installation is higher, as the motor and the auxiliary dynamo of the booster must both be of the same power as that of the haulage motor. The speed of the booster may, however, be high, whilst the haulage motor, being direct coupled to the winding machine, cannot have a speed exceeding 50 r.p.m. to 60 r.p.m. By reversing the field current of the auxiliary dynamo, the booster will work as a booster proper—*i e*, will raise the voltage of the mains. We might, therefore, arrange matters so that the pressure of the circuit will be doubled when the haulage motor is running at full speed. Under these conditions the power of each of the booster machines need not be more than half of that of the haulage motor, thus making the booster less costly. For this purpose the voltage of the haulage motor must be twice that of the mains, and we must, therefore, either reduce the pressure of the distributing system or design a high-tension motor, which with continuous-current machines is difficult when the tension exceeds 500 volts. The problem may also be solved by driving the winding machine by two motors connected in series, each of which will, therefore, only receive half of the total voltage. The latter system, which was brought forward by the Union Elektricitäts-Gesellschaft, has been adopted by Messrs. Schuckert and Co. in the case of the winding machine at the Friederich-Franz mine at Lübtheen (Mecklenburg). Fig. 10 is a diagram of connections. An Ilgner flywheel may be mounted on the booster shaft. This solution has been applied by W. Lahmeyer and Co. to the winding machine of the Tremonde pit of the Mining Company of Liguy-les-Aira. For the purpose of bringing the flywheel into proper play, a second booster is connected in series with the armature of the starting booster in such a manner as to vary the speed of the latter automatically, and also inversely as the strength of the armature current of the haulage motor. M. Creplet reduces this group to a single dynamo, the shaft of which carries a special flywheel. As it is possible to allow a great variation of speed for this dynamo, the flywheel can be much reduced. A machine on this system has been installed by the Compagnie Internationale d'Electricité de Liége for the Fléron pit of the Hasard Collieries at Micherot, near Liège. Very few trials on electrically-driven winding machines have been published up to the present time; the trials made on the machine at pit No. II. Preussen afford the only account we possess of the working of a machine driven by a three-phase motor. We have made a great number of trials on the machine installed at St. Nicolas, at the collieries of Espérance and Bonne-Fortune, Montegnée, and will now give a detailed description of this installation, together with the results we have obtained.

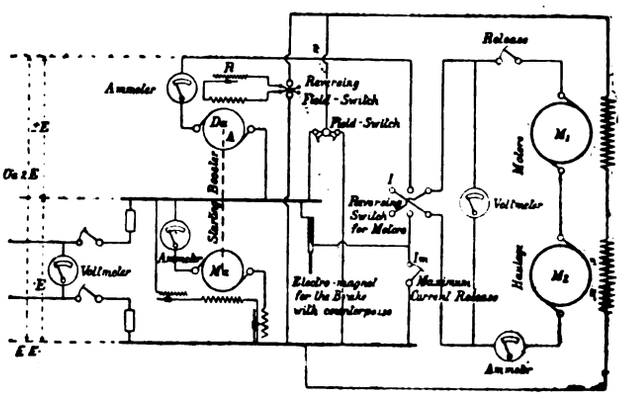

FIG. 10.

IV. *Electrically driven Winding Machines at the Pit of St. Nicolas at the Collieries of Espérance and Bonne Fortune, Montegnée*

1. *Description of the Installation* (Fig. 11).—The machine was supplied by the Société Belge d'Électricité A.E.G. It is designed to draw 500 tonnes (492 tons) from a depth of 800m. (2,625ft.) in eight hours. The loads are four tubs holding 535 kg. (1,102·3lb.) of coal or 750 kg. (1,653·4lb.) of stone; each tub weighs 250 kg. (551·1lb.), and the cage weighs 1,800 kg. (1¾ tons). The electric energy is supplied from the power station, which was constructed in 1899, at the pit of Espérance, and which contains three sets of three-phase generators working at 1,000 volts and with a frequency of 44; the output of each machine is 200 kw. Two of the sets also supply current for pumping, ventilation, picking, etc., at the pits of Espérance and St. Nicolas; the third is a reserve set. The coal is drawn from four underground landing stages at depths of 368m. (1,207ft.), 342m. (1,122ft.), 288m. (945ft.), and 185m. (607ft. On account of the nature of the deposition of the beds and the extent of the field of exploitation, it may eventually be necessary to draw simultaneously from several seams, which will require one or two stoppages

(See also Fig. 12, page 35.)

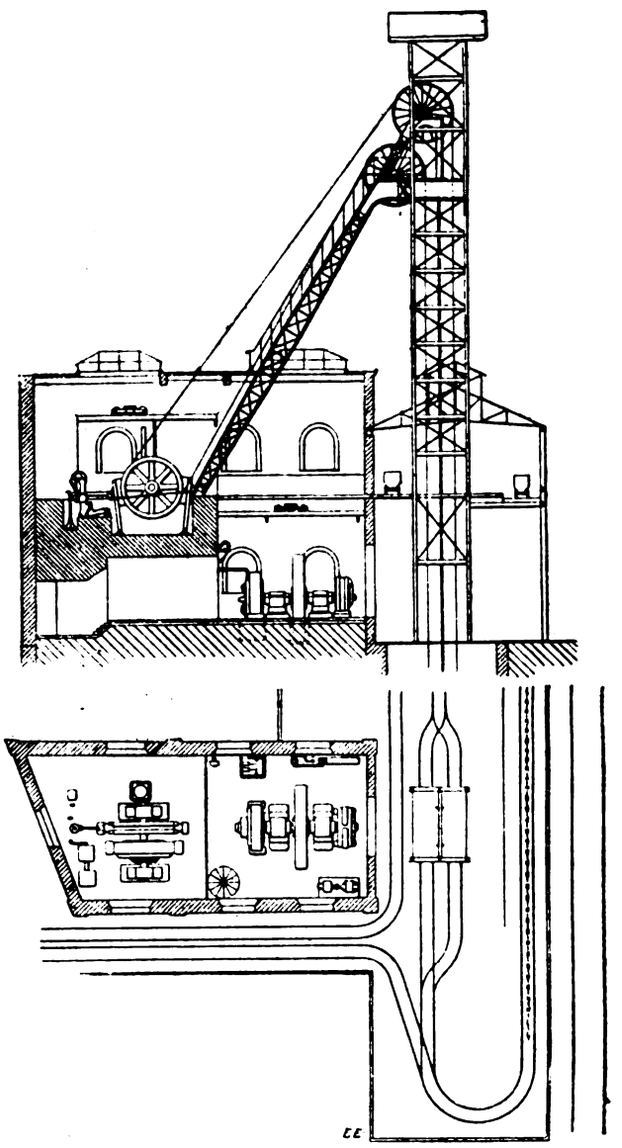

FIG. 11.

during each lift. The time spent in unloading the cage at the bank of the pit, and simultaneously loading the cage at the bottom landing place, is 30 seconds, and loading the cage at intermediate landing stages takes 20 seconds. Under these conditions the maximum haulage speed need not exceed 12m. (39ft. 4¼in.) in order to draw a total of 500 tonnes (492 tons) from a depth of 800m. (2,625ft.). When the depth is less or the tonnage is smaller, the speed may be slower. Local circumstances have led to the adoption of a Koepe pulley with a central groove for a flat-wire rope, and two brake rims, one on each side of the groove. The motor and the Koepe pulley are mounted on the same shaft; the diameter of the pulley is 3m. (9ft. 10⅛in.), and requires, therefore, only a medium size motor. The haulage speed is 10m. (32ft. 9¾in.) when the motor makes 64 r.p.m. Notwithstanding the high

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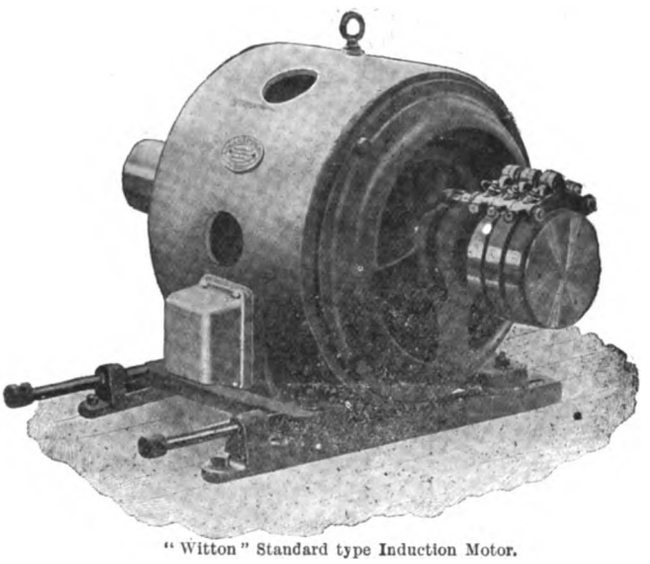
frequency, a three-phase motor might have been designed for this slow speed. Preference has, however, been given to a continuous-current motor; and a motor-generator of the Ilgner type, consisting of a three-phase motor and a continuous-current generator, has been adopted for the following reasons. During the period of acceleration the three-phase motor would have absorbed 615 h.p., a power which the central station would not have been able to supply with the present plant. Besides, a three-phase motor with a starting rheostat is very wasteful, and the loss of power in this case would have been still higher on account of the intermediate stoppages. Notwithstanding the conversion of the three-phase current, the motor-generator is in this case more economical, as it almost entirely prevents any losses during acceleration, and the slow speed, which must be adopted when the haulage is reduced, and also during the night shift. A motor-generator with an Ilgner flywheel will also equalise the demand on the power station, no matter how the load varies. The power station will then be able to supply the other motors if the pumping is done during the night.

(To be continued.)

TRADE NOTICES AND NOVELTIES.

"Witton" Single and Polyphase Motors.

The General Electric Company, Limited, Queen Victoria-street, E.C., have issued a new catalogue of their single and polyphase induction motors, which includes a full specification and a mass of useful data. Accompanying is an illustration of



"Witton" Standard type Induction Motor.

the company's standard-type induction motor on slide rails. It is well known that they have of late made rapid strides with their single and polyphase machinery. There is absolutely no need to go to the Continent for such plant now. That is proved, if proof be required, by the many important contracts entrusted to the company, amongst which reference may be made here to orders from South London, Hastings, and Reigate for single-phase and from Dublin and Cardiff for three-phase plant.

Motorcar Troubles.

The subject of the troubles which motorists have experienced in the past with electric wires on motorcars is dealt with on a card, which includes lighting-up tables, published by Messrs. W. T. Glover and Co., Limited, Trafford Park, Manchester. Those who have had to do with internal-combustion engines, arranged for electric ignition, are well aware of the troubles and expense that arise from the insulation of the leads breaking down, but few persons, we are told, know what causes the same. Messrs. Glover having had their attention drawn to the matter, discovered that the causes are two-fold. The static discharge set up between the conductor and the outside sheathing of the cable is partly to blame, and the destruction of the rubber insulation by vagrant oil is the other cause. As a preventive they now recommend their specially-designed, oil-proof, and static discharge proof cables. The oil-proofing is achieved by covering the insulation with a closely-woven fabric sheath, which is impregnated with an oil-resisting compound. The further feature is the metallic sheathing, which prevents chance of shock and deterioration of the cable by the static discharge induced by the high potentials used for electric ignition. This sheathing is arranged for connecting to the metal work of the car or engine itself, which is at earth potential. Messrs. Glover will be pleased to forward one of these cards to any reader who may apply.

Electric Lighting Accessories.

Messrs. J. H. Tucker and Co., of Sampson-road North, Birmingham, and London, have just issued a new catalogue of the electric lighting accessories which they manufacture. Tumbler switches are listed in great variety, including a special pattern with locking ring to prevent the removal of covers by unauthorised persons. This switch should certainly prove useful for asylums, schools, and public buildings. Fig. 1

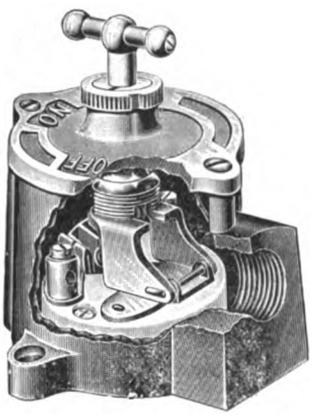


Fig. 1.

herewith illustrates a pattern introduced by the firm to meet the demand for their patent tumbler switch enclosed in a cast-iron case. The handle is in the centre of the cover, and has a "turn" action, being connected in such a manner that the movement is very easy. The "on" and "off" positions are indicated upon the cover. The spindle carrying the handle works through a stuffing box and gland. An indiarubber ring is placed between the cover and box to ensure a watertight joint. Both handle and cover are nickel-plated. Considerable space is also given to wall sockets. The iron-cased two-pin type (Fig. 2) consists of a china interior fitted into a cast-iron box.

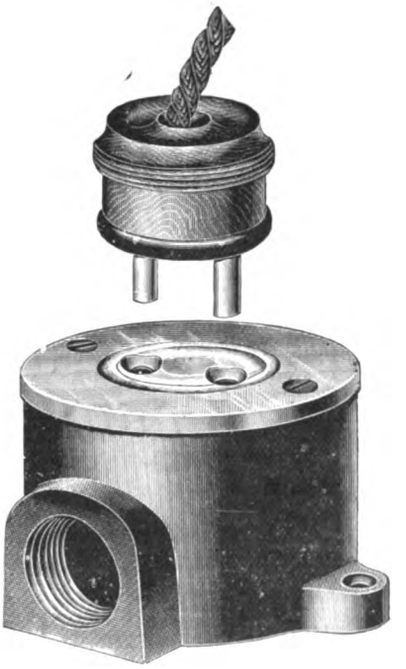


Fig. 2.

The metal parts carrying current are sunk in the china, and the poles are well separated by a wall of china. We notice that a watertight pattern of wall socket, very similar in general construction to the above, is also supplied by the firm. Among the further contents of the catalogue are some well-designed distributing switch and fuse boards, ceiling roses, counterweight sets, cut-outs, lamp-holders, switches of various useful types, and main switchboards.

Aron Meters.—"Notes on Meters and Useful Data" is the title of a little pamphlet just issued by Aron Electricity Meter, Limited, 114, Union-street, Borough, S.E., and we find it faithfully describes the contents, which should be valuable for reference purposes.

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TO CORRESPONDENTS.

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THE TELEPHONE COMMITTEE.

The report of this committee has been issued, though the minutes of evidence are not yet ready. However, the former is the important part, the latter merely assisting to decide how far the former is logical and justified. The committee was appointed to consider the agreement between the Postmaster-General and the National Telephone Company, whether it should become binding or be modified, and whether the interests of the employés of the company had been duly considered. The telephonic policy of the various Governments of this country since telephony has been proved practical has been of such a character as not to be understanded of the multitude unless it be summed up in the phrase, "Don't bother; let things slide, and see what turns up." That state of things continued until the matter became acute, and then came an agreement about trunk lines. Subsequently came the London agreement and municipal licenses. Finally, the agreement upon which the report is made. The history of telephony can be written in ten lines. First, doubt as to practicality, Government afraid to risk a few pounds on experiment, private enterprise proves the matter, and the National gradually gets a monopoly; agitation for Government to take what was legally certified to be telegraphic, and hence, under the Telegraphic Acts; finally, get rid of the enterprising company, which has done most of the pioneer work, at the least possible cost, thus the agreement under consideration. In the opinion of every one who is not biassed the Government throughout has acted in the most contemptible manner, and any private individual so acting would long since have been given the coldest possible shoulder in business circles. The final agreement was made under the ægis of expediency—something that will go down with the electorate. The Government always held the whip-hand because of the legal decision; and, much as we dislike the methods of the National, they have been infinitely superior to those of the Government. The agreement ought never to have been required. There ought never to have been a company with a practical monopoly, which has in equity to be bought out at the nation's expense, and which deserves all that it can in a legitimate manner demand. The text of the committee's report is given elsewhere in full, and, as will be seen, is not a very robust document, dealing more with a summation of details than anything, merely giving a qualified general assent to the agreement and suggesting certain modifications which, if adopted, will leave things pretty much as they are. Clause 27 is the important one. It reads: "On a careful review of the bearing of the agreement as a whole upon the interest of the public, we find that the policy of purchase is to be preferred to the other alternatives; and that if safeguarded as we recommend in paragraph 28, it will leave the position of the municipalities unprejudiced as regards the period succeeding the cesser of the company's rights in 1911. We are of opinion that in order to make it clear that municipal licenses can be granted between Aug. 31, 1905, and Dec. 31, 1911, without giving the National Telephone Company rights to compensation under the Telegraph Act of 1899 in respect of licenses granted after Aug. 31, 1905, it is desirable that the agreement should be modified by omitting on p. 6, paragraph 2 (1) *b*, line 6, the word 'whether' and the words 'or after.' After allowing due weight to the criticisms that have been passed upon details, we think that the agreement provides on balance the best security available in the circumstances that the property purchased shall be good and suitable in quality, and that no more than a reasonable price shall be paid." The succeeding clause recommends the "House of Commons

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should not disaprove of the agreement," but should accept it and the modification suggested. So far as we can judge, therefore, municipal enterprise, be it good, bad, or indifferent, has received a set back, for we cannot believe that any municipality will proceed to trouble and expenditure with the indefinite prospect of in 1912, or some not far-off year, having to consider, agree, or arbitrate as to the then value of their property for sale, or of terms under which they shall be allowed to continue operations. The whole matter, if justness and honour are to reign supreme, is very simple. So far as it concerns the National Company the two parties are agreed—let the agreement stand. So far as the municipalities are concerned the question is not quite so simple, as it depends upon the determination of the Government to work all exchanges or to permit under certain conditions of local control over local areas. When this matter is decided, the really just solution of the problem is, as we say, simple. The report deals satisfactorily with the question of the company's employés.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PUBLIC LIGHTING.

The following letter has been addressed to the town clerk of the city of London, Guildhall, E.C., by the City of London Electric Lighting Company, Limited:

Sir,—The position which has arisen by reason of your letter of the 17th ult., in which you state that the Streets Committee have been authorised to revert to the use of gas for certain of the main thoroughfares of the city, and requesting my company to remove its electric lamps by Sept. 29 next, has been carefully considered by my Board, and I am now directed to write you in reply as follows:

Many members of the Court of Common Council may be unaware of, or may have forgotten, the circumstances under which the three contracts for the electric lighting of the eastern, central, and western districts of the city were entered into, and I therefore shortly recapitulate them. Specifications were prepared by the Corporation, and tenders were asked for in accordance therewith. The tenders of the Laing, Wharton, and Down Syndicate for the eastern district and of the Brush Electrical Engineering Company for the central and western districts respectively were accepted, and were embodied in three contracts.

Under these contracts the contractors were placed under obligations to make a large expenditure on plant, mains, lamps, etc., for the public lighting within a certain time and to supply the public lamps with energy at a very low rate in consideration of certain advantages as regards private lighting given to the contractors, which advantages, as events have happened, have proved to be illusory. The contracts were subject to provisional orders (or Acts of Parliament) being obtained by the contractors, and the Corporation stipulated that the contracts should be embodied in the provisional orders. These latter were granted, but the Board of Trade would only allow certain of the terms of the contracts, which imposed obligations on the contractors, to be inserted in the orders, including the obligation to sell that part of the undertaking relating to public lighting to the Corporation upon more favourable terms than were made applicable to the remainder of the undertaking. These three contracts and provisional orders were in due course transferred to my company with the consent of the Corporation.

My company had nothing to do with the negotiation of the contracts and provisional orders, but simply took them over with all their obligations, including those relating to the public lighting. This transfer took place in 1891, and it was not until about 1899, after my company had expended £119,520 in respect of the public lighting, that the question of the validity of the contracts was raised by the Corporation. At Dec. 31 last this expenditure stood in my company's capital account at £128,997.

This question of the validity of the three contracts was carried through the various courts of law, and a final decision was given by the House of Lord, with regret, that the central and western contracts were invalid *ab initio* on the technical ground that certain members of the Corporation had a small share interest in the Brush Company—the original contractors. In giving judgment, the Lord Chancellor stated: "The defendants—*i.e.*, the Corporation—have repudiated them—not, as I understand, that they have any objection to the substance of the contracts, but, being advised by counsel that the contracts were invalid, they felt bound to test that question in a court of law. . . . I have striven to escape the stringency of the language, since I think that no one will doubt that the contracts were fairly and properly made with a due regard to the public interest, but I cannot escape from the language of the statute." Thus, my company's shareholders had to suffer for something which my company had no hand in, as it merely, as above stated, took a transfer of the contracts with the consent of the Corporation. The contract for the eastern district was declared by the House of Lords to be valid and subsisting.

Since the decision of the House of Lords my company has, at the request of the Corporation, carried on the public lighting until the present time, as though all the contracts were still valid. On March 25, 1905, my company received a letter from you inquiring upon what terms my company would be willing to enter into a contract for lighting the main streets with improved lamps, etc. My company replied asking for particulars of the improvements which were required, and on April 27, 1905, you replied that a specification was being prepared by the electrical engineer to the Corporation, of which a copy would be sent to my company in due course. The specification has not been received, but on May 4, 1905, the Street Committee submitted a scheme for replacing 47 electric arc lamps by gas lamps, of which eight arc lamps are in the eastern district. My company had no official cognisance of this scheme until June 19, when a letter was received requesting my company to remove its electric lamps from Fleet-street, Queen Victoria-street, Monument-street, and part of Lower Thames-street by Sept. 29 next.

To comply with this request would mean the destruction of part of the capital outlay imposed upon my company by the contracts and provisional orders, and a corresponding loss of revenue of about £1,222 per annum. My Board consequently felt that it was a matter which required their most careful consideration, especially as after being requested to tender for improved public lamps, nothing further has been done, and in the meantime gas lighting has been adopted to a serious extent. In this connection I am to remind the members of the Corporation that my company did not have a free hand in the selection of either the standards, the lanterns or the glass of the present electric arc lamps, all of which were settled by the late Colonel Haywood, the then engineer to the Commissioners of Sewers, and to point out that it is not fair to compare electrical apparatus which was the best of its kind in 1891 with modern gas apparatus.

My Board would have been only too pleased to co-operate with the Corporation in improving the lighting of the streets. In all probability my company would have been able to submit such terms as would have shown at least as great a saving as the alleged saving mentioned in the Street Committee's report of May 4, 1905, and the improved electric lamps would have afforded better illumination than any form of gas lighting. But, as stated above, my company had no opportunity of tendering, and have never received the specification promised by your letter of April 27 last.

My Board have been precluded from incurring on their own initiative any further large expenditure on the public lighting owing to the uncertainty of the position of my company as regards the public lighting. It would manifestly have been impolitic for my company to do so without the security of a fresh contract, especially in view of Mr. D. J. Ross's statement in his letter of Oct. 19, 1904, to my company "that the Corporation does not recognise the existence of any contract for the eastern district of the City."

My Board cannot agree with this view, as they are advised that there can be no question after the decision of

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the House of Lords that the eastern contract is still binding on the Corporation and my company. As regards the central and western contracts, apart from the legal position, my Board submit that in equity my company has a just claim upon the Corporation that it should not destroy to the considerable extent involved the capital expenditure made by my company in pursuance of the obligations imposed upon it by the Corporation.

My Board are anxious that the present amicable relations between my company and the Corporation should not be disturbed, and I am therefore directed to suggest that a special committee should be deputed by the Corporation to confer in a friendly manner with my Board with a view to the public lighting of the streets by my company being settled in a manner satisfactory to both parties.

I am to request that you will be good enough to place this letter before the Court of Common Council at its next meeting. I am to add that I am forwarding a copy of this letter to each member of the Corporation.—I am, Sir, your obedient servant,

(Signed) J. CECIL BULL, Manager and Secretary.
The City of London Electric Lighting Co., Limited.

THE PHOTOMETRY OF UNSYMMETRICAL SOURCES OF LIGHT.*

Considerable labour and time has always been involved in photometric determinations on such sources of light as the electric arc lamp because of the want of symmetry in the light radiations. Even the ordinary vertical carbon arc necessitates the determination of a complete light radiation

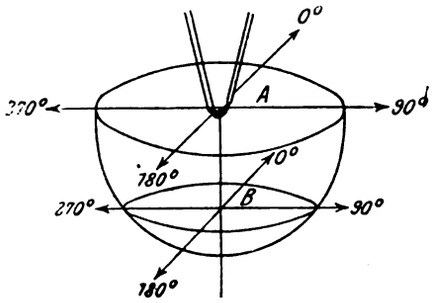

FIG. 1.

curve over a whole vertical plane, whilst the newer flame arc lamps, in which the carbons are inclined to one another and throw the arc downwards, are unsymmetrical not only in the vertical plane, but also in the horizontal plane, so that unless a lumen-meter (Blondel) or a globe photometer (Ullbrich), or some similar more or less complicated apparatus is employed, it would appear necessary to take a large number of readings in various vertical planes and in various horizontal planes. The writer of the present article, however, points out how this labour can be kept within reasonable limits whilst giving quite sufficiently accurate results even with the most unsymmetrical sources.

The method involves (1) the taking of a light radiation curve in any one vertical plane, either over 90deg. or over 180deg., according to the nature of the lamp; (2) the taking of a few readings in two horizontal planes—*e.g.*, in the plane of the arc (A, Fig. 1) and in a plane at, say, 45deg below the arc (B, Fig. 1). Usually four readings for each of these horizontal plane curves are sufficient.

From (1) the mean spherical or hemispherical candle-power for the one particular vertical plane is obtained in the ordinary way.† From (2) the ratio of the average candle-power to the candle-power at the particular vertical plane used in (1) is obtained for each of the two horizontal planes. This ratio will be found to be practically the same for both planes. In order to obtain the real spherical or hemispherical candle-power of the lamp, it is then only necessary to multiply the mean spherical or hemispherical candle-power for the one vertical plane obtained from (1) by the average value of the ratio obtained from (2).

The simplicity of the method is best shown by an example. Fig. 2 shows the polar candle-power curves taken with and without globe on an arc lamp of the inclined-carbon type. The carbons were ordinary (not flame) ones, and were of unequal size (10mm. and 7mm. diameter respectively), so that one was always somewhat longer than the other. This led to an unusually unsymmetrical light distribution The curves in Fig. 2

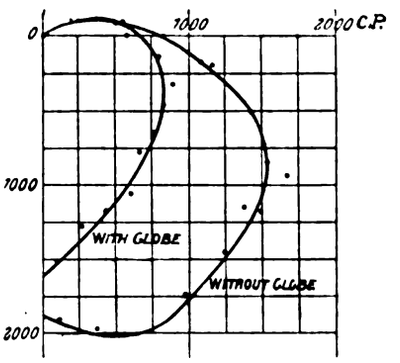

FIG. 2.

were taken for the vertical plane normal to the plane of the carbons. The mean hemispherical candle-powers for this plane calculated from these curves are 1,620 without globe and 980 with opal glass globe. The light distribution in the two horizontal planes, A and B (Fig. 1), was next measured, and is shown in the polar curves in Fig. 3. In order to arrive at the average light intensity represented by these curves, it is not necessary to convert to rectangular co-ordinates, as the average of 16 (or even 4) equidistant radial vectors leads to the same result practically. The vertical plane for which the curves in Fig 2 were obtained

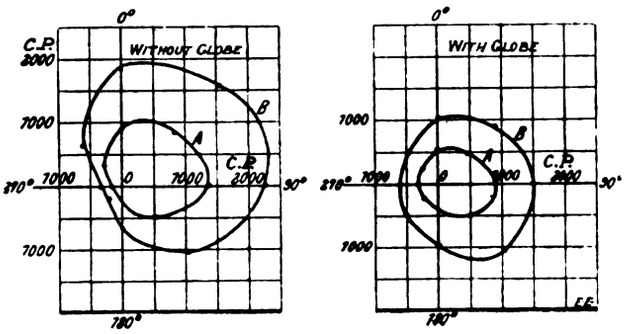

FIG. 3.

is the one marked 0° in Fig. 3. The following table gives the results obtained from Fig. 3:

	Without globe		With globe	
	Curve A.	Curve B.	Curve A.	Curve B.
L_M = Mean candle-power in horizontal plane ... Average of 16 radii	640	1,260	520	1,030
L_M = Mean candle-power in horizontal plane ... Average of 4 radii...	660	1,300	525	1,040
L_0 = Candle-power on plane marked 0° (Fig. 3)	900	1,860	530	1,050
Ratio $\frac{L_M}{L_0}$	·71	·68	·98	·98

Since the ratio is practically the same for the two horizontal planes tested, it will be safe to assume that it is the same for all other horizontal planes. The real hemispherical candle-power of the lamp is, therefore, obtained by multiplying the hemispherical candle-power obtained from Fig. 2 for the one vertical plane by the average ratio obtained from Fig. 3, or real hemispherical candle-power without globe = 1,620 × ·695 = 1,130; real hemispherical candle-power with globe = 980 × ·90 = 960. The results obtained of this method cannot, of course, claim extreme accuracy, but the accuracy is ample for such a fluctuating source of light as an arc lamp.

* Abstract of an article by Dr. L. Bloch in the *Elektrotechnische Zeitschrift*, July 13, 1905.

† It is not even necessary to project the polar curve on to a circle and find the mean ordinate of the resultant curve by planimeter, as quite sufficient accuracy is attained by taking the arithmetical average of, say, 10 equidistant points on the resultant curve,

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THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

(*Continued from page 129.*)

Amongst the witnesses heard last week was Colonel R. E. CROMPTON, who said that he did not regard the Tyneside scheme as any indication of success in London. The advantages of Tyneside were absent from London. The estimate of the cost of distribution put forward by Mr. Merz was ridiculously low, and he could find no justification for it. The total length of street mains was given as 363 miles, and the proposal was to distribute through these 120,000 kw. The cost of mains was put down at £1,089,000, and that worked out at £9 per kilowatt—to him a surprising result, seeing that in London undertakings the cost had varied from £54 in Stepney to £25. 12s. in Poplar. The estimate of £9 would have to be trebled probably. He was certain Mr. Merz had made some mistake, and that there was an under-estimate to the amount of possibly £2,000,000. There was an over-estimate of the amount of power likely to be required in London, and the number of hours' use estimated was beyond the average. The average hours of labour were shorter in London. With the estimated generation cost he had no quarrel. He did not consider the scheme was justified by any demand from existing undertakers or from railway companies, who could generate for themselves more cheaply. For instance, if the Great Eastern Railway electrified their suburban lines and needed 35,000,000 units per annum, with a 45 per cent. power factor, they would have to pay the promoters £76,000 a year. They could generate the electricity themselves for £32,500, leaving £43,700 a year to write off the sum the plant would cost. There was no necessity for such a scheme in London; it was not sound, and the proposal to supply such a large area from practically one centre was wrong from every point of view. In course of cross-examination tenders were put in to show that certain cable companies were prepared to carry out Mr. Merz's scheme for feeders and distributors at the prices given in the estimates.

When the committee met on Monday Mr. Fitzgerald was able to announce the withdrawal of several more opponents to the Bill. Thus the Corporation of Bromley and the Beckenham Urban District Council have agreed to clauses giving them an option for 12 months to take a bulk supply from the company on terms to be fixed by arbitration, and to be more advantageous to them than generating their own supply. The agreed clauses with the London Electric Supply Corporation and the South Metropolitan Electric Light and Power Company provide that these companies should adopt the Administrative Company's maximum price for power supply as their maximum price, any reduction in the charge for bulk supply given by the Administrative Company to go to the benefit of the consumer. The terms on which the bulk supply is to be furnished is to be determined, failing agreement, by arbitration within a year of the passing of the Act, and the terms are to be such as should make it substantially more advantageous for the companies to take a supply than to extend their works and generate the additional requirements for themselves. The South London Electric Supply Corporation have agreed to a similar clause. The agreement with the Charing Cross and West-end Company follows the same lines as that with the County of London Electric Supply Company. The Chelsea, the St. James's and Pall Mall, the Kensington and Knightsbridge, the Notting Hill, and the Westminster Companies have agreed to withdraw their opposition owing to certain clauses being altered. One of these alterations restricts the company from supplying in the non-industrial area to any but authorised distributors and railway companies.

Mr. MACKINNON WOOD gave evidence on behalf of the London County Council. He said he did not believe in the cheap prices scheduled, because past experience in other matters, such as water supply, had shown such promises to be illusory. The Bill would create a monopoly, both in the generation and distribution of electricity. At present the municipalities had the right to the future profits of electricity works, but with this monopoly in existence when the time for purchase arrived the borough councils would only have the cables to take over. He doubted whether manufacturers could demand as a right a supply of electricity at the prices scheduled. The whole scheme was to force existing companies and local authorities to take the bulk supply on the threat of competition. In his opinion the purchase clause proposed by the promoters was altogether worthless. The basis of purchase—payment of capital expenditure—was totally wrong, especially in the case of a company which could buy up other companies. The promoters could claim to be repaid large sums of capital spent on obsolete plant.

Cross-examined, witness said it was true that the London County Council jurisdiction extended over only a quarter of the area for which the promoters asked, and that the Kent, Surrey, and Essex County Councils, who represented 77 per cent. of the area, did not oppose the Bill.

On Tuesday, Mr. HAWARD, controller of the London County Council, laid stress on the difficulties which the auditor to be appointed under the purchase clauses of the Bill would meet with.

Mr. COWARD, K.C., addressed the committee on behalf of the County Council, contending that it would be a huge mistake to create a vast monopoly.

Mr. SPENCER HAWES gave evidence as to the Hackney supply system. The works' cost last year had averaged 0·88d. per unit sold. The output had been over 2½ million units, of which 554,000 units went to power consumers and 640,000 units to public lighting. Including capital charges on the station, the units cost 1·17d. Management and distribution expenses, including capital charges on mains, were 1·09d. per unit. They had now adopted the tariff given in the Bill for supplying the power consumers. The demand was growing, and there were three methods in which the Borough Council could deal with the situation created by this demand. It could (1) extend its own works so as to be able to deal with the entire output; (2) use the present plant to its full capacity, and take from the power company the additional energy required; (3) scrap the entire municipal undertaking, and take a complete bulk supply from the company at the terms quoted above. On an assumed output of 11,130,000 units per year, with a load factor of 20 per cent. and a maximum load of 6,370 kw., Mr. Hawes calculated the financial results of the three alternatives would be as follows:

	Annual working expenses and capital charges.	Per unit sold.
(1)	£51,450	1·109d.
(2)	59,240	1·277d.
(3)	65,540	1·413d.

This showed it would be best for the Corporation to generate its own supply. He assumed that the company's terms for bulk supply would be those agreed with the Stepney Council, and did not think that agreement an advantageous one.

Cross-examined, he said that although the Hackney Council would be able to supply as cheaply as the company, he thought the company would offer special terms to some large consumers to induce the Board of Trade to let them supply in the Hackney area.

On Wednesday last, at the opening of the proceedings, Mr. FITZGERALD said he was informed by the parliamentary agents that unless the committee stage of the Bill was finished by Thursday evening there would be considerable danger of the Bill being lost simply by effluxion of time. Under those circumstances he had to make an appeal which he had never made before, and that was to ask the committee to sit late that day and the next to enable the committee stage to be finished and a decision given on Thursday evening. Having regard to the time spent in Parliament and the great expenditure incurred by the parties, it would be a great misfortune if the Bill were lost by effluxion of time.

This was agreed to by the chairman.

It was then announced that the South London Electric Supply Corporation had withdrawn opposition, as an agreement had been come to with the promoters. A map was then put in to show that in one half of the area sought by the promoters there was either no opposition at all to the Bill or no opposition from persons supplying electricity.

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The case for West Ham was then taken, the witness for the Corporation being Mr. W. J. W. BULLOCK. He said that the coal they used cost 7s. 10½d. per ton, and was delivered into the bunkers for less than 8s. 6d. per ton. The total cost per unit sold was 1·133 last year. He considered the West Ham station was quite as well situated as the proposed works of the company as regards cheap coal and abundant condensing water. He did not think it would be advantageous to take a bulk supply until the present works had been extended to contain 18,000 kw.

Mr. ALBERT GAY was then examined as to the Islington system, which last year sold 406,369 units for power purposes. It would not pay to take a bulk supply at the schedule rates of the company. He was cross-examined at some length on this point.

It was announced that the City of London Electric Lighting Company had withdrawn their opposition.

Mr. A. H. SHAW gave evidence as to the Ilford undertaking, and Mr. J. W. BENTON, the clerk to the Council, was also heard. The opposition on behalf of Battersea was also heard before the committee adjourned.

On Thursday the agreements made with the South London Company and the City of London Electric Lighting Company were put in.

The case for the city of Westminster was then heard. The chief points made by the witnesses were that the purchasing power of the Corporation under the Electric Lighting Acts would be rendered less valuable, and that the breaking-up of the streets should not be allowed. It was shown that the Corporation had by a Bill this year obtained powers to purchase with the works of the Westminster Company the station of the Central Electric Company. The witnesses also objected to the promoters supplying railways in the Westminster area.

Mr. FITZGERALD, K.C., announced that the Gravesend Corporation and the Richmond Electric Light and Power Company had withdrawn their opposition.

Dr. HUGH MANSFIELD ROBINSON, town clerk, Shoreditch, stated, in examination by Mr. Courthope Munroe, that the combination of electricity works and dust destructor and the utilisation of the exhaust steam for heating the baths had resulted in an economy of between £3,000 and £4,000. The Council had as customers the consumers of over 50 per cent. of the power used in the district. A large proportion of the remaining power was used by two large firms who generated for themselves, and were unlikely to change. There had been no lack of "push" in the matter of extending the use of power. He admitted having made a proposition at a meeting of municipal authorities that there should be a scheme of municipal supply in bulk. He agreed that the promoters could in this respect do practically what the London County Council would be able to do. He objected, however, to the provisions of the Bill respecting capital charges.

Mr. C. NEWTON RUSSELL, Shoreditch Borough Council, stated that the highest load factor of any power consumer in the district was 22 per cent.; the average was 15 per cent. He calculated that in four years' time, by utilising the land already acquired, the Council would be able to generate at £6·2 per kilowatt against £8·4 estimated by promoters.

Cross-examined by Mr. Lloyd: He had no objection to buying in the cheapest market, but in a few years the Borough Council would be able to generate quite as cheaply for themselves as the company would do. Witness stated that his Council had given a quotation to the prospective North-East London Railway for supply of energy, but for lighting only. He agreed that in order to supply the suburban lines of the Great Eastern Company, if they were electrified, would need something like a tenfold enlargement of the Council's plant. During the Council's last financial year a third of the energy generated was used for power.

Mr. C. H. WORDINGHAM stated that he had inspected the extension of the Shoreditch Borough Council's works. It was of quite an up-to-date character, and similar in type to that proposed by the promoters.

COUNSEL for Dartford Urban District Council opposed the Bill on the principle of monopoly, besides which a few years might see a substantial alteration in prices of electrical supply all round.

COUNSEL for Southwark Borough Council, after explaining the history of the Council's electrical undertaking, made the objection that all the promoters' tributary mains were to be laid on the solid system, necessitating the breaking up of streets for extensions. The Council also objected to the Board of Trade acting in a judicial character, and to companies having power to transfer their undertakings without consent of the local authority. It was a fallacy to suppose that small power users would obtain a supply at ¾d. per unit. This was the "standard" price, but as a large quantity of energy would be supplied to big concerns for traction and the like purposes at little more than ½d. per unit, the small consumer would have to pay nearly 1½d.

Mr. COURTHOPE MUNROE, stating the case for the Bermondsey, Leyton, and Lewisham authorities, contended that the provision in the promoters' Bill, that they should not supply a customer with energy for lighting beyond 20 per cent. of the total power supplied, was illusory, because this proportion was ample to supply current for lighting, even if the consumer had to go to the trouble of having a motor of nominal size installed for power.

At 5.45 the CHAIRMAN announced that the case would be resumed at 11 o'clock to-day, when it is understood an attempt will be made to reach a decision, at any rate on the preamble. The evidence, however, has not yet been finally disposed of, as a witness is to be called on behalf of the City of London Electric Lighting Company.

BRIGHTON ELECTRICITY ACCOUNTS.

The accounts of the Brighton Corporation electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £595,039. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	34,795	3	5
Distribution of electricity	4,192	14	8
Attending and repairs to public lamps	3,659	5	9
Rents, rates, and taxes	4,171	12	10
Management expenses, salaries, etc.	5,684	8	11
Special charges, insurance, etc	297	9	11
	52,800	15	6
Amount allowed for bad debts, etc.	338	7	11
Amount transferred to net revenue account	36,564	17	6
	£89,704	0	11

Cr. Income.	£	s.	d.
By sale of current per meter	64,164	14	4
Public lighting	10,052	15	10
Sale of current to tramways department	11,350	8	5
Meter rents and sundry revenue	4,136	2	4
	£89,704	0	11

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Redeemable stock	472,048	11	2
Balances of loans outstanding	10,750	0	0
Premiums on stock issued, less discounts	1,877	13	7
Floating lisbilities	44,518	0	8
Balance at credit of reserve fund	15,731	5	10
Surplus account	96,768	12	6
	£641,694	8	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	590,542	18	10
Stores on hand	3,289	8	8
Sundry debtors, cash in hand, etc.	39,520	16	3
Investment—Brighton Corporation stock	8,341	5	0
	£641,694	8	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			8,661,102
Quantity sold	Private consumers by meter	4,984,994	7,780,220
	Public lamps	979,159	
	Tramways	1,816,067	
Quantity used on works			372 900
Total quantity accounted for			8,153 120
Quantity not accounted for			507,982

Number of public lamps—372 arcs, 1,634 incandescents.

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WOLVERHAMPTON ELECTRICITY ACCOUNTS.

From the accounts of the Wolverhampton Corporation electricity department for the year ended March 30, 1905, it appears that the total expenditure on capital account to that date amounts to £163,875. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	6,153	13	11
Distribution of electricity	617	16	5
Attending and repairs to public lamps	307	11	2
Rents, rates, and taxes	533	1	1
Management expenses, salaries, etc.	1,793	16	7
Law expenses	12	8	0
Insurances	177	9	4
Bad debts and allowances	185	1	7
	9,778	18	1
Amount carried to net revenue account	12,983	18	1
Provision for bad and doubtful debts	150	0	0
	£22,912	16	2

Cr. Income.	£	s.	d.
Balance from last account	150	0	0
By sale of current per meter and by contract	20,828	12	6
Public lighting	1,366	9	9
Rental of motors	89	17	3
Rental of meters, etc.	413	15	11
Work executed on account of customers	64	0	9
	£22,912	16	2

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—redeemable stock	141,015	14	11
Sundry creditors	3,373	6	1
Loans repaid, less depreciation	25,883	9	10
Balance at credit of reserve fund	6,568	16	2
Sundry creditors on revenue account	1,765	16	9
Sundry consumers, deposits	50	7	1
Interest accrued but not paid	581	11	3
Balance due to treasurer	5,609	10	7
Reserve for bad debts and allowances	150	0	0
Net revenue account—profit for year	3,454	1	10
	£188,461	14	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	158,781	6	7
Sundry debtors	15	10	2
Balance in treasurer's hands	11,480	14	1
Reserve fund—balance in treasurer's hands	6,568	16	2
Stores on hand	1,828	10	7
Motors on hire on consumers' premises	847	6	3
Sundry debtors for current supplied, etc.	8,939	10	8
	£188,461	14	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			3,157,492
Quantity sold: Private consumers by meter	1,218,530		
By contract	98		
Public lamps	128,221		
Traction	1,281,626		2,628,475
Quantity used on works			202,725
Total quantity accounted for			2,831,200
Quantity not accounted for			326,732
Maximum load observed (kilowatts)			1,460

Number of public lamps—56 arcs, 128 incandescents.

APPOINTMENTS VACANT.

Chief Instructor in Mathematics, Northampton Institute, Clerkenwell. Salary, £150 per session. Applications by 30th inst. See advertisement.

Premium Pupil, Kilmalcolm Electric Lighting Co. See advertisement.

Assistant Engineer about 25 years of age, with good knowledge of mechanical engineering. Applications to G M 532, Messrs. Deacon's, Leadenhall-street, London, E.C.

Practical Engineer to supervise the equipment of a complete electrical tramway in India. Applications to Box No. K 10, *Electrical Engineer* Office. See advertisement.

Mechanical and Electrical Engineer. Salary, 30s. per week. Applications to R. N., *Electrical Engineer* Office.

Junior Assistant Electrical Engineer, Burnley electricity works. Salary, £119. 12s. per annum. See advertisement in last issue.

Pupil, Stretford Urban District Council electricity department. See advertisement in last issue.

Chief Draughtsman, also Assistant Draughtsman. Applications to T. K., care of Davies and Co., advertising agents, Finch-lane, Cornhill. See advertisement in last issue.

POST OFFICE TELEPHONE AGREEMENT, 1905.

The following is the full report of the Select Committee appointed to consider the agreement of Feb. 2, 1905, between the Postmaster-General and the National Telephone Company, and to report as to any recommendations thereon whether it is desirable in the public interest that the agreement should become binding, with or without modifications, and also whether the interests of the employés of the National Telephone Company have been duly considered. The committee have agreed to the following report:

1. The situation which has occasioned the provisional conclusion of the agreement referred to us as above is as follows: The license to the National Telephone Company to carry on telephonic business, either in London or elsewhere in the United Kingdom, is about to about to expire on Dec. 31, 1911. That company at present carries on about 90 per cent. of the telephonic business of the country. At the end of 1911, therefore, with the exceptions mentioned below, practically the whole of the facilities for telephonic communication now enjoyed by the public would, if nothing had already been done, and if nothing were to be done in the interval between now and then, entirely disappear. Exception has to be made in the case of a few provincial areas where municipalities have installed telephonic services in competition with the company under licenses which will expire at dates varying from 1913 to 1926.

2. The case of the district known as the London exchange area has already been provided for by an agreement dated Nov. 18, 1901, between the Postmaster-General and the National Telephone Company (herinafter called "the London agreement").

3. That agreement provided for the purchase of the plant of the company in the London exchange area on Dec. 31, 1911. Among other conditions, the plant was to be purchased at its value *in situ*, and no payment was to be made in respect of compulsory purchase, goodwill, or past or future profits. The company received underground facilities, and undertook to give intercommunication between the systems of the Postmaster-General and of the company in London during the continuance of the company's license, and to concede uniformity of rates.

4. The London agreement was never expressly submitted to Parliament, but is considered to have received parliamentary approval by the negativing of an amendment to the address on Jan. 27, 1902, and it has since been acted upon.

5. It is proposed by the agreement now referred to your committee to extend to the provinces, where the conditions materially differ, some of the principles of the London agreement.

6. The case of the provinces differs from that of London, chiefly in the fact that in certain provincial towns a municipal telephone system exists side by side and in competition with that of the National Telephone Company. These municipal systems are conducted under licenses from the Postmaster-General; and it is provided by the Telegraph Act of 1899 that where a municipality receives a license extending beyond Dec. 31, 1911, the license of the National Telephone Company to carry on business in the same area shall enjoy an extension for the same period. Another enactment of the Telegraph Act, 1899, provides that where in consequence of the grant of a license to a municipality the company obtain an extension of their license for as much as eight years beyond Dec. 31, 1911, they are bound (on certain conditions) to grant intercommunication within the exchange area.

7. The only places where the above enactments now have effect are the following:

Hull, whose license expires		Dec. 31,	1911.
Glasgow	,,	,,	1913.
Swansea	,,	,,	1920.
Brighton	,,	April 30,	1926.
Portsmouth	,,	July 30,	1926.

The resulting effect is that in Hull the municipal right to carry on telephonic business will expire at the same time as the company's right; in Glasgow, Swansea, Brighton, and Portsmouth the company's right will remain alive for various periods after 1911; and in Swansea, Brighton, and Portsmouth the company will enjoy the extended period subject to an obligation to give intercommunication to the subscribers to the municipal system.

8. Elsewhere than in the London area and the towns mentioned above, and the few places in which the Post Office are working telephonic services, the National Telephone Company is at present practically the only agency supplying telephonic facilities. It is to provide for the situation which will arise at the end of 1911 that the agreement of Feb. 2, 1905, was entered into between the Postmaster-General and the National Telephone Company. It will come into force on Aug. 31, 1905, if not previously disapproved of by the House of

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Commons. For more convenient reference we append a copy of it to our report.

9. Broadly speaking, that agreement adopts the same method as was applied in the London area by the agreement of 1901. The Postmaster-General undertakes to purchase at the end of 1911 some, but not the whole, of the plant, land, and buildings that will then be in the hands of the company. The agreement contains provisions designed to secure that the property so taken over shall not be obsolete or otherwise unsuitable for the Postmaster-General's requirements. As to the sufficiency of those provisions, we shall have more to say hereafter. For the present, it suffices to note that the agreement contemplates the preservation of certain selected assets of the National Telephone Company, and the ensuring that they shall be made both available and useful to their successors. It follows that, so far as concerns those assets, the National Telephone Company is relieved of the otherwise difficult task of finding a purchaser, and their shareholders are relieved, as regards so much of their property, of the fear of losing it by the expiration of the license in 1911. In return, the company undertakes (besides the obligation of making and keeping their property good and serviceable for the purposes of the transfer in 1911) to give certain advantages not hitherto enjoyed by telephone users.

10. It should be mentioned here, as an exception to the provision that goodwill and profits shall not be considered in fixing price, that goodwill up to a maximum amount will have to be assessed on what is called the private wire business of the company, which the company give up under the agreement, notwithstanding that not requiring a license it could be carried on after 1911. Goodwill will also have to be paid for in the few cases of unexpired rights that the company will enjoy after 1911 in the areas of the competing municipalities mentioned above.

11. We have carefully considered the bearing of the agreement on the public interest, and to enable us to do so we have heard evidence as to the policy of the proposed purchase, as to the provisions in the agreement designed to secure that the assets to be taken over shall be properly selected and valued, and as to the possible consequential effects of the agreement on the interest of the public, whether regarded in its national capacity or as organised in municipalities which now carry on telephonic services or may in the future desire to do so. We have also considered the probable effect of the adoption of the agreement on the interests of the employés of the National Telephone Company.

12. On the general question of the policy of this purchase, protests were made not only by the present telephone-owning municipalities, but also on behalf of the London County Council, which claimed to represent one-fifth of the telephone users of the kingdom. Such witnesses have pointed out that the municipal services are both good and cheap, and that their competition with the National Telephone Company has greatly improved and cheapened the company's services in their areas. They have alleged that in London, where, under the agreement of 1901 the Postmaster-General has taken the field as a competitor of the National Telephone Company, the public has got a service neither so good nor so cheap as the municipal services. They have expressed fears that between now and 1912 it will be possible under the agreement for the National Telephone Company to institute so severe a competition with the municipal services as to starve them out of existence. And to prevent this, they have claimed that either the minimum rates allowed by the agreement should be fixed higher, or that favour or preference should be prohibited not merely, as under the agreement, between individual subscribers in the same area, but also between bodies of users in different areas.

13. But in the case of all the municipal witnesses it has become apparent that while they have been drawing our attention chiefly to the apprehended effects of the agreement during the intermediate and transitional period between 1905 and 1911, their chief fears have been as to its permanent effects after the disappearance of the company at the end of that time. They have pointed to the danger of their services being absorbed and superseded by the Post Office in a manner and on terms which would inflict financial loss on their ratepayers, inconvenience and detriment upon their constituent users, and an interference with that rapid development which they believe is fostered by municipal enterprise.

14. We are bound to say that some ground was given for these fears by the fact that the Post Office witnesses enunciated before us, as the present view of the Postmaster-General's department, the opinion that the Post Office should, after 1911, become the universal and exclusive provider of telephonic services in the United Kingdom. Among other things, the Postmaster-General had stated in a recent letter to Glasgow that "he did not anticipate any prolongation of existing licenses or otherwise," and Sir George Murray said "that it was desirable in the future that municipal telephones should be absorbed by the State." The case was not made better in this respect by the fact that these announcements were thought to be out of harmony with previous and even recent utterances of the same department. So recently as March 23, 1904, Lord Stanley, the present Postmaster-General, said in this House: "He would be only too ready to help in every way any municipality that wished to start its own telephones, and he hoped that the present difficulty, that a municipality could not get an extension beyond 1911 without the company receiving the same extension, might be overcome when they came to a general agreement." This policy, however, of unification under State management, though advocated by the Postmaster-General's witnesses, is not in the present agreement. It has been contended that one consequence of the agreement would be that during the transitional period 1905-1911 no fresh municipal licenses could be expected to be granted, nor could extensions of existing municipal licenses be promised.

15. We have not felt it necessary to go into the question of the comparative merits of municipal and national telephonic services, a question which we do not consider to have been referred to us. Nor have we followed up the controversies which arose as to the mechanical efficiency or financial stability of the existing municipal undertakings. For we felt no doubt that the relative claims of municipal and national systems will be settled by Parliament on higher considerations than that some municipalities may have made mistakes at their first essay. We express no opinion as to whether such mistakes have been made; but we see no reason to suppose that, even if they have, municipalities will not be able and willing to profit by the experience gained.

16. In favour of the general policy of purchase in 1911, the solicitor (Sir R. Hunter), the secretary (Mr. H. Babington Smith), and the engineer-in-chief (Mr. Gavey) to the Post Office appeared before us and, directing their attention mainly to the period 1905-1911, argued substantially as follows: (*a*) That the continuance, without break, of the supply of telephonic services after December, 1911, is secured in the best practicable way, without wasteful duplication of plant. (*b*) That a motive is provided and an enforcement secured for the maintenance of the company's plant in a fully efficient state. (*c*) That even if the company were left alone until their rights expire, no competitor could in the meanwhile make much profit who had not secured the intercommunication, which the agreement secures, with the company's subscribers. (*d*) That the agreement precludes preferential charges and unfair discriminations between subscribers in the same area. (*e*) That the rates charged by both Post Office and company will be confined within maximum and minimum limits. (*f*) That the experience gained under the London agreement showed that its policy has been justified by success. In two years 44,000 new subscribers (equally divided between the two systems) had been added. (*g*) That the immediate erection of new plant by the Postmaster-General, even if not financially imprudent, could not, except under extreme pressure, be accomplished in the time available before the disappearance of the company's system. (*h*) That the fullest right of starting or licensing competitive systems is an added guarantee of efficiency, and is made effective by the right of intercommunication, without which competition could not pay. (*i*) That it would be a proper course for the Post Office to acquire any municipal exchange which is unable to maintain itself against the competition of the company.

17. By way of securing that the assets to be bought by the Postmaster-General shall be properly selected and valued the agreement in the first place (Clause 4) makes all questions of price in case of disagreement the subject of arbitration. Except in the few cases mentioned in paragraph 10 of this report the price will receive none of the enhancements that usually attend a statutory expropriation. Many indeed of such elements of added price are expressly negatived. The words of Clause 4 (1) are as follows: "4. (1) The value on Dec. 31, 1911, of all plant purchased by the Postmaster-General in pursuance of the provisions hereof shall be deemed to be its fair market value at the time of the purchase due regard being had to the nature and then condition of such plant and to the state of repair thereof and to the circumstance that it is in such a position as to be ready for immediate working and to its suitability for the purposes of the Postmaster-General's telephonic service and no addition shall be made to such value in respect of compulsory purchase or of goodwill or of any profits which might have been or be made by the company by the use of such plant and in determining the value of any plant no advantage arising from the construction of such plant by leave of the Postmaster-General upon any railway or canal over which the Postmaster-General possesses exclusive rights of way for telegraphic lines shall be taken into account."

18. The words "fair market value at the time of purchase" are identical with those used in the London agreement (Clause 9 (3)). They occur also in the corresponding part (Clause 30) of the licenses usually granted to municipalities, of which the model form as revised in 1902 is printed in the appendix. Some exception was taken to these words on the ground that they differed from those employed in the Tramway Act of 1870. The words there were "the then value." These became the subject of a judicial decision of the House of Lords to the effect that they excluded past or future profits and compensation for compulsory sale, and fixed the proper value of the property in question at such sum as it would cost to con-

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struct and establish the same, less an appropriate deduction in respect of depreciation. We regard it as important to secure the adoption of the words which carry the authority of a legal decision. We, therefore, recommend that Clause 4 (1) in the agreement should be so amended as to run as follows: "1. The value on Dec. 31, 1911, of all plant, land, buildings, stores, and furniture purchased by the Postmaster-General in pursuance of the provisions hereof shall be the then value (exclusive of any allowance for past or future profits of the undertaking or any compensation for compulsory sale or other consideration whatsoever) of such plant, land, buildings, stores, and furniture having regard to its suitability for the purposes of the Postmaster-General's telephonic service and in determining the value of any plant no advantage arising from the construction of such plant by leave of the Postmaster-General upon any railway or canal over which the Postmaster-General possesses exclusive rights of way for telegraphic lines shall be taken into account." This involves the consequential deletion of Clause 4 (2).

19. We are unable to suggest a better method than arbitration for settling the purchase price in case of disagreement. The process of arbitration has, however, to be applied to the determination of other questions besides that of price. The agreement proposes to resort to it for the purpose of testing plant in some instances in respect of its "suitability for the requirement of the telephonic service of the Post Office." In respect of these cases we should mention that it has been contended before us that the Postmaster-General should be his own judge of suitability. It becomes necessary, therefore, to examine the provisions of the agreement under which it is designed to effect a proper discrimination between the assets to be taken over.

20. From an examination of Clauses 2 and 3 of the agreement it appears that, except as mentioned below, the Postmaster-General will, as regards every item that he has to buy, have the protection afforded by the fact that either (*a*) it has been acquired or constructed with his consent, or (*b*) it comes up to the scheduled specification in point of technical efficiency, or (*c*) it is found by an arbitrator to be suitable for the Postmaster-General's requirements. The exceptions to the above are (i.) land or buildings acquired before the agreement in non-competitive areas, if in use on Feb. 2, 1905; (ii.) plant acquired before the agreement, not coming up to specification, and being switchboards or other internal plant in use in non-competitive areas on Aug. 15, 1904, and specified in list by company to Postmaster-General before Aug. 2, 1905. All plant, land, and buildings must in order to be qualified for purchase be actually "in use" by the company on Dec. 31, 1911, for the purpose of the licensed telephonic business of the company (see Clause 2 [1A]). So that it may be remarked of (i.) *supra* that land or buildings bought or erected before Feb. 2, 1905, in use then, and still in use nearly seven years later, are not very likely to be not worth taking under the carefully guarded conditions of the arbitration. And as regards (ii.) it is to be remarked that these classes of assets will also have to be still "in use," under Clause 2 (1A), on Dec. 31, 1911, and that should they be then worn out, obsolete, or otherwise unsuitable, the want of newness or the unsuitability can still be urged before the arbitrator in reduction of the price. The switchboards and other plant mentioned in (ii.) were stated before us to amount to not more than 1 per cent. of the whole amount of plant to be purchased.

21. A variety of detailed objections were taken to many of the provisions of the agreement, in respect of which it was sought to show that the terms of purchase were too favourable to the National Telephone Company, and that this was evidenced by a substantial rise in the value of the company's stocks as between certain dates. No doubt it would be possible to bring to an end the existence of the company in ways which would have been most unfavourable to the company. Had that been the Postmaster-General's object he could doubtless have aimed at it by settling in his own favour every point which tended in that direction. Indeed, he could in that case have done without the company's plant, and he could have done without an agreement altogether. But it does not follow that by so doing he would have furthered the interest of the public. Loss to the Telephone Company's shareholders is not necessarily and in any event gain to the public; and putting an end to the company's existence is not the only thing that the public interest requires. The main interest that the public have is in the maintenance of a cheap efficient and improving service without break of continuity.

22. In the course of these criticisms it was sought to show that the specifications in the third schedule to the agreement were not of adequate stringency to secure that the plant taken over should be modern and efficient. In particular it was contended that the specifications of this agreement were less stringent than the corresponding requirements attached as conditions to licenses granted to municipalities. The questions here involved were of necessity highly technical, and our task was not rendered easier by the fact that we had not before us the evidence of any witness who had not been employed either on the installation of the Post Office or on those of the telephone-owning municipalities. Neither side called an independent expert. The case for the Post Office with respect to the specifications was that they represented the latest standard practice, not merely of the National Telephone Company, but of the Postmaster-General's own telephone system; and that they followed the better and more modern practice of specifying results (such as audibility, etc.) to be aimed at, without too greatly limiting discretion as to how those results were to be attained. Indeed, it was said that it was intended to alter in the same direction the corresponding specifications in the municipal licenses.

23. If the price to be paid is not excessive and the specifications and other safeguards are sufficient to secure that the plant shall be good, the only question that remains is whether it would be possible and, if possible, better for the telephone users and the taxpayers for the Postmaster-General to provide his own plant.

24. On the question of possibility, the Post Office witnesses estimated that at least six or seven years would be required to construct a plant which, when completed, would be equal to three times the capacity of that now owned by the National Telephone Company, which is estimated to be the minimum probable requirements of 1911. For the weighty reasons appearing in the answers to Questions 200-203, the Postmaster-General has not availed himself of the option that was open to him on Dec. 31, 1904, to give six months' notice to purchase the undertaking of the company. He has, therefore, only the period from the present time to Dec. 31, 1911, in which to replace with all their accessories the 250,000 telephones that the National Telephone Company had in the provinces on March 31, 1905, besides creating the large additional number that will be wanted by the beginning of 1912. It is fair to mention that Mr. Bennett, the engineer to the telephone-owning municipalities, estimated that this work could be accomplished in four years. In this period, however, he had made no allowance for the time likely to be occupied in the compulsory acquisition of lands.

25. But even if it were possible to complete this duplicated installation by the beginning of 1912, it must be borne in mind that from now till then, should the policy of duplication be preferred to that of the agreement, the telephone users of the one system will get no intercommunication with those of the other; and those of the company's system in areas in which the Post Office have not set up competition will have to submit to whatever high rates, preferential charges, and other vexatious treatment it may be competent to the company in the exigencies of conducting an expiring business to impose upon them. At the same time the taxpayer will for some time have to go without interest on the necessarily large sums that will have to be raised for the purpose of equipping and starting the new service.

26. The cases of Glasgow and Hull present some special features. Glasgow (in the year 1900) took a license expiring in 1913. Hull (in 1902) took a license expiring in 1911. In both cases it was represented to us that the short term was accepted in the expectation that the Government, having thereby been spared the inconvenience of the consequent prolongation of the company's license, would recognise the forbearance of those municipalities by renewing their licenses in 1913 and 1911 respectively. In the case of Hull it was even said that at an interview with the Postmaster-General in 1901 a renewal had been expressly promised. After hearing some of those present at that interview on both sides, we found that, though there was no substantial conflict of testimony as to the words used, there were irreconcilable differences of opinion as to the inferences to be drawn. In any case Hull had felt so far encouraged by what had passed as to feel justified in going forward with the installation of a competing system with no better security for their hope that the license would be extended beyond 1911 than assurances said to have been given in a conversation never reduced to writing. Both Hull and Glasgow professed, therefore, to have received with surprise and some sense of hardship the subsequent uncompromising pronouncements of the Post Office in favour of the unification of all services under the management of the State. We think that these two cases should receive special consideration in the event of any parliamentary action being taken such as we foreshadow in paragraph 28.

27. On a careful review of the bearing of the agreement as a whole upon the interest of the public, we find that the policy of purchase is to be preferred to the other alternatives; and that if safeguarded as we recommend in paragraph 28 it will leave the position of the municipalities unprejudiced as regards the period succeeding the cesser of the company's rights in 1911. We are of opinion that in order to make it clear that municipal licenses can be granted between Aug. 31, 1905, and Dec. 31, 1911, without giving the National Telephone Company rights to compensation under the Telegraph Act of 1899 in respect of licenses granted after Aug. 31, 1905, it is desirable that the agreement should be modified by omitting on p 6, paragraph 2 (1) *b*, line 6, the word "whether" and the words "or after." After allowing due weight to the criticisms that

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have been passed upon details, we think that the agreement provides on balance the best security available in the circumstances that the property purchased shall be good and suitable in quality, and that no more than a reasonable price shall be paid.

28. While, therefore, we recommend that, in the general public interest, the House of Commons should not disapprove of the agreement, we think that the agreement, with the modifications that we have proposed, should not be allowed to become operative until a pledge has been given to the House that between now and January, 1912, nothing shall be done by the Government whereby the question of the future ownership and management of local telephone installations (as distinct from the ownership and management of trunk lines) may be prejudiced; and that, unless by a vote of the House it has otherwise been determined, the Post Office shall continue to grant licenses to municipalities on terms not more onerous in respect of royalties than the terms of the standard telephone license as revised in January, 1902.

29. We recommend that the purchase of any plant by the Postmaster-General from the municipalities shall be governed, if the municipalities so desire, by Schedule 3 attached to the agreement.

30. We also suggest the following amendment to the agreement: add to Clause 9, line 4, after the word "exchange," the words "or any municipal system established under a license granted after Aug. 31, 1905."

31. We pass to the consideration of the probable effects of the adoption of the agreement on the interests of the employés of the National Telephone Company. We interpret this part of the reference to us as meaning that we should inquire whether those employés will, if the agreement becomes binding, be thereby placed in a substantially worse position than that which they occupied on Feb. 2, 1905. We have heard evidence on this subject from the secretary to the Post Office, the manager of the National Telephone Company, and representatives of the workpeople and others on their behalf. The total number of employés at present is 14,227, which, it is anticipated, will have been largely increased in 1911. The claims put forward on behalf of the staff were, mainly, for a guarantee of continuity of employment when the service is taken over by the Postmaster-General, compensation for loss of office for those whose services are not retained, and a claim to pensions. Those members of the company's staff with a salary of £100 a year and upwards, who at present number about 1,200, and are beneficiaries in a pension scheme started by the company in 1896, which is secured by a trust deed and financed by a contribution of 2½ per cent. from salaries and a like amount contributed by the company, asked that the assets and liabilities of the pension fund should be taken over and the fund continued on its present basis, and be kept alive for the benefit of its members, or, alternatively, that the Postmaster-General should take over the assets of the scheme and count the employés' years of service with the company for superannuation purposes as if they had been spent in the service of the State. Unless something of this kind were done, it was stated, the staff would lose considerably by the transfer. Operators and others who, had they been employed in the Civil Service, would have been entitled to superannuation benefits have asked that their years of service with the company shall, on their being taken over in 1911, count as if spent in the Civil Service. In support of these claims Mr. Gaine, the general manager of the National Telephone Company, stated that unless they were conceded the effect would be very detrimental to the telephone service, since the class of people required would not offer themselves for training in a concern where they had no safety for continuity of service. Further, that the constant development of the telephone system would speedily absorb any surplus which might be caused in the Post Office by taking over the entire staff. In this latter view Mr. Babington Smith concurred, and further stated that the Postmaster-General had in effect given an assurance that in 1911 the existing staff would be taken over *en bloc*.

The only clause in the agreement which deals with the case of the staff is Clause 8. By that clause the Postmaster-General has reserved a free hand; but he has given certain assurances to deputations of employés. It is clear from the tables of wages presented to us by the National Telephone Company and by the secretary to the Post Office, and from the evidence, that the terms of employment under the Post Office, having regard to the conditions of service, are very similar to those of the company, and it has to be remembered that the employés of the National Telephone Company, including the pensionable class, have entered on their employment subject to a liability to be dismissed on notices varying from a week to a month, and also with a knowledge of the fact that the license to the National Telephone Company expires in December, 1911. Having regard to these facts, we recommend as follows: (*a*) All officers and servants who shall have been not less than two years continuously in the service of the company on Dec. 31, 1911, shall as from that date become officers and servants of the Postmaster-General on the terms of hiring and conditions of employment which obtain in the grade to which they are transferred. (*b*) Such officers and servants as are not beneficiaries of the pension scheme of the National Telephone Company, but who, if in the service of the Postmaster-General, would be on the established list, on entering the service of the Postmaster-General shall, for the purpose of superannuation and of being placed on the established staff, be entitled to count their past years of continuous service with the National Telephone Company, subsequent to 1899, as years passed in the Civil Service of the Crown. (*c*) The company should be required to submit all candidates for the National Telephone Company's service from Aug. 31, 1903, to the same, if any, medical examination as that required for officers and servants entering the Government service in the same grade. And we recommend that employés of any class now in the service of the company, and in their service on Dec. 31, 1911, should, if taken over by the Post Office, not be required to submit themselves to medical examination.

We recommend an undertaking by the Postmaster-General that no servant of the company taken over by the Post Office shall suffer by this transfer whenever it takes place—*i.e.*, that the employés of the company shall have the option of either continuing on the same terms as to pensions which they now enjoy under the company, or adopting the superannuation terms and conditions of the Post Office service.

Having regard to what we have recommended, and assuming that those recommendations are carried out, we do not think that the coming into operation of the agreement will place the staff in any worse position than that in which they stood on Feb. 2, 1905.

LEGAL INTELLIGENCE.

VIBRATION FROM ELECTRICITY WORKS.

At the Manchester Assize Courts last week Mr. A. Hopkinson, K.C., the deputy of the Chancellor, had before him two matters—Harter *v.* Manchester Corporation and Sillitoe and Soares *v.* Manchester Corporation—which arose out of alleged excessive vibration at the Dickinson-street electricity works. The litigation was begun in 1902, but there have been various adjournments for the purposes of improvements being made in the machinery complained of.

Mr. MABERLY, who appeared for the defendants in both matters, explained that the present application was that an order to stay proceedings be taken on an agreement come to between the parties.

Mr. GRANT, who represented the plaintiffs, stated that in Harter's case judgment had been already given, but the order now taken would finally close the action.

An order staying proceedings was accordingly made in both cases.

ELECTRICITY IN MINES.

At Wakefield last week Mr. William Stewart, as manager of the Crigglestone Colliery Company, was summoned for having failed to see that a coal-cutting machine was so worked and maintained as to reduce the danger from accidental shock or fire to a minimum, and further with failing to have the underground cables suspended by leather or other flexible material.

Mr. W. M. GICHARD, who prosecuted for the Home Office, said that on the night of June 2 an explosion of gas occurred in Crigglestone colliery, caused by one of the coal-cutting machines, the switch-box of which was afterwards found to be defective through the absence of the indiarubber ring through which the electric cables ought to pass.

The defence was that a manager could not be held responsible for every trifling dereliction of duty on the part of those engaged in the mine.

The charge of non-suspension of the cables upon flexible material was dismissed, but on the other summons the Bench held the defendant responsible, and imposed a penalty of £5 and costs.

PERSONAL.

The Gloucester City Council have been recommended to increase the salary of Mr. Bache as city electrical engineer from £300 to £325 for the current financial year, and to give him an additional increase of £25 a year for each of the two following years, on the understanding that such increasing salary will be accepted by Mr. Bache in satisfaction of the special services rendered and to be rendered by him in connection with the light railways and the extensions now being carried out at the electricity works.

Mr. H. A. Harding, of the Leatherhead Electricity Supply Co., has been appointed assistant electrical engineer to the Acton Urban District Council. There were 114 applications for the appointment.

A hundred friends of Mr. W. S. Doran assembled last Thursday night at the Hotel Cecil to give him a farewell dinner previous to his departure for the United States, where he intends to take up his residence. Mr. Doran was formerly with the Worthington Pump Co., but has been associated for the last few years with the Westinghouse interests in this country. His genial manner has gained him many friends, and he will be greatly missed by all those who have come into contact with him.

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COMPANIES' MEETINGS AND REPORTS

METROPOLITAN RAILWAY.

The half-yearly meeting of this Company was held on Tuesday at the Cannon-street Hotel, Sir Charles M'Laren, M.P., presiding.

The CHAIRMAN, in moving the adoption of the report, which recommended a dividend on the ordinary stock for the past half-year at the rate of 2½ per cent. per annum, said they had not only carried an increased number of passengers during the half year, but there had been an increase in the money taken from fares. They had made some alteration in the classes consequent upon bringing into traffic the new electrical cars, which were of two classes only, and, therefore, between all stations from Baker-street to Harrow and Uxbridge, and from those stations to the Circle, they only now issued first and third class tickets. They would do the same thing as regarded persons travelling between Hammersmith and stations on the Circle as soon as the electrical service was in full working on that line. They would further only have two classes between Harrow and Verney Junction in the near future. The directors of the Metropolitan Company had revised their fares to some extent, and probably a further revision might be advisable, especially as they found that what they had done had been a success. The cost of making the change from steam to electricity was proving to be somewhat greater than the Board at one time thought, but they were perfectly satisfied that they had taken the right course, and believed they would, in a short time, reap the benefit of it. They were passing through a very trying half-year, because they had not yet wholly surmounted the difficulties of transition, and in the course of a few months the new joint line of the Great Western and Great Central Companies might be ready for opening, and some of the Great Central trains which now passed over the line would be diverted to it. The company commenced on Jan. 1 to run some electric trains between Baker-street and Harrow, and between Harrow and Uxbridge. They gradually increased the number of these trains until the whole of the service on the extension lines between Baker-street and Harrow and Uxbridge was now worked electrically, though trains from Baker-street to and from stations beyond Harrow on the Aylesbury line were still worked by steam. They had had some few failures and stoppages while bringing in the electrical service, but nothing of a serious character, and certainly nothing more than might be regarded as inevitable in the making of so radical a change. With regard to the working of the Circle, by agreement with the District Company, the Company made arrangements to commence to work all the trains on the "up" road electrically on July 1, but unfortunately the service over the District Company's part of the Circle line had to be discontinued in the course of a few hours, as certain difficulties became apparent in connection with the conductor rails and car equipments. The matter had been, and still was, in negotiation with the District Company, with a view to deciding upon the necessary slight alterations to be made, and they hoped to be in a position very soon to resume continuous working round the Circle with electric trains. In the meantime they were running a service of electric trains between 7 a.m. and midnight, in addition to the ordinary service of steam trains, on their portion of the Circle — viz, between South Kensington and Aldgate, *via* Paddington.

The report was adopted.

CITY AND SOUTH LONDON RAILWAY.

The half-yearly general meeting of this Company was held on Tuesday, Mr. C. J. Mott presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN stated that there had been a decrease in the number of passengers carried of 564,399 and in traffic receipts of £4 677. The total decrease in receipts was £4,041, and the amount available for dividends showed a diminution of £1,485. The competition of the London County Council electric trams had affected them principally. They had practically annihilated their 1d. fares on the part of the line where they ran. He believed, however, that the tramways had done their worst. Their long-distance fares now constituted the bulk of their traffic, and those could not be touched by the trams. They did not think they had much to fear from the motor omnibuses. He thought that in many cases they would bring traffic to the railway. The reduction of fares had not met with a satisfactory result. They had not lost anything, but they had had to carry a great many more passengers. It might be that in the future they would get some return.

The report was adopted.

DISTRICT RAILWAY.

The half-yearly meeting of this Company was held on Wednesday, Mr. R. W. Perks, M.P., presiding in the absence, through ill-health, of Mr. Chas. Yerkes. Particulars of the report were given in our last week's issue.

The CHAIRMAN stated that the extension of the electrical service was steadily proceeding, and in five weeks the Board hoped to begin the Wimbledon service, which would leave only the Inner Circle and the North-Western trains not propelled by electricity. Until all steam trains had been removed they could not institute automatic signalling, which was a necessary prelude to the Company having the frequent service for which provision had been made. He saw no reason to depart from the figures which had been set forth before Parliament, that the Company would carry a hundred million passengers a year, and some thought that that total would be largely exceeded. The shareholders had paid for a large amount of the equipment of the line in ordinary and preference stocks issued at a discount, and as reference was frequently made to the subject he would like to say that the discount at which the Underground Company had taken those stocks represented, he thought, a higher price for the stocks than the bulk of the ordinary proprietors in the Company had paid for their holdings. Practically the whole of the former proprietors who bought their stock at high prices had sold out long ago, and at the present time the holders consisted almost wholly of people who had bought their stock within the last 20 years at prices ranging from 25 to 36 or 37. Therefore, when it was said that the Underground Electric Railways Company of London would be making large profits it was as well to remember that that company had bought its stock at very much the same price as the other proprietors. The zone fares, which would represent a very large reduction—2d. from Hammersmith to Aldgate and 3d. from Ealing or Putney to Aldgate—would not come into operation until the whole system was electrified.

The adoption of the report was approved without discussion.

CENTRAL LONDON RAILWAY.

The half-yearly meeting was held on Wednesday, Sir Henry Oakley presiding. Particulars of the accounts appeared in our issue of last week.

The CHAIRMAN, in moving the adoption of the report, stated that in the aggregate the passengers had increased by over 60,000, but while the ordinary traffic had risen by 80,000, the workmen traffic had, curiously enough, fallen off by some 30,000, which was a matter for surprise, considering the favourable terms they are carried upon. The earnings were 5s. 6d. per mile, which was the highest figure attained, except in Coronation year, when it rose to 5s. 6½d. The working expenses remained stationary. The Board had considered the report of the London Traffic Commission, but had no definite suggestions to make regarding same at the moment. Arrangements have been concluded with the Great Western Railway for through bookings to certain of the latter's suburban stations. The matter of ventilating the tube is to receive further consideration.

The report was adopted.

ANGLO-AMERICAN TELEGRAPH.

The report states that the total receipts from Jan. 1 to June 30, including the balance brought forward, amounted to £183,678. The traffic receipts show an increase of £15 711 as compared with the half-year ended June 30, 1904. The working expenses of the half-year, including expenses of steamship "Minia," pensions account, etc., amounted to £70,925, being an increase of £7,346. The directors have set apart the sum of £10,000 to the renewal fund, leaving a balance of £102,752. Quarterly interim dividends of 15s. per cent. on the ordinary stock and of £1. 10s. per cent on the preferred stock were paid on May 1, 1905, absorbing £52,500, and second quarterly interim dividends of 14s. per cent. on the ordinary stock and £1. 8s. per cent. on the preferred stock, amounting to £49,000, will be paid on Aug. 5. The balance of £1,252 will be carried forward.

CHATHAM AND DISTRICT LIGHT RAILWAYS.

The report for the half-year ended June 30 last, to be presented to the meeting on 18th inst., states that the receipts were £16,611 and expenses £10,370. Adding the balance brought forward (£1,700) and deducting the interest on debentures (£1,000) there is £6,940. The directors recommend a dividend at the rate of 5 per cent. per annum on the ordinary shares for the half-year, carrying forward £2,568. The directors regarding this as an interim account, have made no provision for depreciation, and, as usual, postpone doing so until the final account is made up at the end of the year. The receipts continue to show satisfactory progress. By resolution passed at an extraordinary general meeting, held on April 12 last, the raising of additional capital to the extent of £61,000 was authorised. Of this amount £57,500 has been issued, half in preference shares and half in ordinary shares of £10 each, and has been fully paid up. Out of the proceeds the Lloyd's bonds appearing in former accounts to the value of £19 533 have been paid off and cancelled, and the Company has also paid off over £30,000 to creditors for new cars, and extension to Rochester, and parliamentary and other expenses in connection with the Act of 1903. Five new cars have recently been put in service, and it is anticipated the receipts for the current half-year will show still further improvement.

GREAT NORTHERN AND CITY RAILWAY.

The report of the Great Northern and City Railway Company for the half-year ended June 30 last, to be submitted at the meeting on Aug. 4, states that the total revenue receipts for the six months amounted to £46,239, as against £36,509 for the previous six months. The number of passengers carried for the same periods, excluding season-ticket holders, were 6,391,574 and 5,227,595 respectively. The number of local season tickets issued during the half-year was 2,913 as against 2,511 for the half-year ended Dec. 31, 1904. The number of three-route season-ticket holders using the Company's line during the past half-year was 2,547. The number of through bookings from the Company's stations over the Great Northern and the City and South London Railways is steadily increasing.

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report for the half-year to June 30 states that the receipts and disbursements respectively are nearly identical with those of the corresponding period of last year. After providing for debenture interest there is an available balance of £1,249. 6s. 5d., out of which the directors recommend the payment of the usual half-yearly dividend

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(£2475) on the 5 per cent. preference shares, and of three months' (£237. 10s.) arrear of dividend on those shares. Also that £400 shall be paid to the contractors on account of the principal sum remaining due to them for electrical equipment, and that the balance of £136. 16s. 5d. shall be carried forward to next half-year. The above-mentioned payments of £237. 10s. and £400 will clear off all arrears of dividend on the preference shares to June 30, 1905, and reduce the electrical equipment debt to £1,600.

NEW COMPANIES REGISTERED.

Para Electric Railways and Lighting Co., Limited.—Capital, £700,000. Objects: to acquire from the Works Construction Co., Limited, the existing tramway and electric lighting undertakings of the Companhia de Estrada de Ferro Paraense, of Pará, and a provisional concession of Jan. 27, 1905, granted to C. H. C. Moller by the municipality of Pará to construct or acquire and work tramways, railways, and electric lighting and power supply works and undertakings in Pará or elsewhere in Brazil, etc. Registered office: 75, Lombard-street, E.C.

Bombay Hydro-Electric Syndicate, Limited. — Capital, £15,000. Objects: to adopt an agreement between D. J. Tata and E. Miller on behalf of themselves, and also on behalf of R. J. Tata, J. W. Brown, and D. E Gostling, to produce, generate, accumulate, store, acquire, utilise, supply, apply, employ, distribute, sell, lease, or otherwise dispose of electric current, power, and energy, and to carry on the business of engineers or contractors in all its branches.

Liens Registered.

Kent Electric Power Syndicate, Limited—A mortgage or charge on the company's undertaking and property, present and future, including uncalled and unpaid capital (if any) dated July 3, 1905, to secure £750, has been registered. Holders: The Hon. J. B. Lubbock and G. C. Curtis, 15, Lombard-street, E.C.

Perth Electric Tramways, Limited, London, E.C. — Lien registered July 27, for £3,000 debentures, part of £50,000; amount previously issued, £36,000; charged on the tramways and tramway undertaking, plant, machinery, etc., in Perth, Western Australia.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Warrington. — Tenders are required for cables. Tenders by Aug 11.

Sophia.—The District Finance Commission require tenders for telegraph material by Aug. 25.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Turnu-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct coupled steam set.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Zaragoza. Tenders by Sept. 12.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Malago. Tenders by Aug. 19.

Madrid.—The Public Works Department require tenders for the construction and working of two electric tramways in Barcelona. Tenders by Aug. 18.

Brussels.—The Government Telegraph Department require tenders for 14,700 pine telegraph poles. Specification 76 may be obtained from their office at Brussels. Tenders by Aug. 9.

Acton.—The Urban District Council invite tenders from manufacturers for the supply of arc lamp carbons and house fuse-boxes for a period of 12 months. Tenders by Aug. 21. See advertisement.

Paris.—The Post and Telegraphs Department require tenders for tubes for telephone and telegraph cables. Specifications from the above office, First Bureaux, 103, Rue de Grenelle. Tenders by Aug. 7.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10 000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Dublin.—The Lighting Committee of the Corporation invite tenders for certain alterations and additions to the coal storing and conveying plant at their Pigeon House generating station. Tenders by Aug. 15. See advertisement.

Swansea.—The Corporation invite tenders for supply, delivery, and erection of one intercommunication switchboard section for central exchange, and apparatus for sub-exchanges at Morriston and Mumbles. Tenders by Aug. 11.

Calanas (Spain).—The Municipality require tenders for the installation and working for 10 years from Jan. 1, 1906, of the electric lighting of the town. Tenders by July 27 to the Alcalde of Calanas, province of Huelva, Spain.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Fulham.—The Council invite offers for a 300 kw. horizontal compound condensing slow-speed set with condenser complete, consisting of Musgrave engine fitted to a General Electric Co.'s alternator, speed 95 r.p.m. Offers to the Town Clerk by noon on Aug. 16.

Ebbw Vale (Mon.)—Tenders are invited for the following, for the Ebbw Vale Urban District Council: (Section A) cables; (B) overhead lines; (C) street lamps and fittings; (D) meters. Specifications, etc., may be obtained at the offices of the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders to the Clerk of the Ebbw Vale Urban District Council by 12 noon on Aug. 5.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23. See advertisement.

Madrid.—The Director-General of the Telegraph Department, Carretas 10, Madrid, invite tenders for the supply of 50 tons of galvanised iron wire, 4mm. in diameter, and 5 tons of bronze wire, 2 mm. in diameter. The maximum price at which tenders will be received is 1,570 pesetas (about £47) per ton for galvanised iron wire, and 3,450 pesetas (about £108) per ton for bronze wire. A deposit of 5 per cent. of the value of the goods at the upset price is required to qualify any tender. N.B.—It is notified from H.M. Embassy at Madrid that a foreigner, when entering into contracts for the performance of public works in Spain, must renounce by public act all rights to which he might be entitled by virtue of the law of his own country in so far as his contract is concerned, and accept any administrative decisions that may be issued respecting questions arising from that contract. In entering into such contracts a local agent is a practical necessity. Tenders by Aug. 19.

RESULTS OF TENDERS.

Bury.—The Corporation have accepted the tender of Triumph Stoker, Limited, of London and Leeds, for stokers for the electricity works.

Redditch.—The Urban District Council have accepted the tender of A. G. Avery, at £144. 10s., for the erection of a pump-house at the electricity works.

Bolton.—The Corporation have accepted the tender of Triumph Stoker, Limited, of London and Leeds, for two mechanical stokers for the electricity works.

Bath.—The Town Council have accepted the tender of Mr. C. Wibley, amounting to £227, for work necessary for the accommodation of the new storage battery.

Islington.—The Borough Council have accepted the tender of R. Cutting and Co., at £70, for the stopping of a crack in the chimney shaft of the new boiler-house at Elen-grove.

Gloucester.—The Electricity Supply Committee have recommended the Council to accept the quotation of Messrs. Crompton and Co., at £372. 15s. 6d., for extension of buildings and plant at the electricity works.

Cables, etc.—Messrs. Johnson and Phillips, Victoria Works, Old Charlton, Kent, have received the following contracts: hot wire ammeters and transformers for the County of London Electric Supply Co.; cables (concentric, for C.C. system) and flexible wires for one year for the Metropolitan Asylums Board; and 8 miles $^{7}/_{23}$ V.I.R. cable for the G.P.O. Telegraphs Department.

Islington.—The Electricity Committee have received the following tenders for the supply of steam turbo-generators:

Mather and Platt	£14,600	0	0
British Thomson-Houston Co. (Mirrless-Watson condenser)	10,064	0	0
Ditto (Worthington condenser)	9,682	0	0
Ditto (Allens condenser)	9,680	0	0
Bruce Peebles (Parsons turbine)	9,750	0	0
Ditto (Brush turbine)	8 811	0	0
Ditto (Richardson-Westgarth turbine)	8,170	0	0
Willans and Robinson (Bruce Peebles alternator)	9,078	0	0
Ditto (General Electric Co. alternator)	8,341	0	0
Ditto (Dick-Kerr alternator)	8 258	0	0
Brush Engineering Co.	8,477	0	0
British Westinghouse Co.	8,430	0	0
C. Parsons and Co.	8,405	0	0
General Electric Co. (Parsons turbine)	8 192	10	0
Ditto (Brush turbine)	7,445	0	0

The engine offered by Messrs. Willans and Robinson for a Willans-Parsons turbine coupled to a Dick-Kerr alternator, has been recommended for acceptance.

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London County Council.—The Bridges Committee have received the following tenders for the reconstruction of four bridges carrying the Albert Embankment road over certain dock entrances, and for the reconstruction of Mill Pond Bridge in Nine Elms lane in connection with the reconstruction of the tramways:

A. Fasey and Son*	£3 314	18	3
T. W. Pedrette	3,428	7	6
Muirhead, Grieg and Matthews	3,428	11	6
Cochrane and Sons	3 444	15	5
Pedrette and Co.	3 612	0	0
Butler and Co.	3 529	5	6
Baker and Co.	3 660	3	6
Kavanagh and Co.	3 695	8	9
Heenan and Froude	3,783	0	6
Westminster Construction Co.	4,227	10	9
Mowlem and Co.	4,537	0	0

The amount of the estimate of the cost of the work was £3 835. 2s. 6d.
*Recommended for acceptance with power to sublet the steelwork.

The Highways Committee have received the following tenders for the execution of the roadwork and platelaying in connection with the construction or reconstruction for the underground conduit system of electrical traction of the tramways:

R. W. Blackwell and Co., London	£96 202	4	6
Dick, Kerr, and Co., London*	96,242	3	7
J. Mowlem and Co., London	95 384	0	0
W. Griffiths and Co., London	97,091	1	5
J. G. White and Co., London	98,478	9	6
Muirhead, Greig, and Matthews, London	99 893	7	2
T. C. Starkey, Hull	262,271	3	2

Engineer's estimate, £98,736 5s. 6d.
*Recommended for acceptance on account of favourable conditions *re* time for completion.

The tender of J. G. White and Co. for the reconstruction of the tramways from North-street, Wandsworth, *viâ* York-road, Battersea Park road, etc., to Westminster Bridge, together with the lines in Lambeth-road and Falcon-road, at £163,874. 11s. 2d., is also recommended for acceptance, with power to sublet to Anderston Foundry Co. the manufacture of castings, Hadfield Steel Foundry Co. and Lorain Steel Co. the supply of special work, and Associated Portland Cement Manufacturers Co. the supply of cement.

The Highways Committee have received the following tenders for the supply, delivery, and erection of one 5-ton and one 2½ ton overhead travelling crane at the New Cross car-shed:

Carrick and Ritchie, Edinburgh	£859	0	0
H. Morris and Bastert, Loughborough	881	13	7
J. Hitchen and Son, Halifax	915	0	0
	980	0	0
	1,010	0	0
J. Booth and Bros., Ridley, Leeds	952	6	0
Jessop and Appleby Bros., Leicester*	1,009	0	0
T. Broadbent and Sons, Huddersfield	1,102	2	0
Leeds Engineering and Hydraulic Co.	1,128	17	0
C. and A. Musker (1901), Liverpool	1,134	4	0
Dawsbury Electric Manufacturing Co.	1,230	5	0
J. Spencer and Co., Hollinwood, Lancs	1 310	0	0
J. Musgrave and Sons, Bolton	1,498	0	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Chester.—The Corporation have decided upon ½d. stages for workmen.

Ipswich.—Half fares up to 8 a.m. and return tickets are to be introduced.

Halifax.—The local Trades and Labour Council is conducting a compaign in favour of ½d. fares for children.

Maidstone.—The Urban District Council have decided to invest £2 000 out of profits as a reserve fund in connection with the light railway.

Newcastle.—At a meeting of the Corporation on Wednesday it was decided, after some discussion, to set aside the sum of £9,000 as the nucleus of a depreciation fund.

Rotherham.—The Tramway Committee propose that in future the tramways centre be at the top of High-street instead of at College-square, and that an estimate of the cost of the additional lines be prepared.

Keighley.—The Corporation have referred back to committee a proposal that a charge of 1d. be made for "bulky parcels," a councillor expressing the opinion that confusion would ensue as to the definition of the term.

Belfast.—Although a considerable distance of track remains to be reconstructed, it is expected that the entire work will be completed next month. A deputation is to wait upon the Corporation in favour of ½d. fares.

Bournemouth.—After a lengthy discussion the Corporation decided against Sunday trams in the borough, although they already run over the Poole section. Even a suggestion for a half-day service did not meet with approval.

Damascus.—A combined electric lighting and tramway system is stated to be under serious consideration. The possibilities of this enterprise have been studied on the spot by a competent Belgian engineer, whose report is on the whole distinctly favourable.

Hastings.—The tramway service was inaugurated at 7.30 a.m. on Monday, a special car having previously made a satisfactory trial trip. On the first day 18 792 passengers were carried, the receipts amounting to £145, and on the subsequent days the traffic appeared to be, if anything, larger.

Falkland.—The Light Railway Commissioners have reported favourably upon a line three miles in extent for this district. The passenger traffic was estimated at 40 000 persons, and the goods traffic at 19,000 tons, exclusive of agricultural traffic. The cost was estimated at £18,500. The North British Railway Co. and a landowner opposed.

Croydon.—A start has been made with an extension of the tramway system which will bring it nearer to London. The line to South Norwood is to be carried through Anerley to two of the principal entrances of the Crystal Palace. On the completion of this work the system will extend from the Crystal Palace to West Croydon, and from Norbury to Purley, serving a very wide radius. A further extension to Mitcham is about to be commenced.

Derby.—The extension of the tramway service along the Duffield and Kedleston-road route was opened on Monday afternoon. A special car met Lieut.-Colonel Druitt, of the Board of Trade, at the Midland Railway Station. The car ran with the greatest of ease and comfort, and at 5.30 the first public car along the Irongate to the Kedleston-road made its initial journey, the vehicle being crowded. Six new cars are to be purchased at an estimated cost of £3,756.

Liverpool.—At Wednesday's meeting of the Corporation the following recommendation of the Tramways Committee was adopted: "That the sum of £75 000, being the cost of the purchase of the site of the new tramway offices, Hatton-garden, and the erection of the buildings thereon, be defrayed out of the reserve, renewal, and depreciation fund of the tramways undertaking for the present, and that the question of borrowing the amount under the sanction of the Board of Trade be postponed."

Southampton.—At the meeting of the Town Council a letter was read from the Bitterne Park and District Progressive Association appealing to the Council to apply for powers to continue the trams from Northam toll-gate to Bitterne Park terminus in order to complete the circular route. The matter was referred to the Tramways Committee. The manager recommends that in the reconstruction of the tramlines in Above Bar-street rock asphalt should be used instead of wood blocks on the score of durability and cheapness.

Accident.—Much excitement was caused at Ramsgate yesterday by the spectacle of an electric tramcar descending rapidly the Madeira-road, a sharp descent leading from the East Cliff to the harbour. The car in turning a corner left the rails, and then, knocking down a fence skirting the cliff toppled over and fell into a yard below, a distance of at least 40ft. The passengers were very few, and miraculously escaped serious injury, some of them jumping off the car. The driver went over the cliff with the car and was terribly hurt.—*Westminster Gazette.*

Parliamentary Bills.—The Lords' amendments have been considered and agreed to by the Commons in the case of the following Bills: Great Northern, Piccadilly, and Brompton Railway (No. 1) Bill; Shropshire, Worcestershire, and Staffordshire Electric Power Bill; Baker-street and Waterloo Railway Bill; Charing Cross, Euston, and Hampstead Railway Bill; Edgware and Hampstead Railway Bill; London and North-Western Railway Bill; Metropolitan Electric Tramways Bill; and the Dublin United Tramways Bill. The South Lancashire Tramways Bill has been read a third time in the Commons.

Wallasey.—The third annual report of the Council's tramways shows working expenses, £13,886. 11s. 2d.; receipts, £38,168. 3s. 5d. The passengers carried numbered 7,142,881, being an increase over the previous year of 569 952, representing an additional £2,903. The total number of miles run by all cars was 778,851, as compared with 757,688 for last year, an increase of 21,163, or 2·7 per cent. Twenty-six of the cars have had top covers fitted, and the remaining four are being similarly dealt with in accordance with resolution of the committee. The rolling-stock and general equipment of the undertaking have been maintained in good condition.

Dundee.—A *plébiscite* was expected to be taken yesterday on the question of Sunday running. The estimates for the current year make provision for an expenditure of £45,020, which is £384 in excess of the allocation for last year. The working expenses are stated at £27,800, some £79 over what was actually paid and £930 more than what was estimated for last year. The wages bill remains stationary. On the revenue side it is computed that the traffic receipts will total £44,350, which is £303 over what was actually earned during the year ending Whitsunday and £808 more than was estimated for last year. The estimates show a probable surplus on the year's working of £62, apparently without any allowance for Sunday running.

Lancashire and Yorkshire Railway.—The report for the half-year ended June 30 last states that the revenue account shows receipts from passengers, parcels, and mails £1,075 052, an increase of £22,110. Working expenses amounted to £1,523,193, an increase of £34,526. The net revenue balance available for distribution is £798,318, as compared with £760 394 in the corresponding half-year. The balance of net revenue account, after meeting the charge for interest on guaranteed and preference stocks, amounts to £319,351, which is available for dividend on the ordinary stock, and the directors recommend a dividend at the rate of 3½ per cent. per annum, carrying forward £20,504, as against 3 per cent. per annum for the corresponding period with a balance forward of £19,395.

Colchester.—The Corporation have adopted the following recommendation of the Tramway Committee: (1) To rescind its decision arrived on May 3 last relative to the price of such current supplied during the said eight months, and in respect of the supply for the financial year ending March 31, 1906; (2) to fix the price of current so supplied during the said eight months at 1½d. per unit; and (3) to

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direct that the question of price for the financial year ending March 31, 1906, be considered by the joint committees previously to the completion of the next annual accounts of the electric light and power department, the tramways department in the meantime to pay on account for current at the same rate—viz., 1½d. per unit—the peyment to be subject to any needful adjustment after conference.

East Ham.—The Tramways Committee have reported that they had considered a letter from the Barking Council stating that they were prepared to grant a lease of their tramway track from the eastern boundary of the borough to Ripple-road for seven years, subject to the same being cancelled in the event of any extension being made. The committee recommended that the following clause be inserted in the agreement: "That the lease shall be for a fixed period of seven years, and that if in the meantime the portion of the proposed tramway track between Ripple-road and Fanshawe-avenue is constructed, the Corporation should be allowed to run over this length also, upon terms to be agreed, and that, failing agreement, the matter to be referred to arbitration." The Corporation have confirmed this.

Aberdare.—A special meeting of the Urban District Council was held last week to consider the report of the Parliamentary Committee and to receive the bill of costs for the promotion of the Tramway Bill. At the last ordinary meeting strong objections were taken to certain items in the bill. After some discussion, the report of the Parliamentary Committee was read, and sums amounting to £314 7s. for witnesses, £500 for counsel fees, £280 for engineers, and £224. 18s. out-of-pocket expenses to the surveyor, were recommended for payment, together with a sum of 200 guineas as a gratuity to the surveyor for extra work. The chairman of the Parliamentary Committee recommended the adoption of the report. Ultimately, the voting resulted in a tie, the chairman giving his casting vote in favour of the report.

Proposed Light Railway.—An inquiry has been held by the Light Railway Commissioners into the application of the Ryhope, Murton, and Hetton Syndicate for a provisional order authorising the construction of a light railway between Ryhope, Seaham, Murton, and South Hetton, joining the Sunderland and District Tramways Co.'s system at Ryhope and South Hetton. The original scheme was slightly altered, in that, owing to opposition on the part of the North-Eastern Railway Co. and the Marquess of Londonderry, that portion of the system between Ryhope and Seaham Harbour has been dropped. All the local bodies were in favour of the scheme. Colonel Boughey, the chairman of the Commissioners, said the evidence showed a considerable population round Hetton, Easington Lane, Murton, and Haswell which required access to Seaham.

Signalling.—The British Miller Signal Syndicate calls attention in a letter to the various railways to the Liverpool Southport disaster as another proof that the railway signalling system in this country is sadly defective. The letter states: "We have again and again called your attention to the wisdom—may we not say the necessity—of repeating the signal to the engine-driver in the cab of his locomotive where he can always see it. Further, and with special reference to Thursday's accident, the Miller system of signalling intimates to the driver, automatically, if the line ahead is blocked by another train, so that the signalman's mistake is promptly checked by the warning red light full on the driver's eye within the cab of the locomotive. The Belgians are busy installing this life and property saving system, the Americans are extending it, the French are examining it. Has not the time come for England?"

North-East London Railway.—A committee of the House of Lords, presided over by Lord Ludlow, commenced on Wednesday the consideration of the North-East London Railway Bill, which has passed the House of Commons. The Bill is opposed by the Great Eastern Railway Co. and by the trustees of the late Mr. E. Jones in respect of property in the City. The London County Council and the promoters of the Hammersmith, City, and North-East Suburban Railway, who opposed the Bill in the House of Commons, presented petitions "against alterations." The Bill proposes to incorporate a company, with a capital of four millions sterling, for the purpose of constructing an electric railway, partly underground, from the Monument to Waltham Abbey. Mr. Balfour Browne, K.C., having opened the case for the promoters, Mr. Courtenay Warner, M.P., repeated the evidence he gave in favour of the Bill before the House of Commons Committee, and the further consideration of the Bill was adjourned.

London United Tramways.—A complaint was made at a meeting of the Kingston Town Council as to the company's delay in completing the construction of lines. The Chairman of the Highways Committee replied that he did not think the position warranted the Council in taking legal proceedings at present. The Highways Committee recommended that the plan submitted by the company for the widening in Eden-street be approved, and that the plan for a double line of rails instead of a single line at the corner of Surbiton-crescent be approved, subject to the company making the necessary widening at the corner property. This was agreed to. The employés of the company held their annual sports at Brentford last Saturday, when several of the competitors distinguished themselves in the various events. Sir Clifton and Lady Robinson attended during the afternoon, and met with an enthusiastic reception. The Highways Committee of the London County Council recommend that the Council agree to the company's proposal for an alternative route of mains from Chelsea to Kingston, the idea being to select less busy thoroughfares.

Beckenham.—The draft agreement with the British Electric Traction Co. for the cancellation of the tramway agreement was submitted to a committee of the Urban District Council, and with the exception of some verbal alterations, which the committee recommend should be left to the solicitor to settle, the draft was approved and is recommended to the Council for acceptance. Points not previously agreed by the parties, but now included in the agreement, are as follows: (1) As to the costs of the Bill. Towards these costs the traction company agree to pay £4,000 by ten annual instalments, with interest. (2) Current for Penge tramways. The company do not propose to carry out the whole of the tramways authorised by the Croydon and District Electric Tramways Act, 1902, but they undertake that Beckenham shall supply the whole of the current for such tramways as they do construct, and guarantee a minimum consumption of 240,000 units per annum. (3) Term of contract for the supply of current for tramways. The company offer a contract for seven years at least, the price, etc., to be revised every five years.

Electric Tramway Concessions.—The *Gaceta de Madrid* contains a notice inviting tenders, which will be opened at noon on Sept. 20 at the Directorate General of Public Works, Madrid, for the concession of an electric tramway in Zaragoza. An application for this concession has already been made by the Zaragoza Tramways Co., who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on the reduction of the tariffs proposed, and if two or more identical propositions are made, a further competition will take place verbally as to what reduction (if any) of the period (60 years) of the concession tenderers may be prepared to accept. A deposit of £14 is required to qualify any tender. The same issue of the *Gaceta* announces that an application, accompanied by a plan and guarantee, has been received at the Directorate-General of Public Works, Madrid, from the Malaga Tramways Co. for a concession for an electric tramway in Malaga. One month from the date of the publication of this announcement in the *Gaceta* (July 17) is allowed for the presentation of applications, accompanied by their corresponding plans and guarantees, upon terms more favourable to the Government.

Glasgow.—The report for the year ending May 31 states that the income amounted to £764,790. 16s. 8d., and the working expenses to £387,167. 9s. 2d., leaving a gross balance of £377,623. 7s. 6d. The income of the previous year was £723,190. 11s. 7d., and the working expenses £355 919. 5s. 5d., leaving a gross balance of £367,271. 6s. 2d. This year's gross balance thus shows an increase of £10,352. 1s. 4d. The gross balance of £377,623. 7s. 6d. has been applied in meeting rental of Govan and Ibrox tramways, payment to Paisley District Tramways Co., interest on capital, sinking fund, income tax, depreciation and permanent-way renewals, parliamentary expenses, and annual payment to the common good, these payments amounting in all to £287,437. 19s. The net balance remaining amounts to £93,298. 13s. 6d., of which £68,500 has been applied in meeting special depreciation on buildings, ducts, cables, overhead equipment, and power station and sub-stations plant, the balance of £24,798. 13s. 6d. being added to general reserve fund. It is pointed out that, although the gross revenue for the past year shows an increase of £41,600. 5s. 1d. over that of the previous year, the average traffic revenue per car mile has decreased from 10·58d. to 10·12d. This decrease is chiefly due to the augmented service of cars which is now given on all routes. Allowances are made for depreciation and renewals under a number of heads.

Birkenhead.—Mr. W. Wyld, general manager of the Corporation tramways department, states in his fourth annual report that although the income showed a decrease on the previous year of £1,047. 15s. 8d., and they had also had to meet an increased expenditure of £757 on interest and sinking fund account, yet they were, by reason of the saving effected in operating expenses, able to show a larger net profit on the year's working than last year. As the year progressed it was seen that the receipts were much below expectations on account of industrial depression, and it was realised that a surplus on the year's working could only be shown by exercising the most rigid economy in regard to operating expenses. There was a saving in the traffic and management expenses of £1,546. 1s. 10d., and a saving in cost of generation of electrical power and upkeep of overhead line work of £971. 13s. 2d., making a total decrease on those two items of £2,517. 15s.; but the expenditure on repairs and upkeep of permanent way continued to increase, showing an increase for last year of £617. 9s. 3d., bringing down the total saving in costs for the year to £1,900. 5s. 9d. That the decrease in receipts was without doubt due almost entirely to the bad condition of trade was shown by the fact that there was a decrease on the year of £925. 13s. 10d. for traffic along the docks route. That was more than the total decrease in the traffic receipts on the whole system. The total income amounted to £55,025, against £56,073 last year. The New Ferry route showed a decrease in profit of £690, this being due to the increased mileage it had been necessary to run. From July, 1904, to March, 1905, 26,000 1d. and 6,000 ½d. prepaid tickets had been disposed of, representing an income of £120. 16s. 8d.

Electrification in the States.—The New York *Times* states that contracts for electrical power recently let by the New York Central Railway suggest that the Vanderbilt syndicate is preparing the way for the development of electric lines along its system. The amount of electric power already contracted for suggests the possibility that something more is in contemplation than the operation by electricity of tributary lines. Among the contracts that the New York Central has already entered into for electrical power is one with the Ontario Power Co. for all the electrical power that the New York Central requires for the operation of its traction lines from Syracuse west to Buffalo. Another contract has been made with the Hudson River Electric Power Co., under which 4,500 h.p. is now being delivered to the Central lines in Utica, and which in its entirety calls for the increase of this power up to 25,000 h.p. as it may be needed. Plans are now under way for the electrification of the main line of the West Shore Road between Utica and Syracuse, and while this is directly connected with the development of the auxiliary trolley system, it appears to open the way to a still wider application of electrical power to the operation of parts of the Central system. The company's own

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power house at Yonkers, under construction in connection with the terminal improvements now in progress at the Grand Central Station and northward, will probably be the nucleus of the first stage of the main line's electrification, and other sections are likely to follow. The general indications suggest, in fact, that the electrification of main lines is not such an impracticable step as was supposed until lately. In pursuance of its plan for the extension of auxiliary electric traction lines the New York Central management some time since created a special department for the direction of these lines. William K. Vanderbilt, jun., is now in charge of this department.

Railway Companies and Motor Omnibuses.—Lord Kintore's Select Committee of the House of Lords last week considered the North-Eastern Railway Bill, one of the principal objects of which is to authorise the company "to provide, own, work, and use in any district or to or from any place situate upon railways owned or worked by the company, not including railways over which the company have running powers, omnibuses, coaches, cars, and other road vehicles to be drawn or moved by animal, electrical, or any mechanical power" for the conveyance of passengers, luggage, parcels, merchandise, and goods. A committee of the House of Commons sanctioned the clause embodying this proposal, but imposed upon it modifications providing that the local authority might from time to time prescribe the route to be taken by these omnibuses between the points of arrival and departure, and prohibiting the running of any such omnibus "otherwise than to or from a station or hotel of the company, without the consent in writing of the local authority," with an appeal to the Board of Trade if the company considered themselves aggrieved by any decision or refusal of consent of a local authority. It was in this amended form that the company asked the Lords' Committee to sanction the clause. Sir George Gibb, general manager of the North-Eastern Railway, gave evidence in support of the clause, and stated that there was a considerable public demand for the service proposed to be rendered by means of motor omnibuses. Mr. Lloyd, addressing the committee on behalf of both the opposing corporations, admitted that there were many districts in which it might be, and probably would be, a great convenience to the public for railway companies to run a service of motor omnibuses, but contended that, in the special circumstances of Newcastle and Hull, there was no necessity whatever for including them within the purview of the clause. Evidence having been called in support of this view, the committee passed the clause. The Bill was subsequently ordered to be reported to the House for third reading.

Edinburgh and Dalkeith.—An inquiry was held last week into the provisional order asked by the Edinburgh Suburban Electric Tramways for a system between Edinburgh, from Liberton, and Dalkeith and Bonnyrigg. Mr. Wilson, K.C., in stating the case for the promoters, said the scheme was one urgently demanded by the neighbourhood, and it was looked upon with favour by all the local authorities interested. The district was an admirable situation for fening, there was a good supply of water, and the inhabitants with one voice were asking for the scheme. The line would commence from Liberton and go to Eskbank, where it would branch off to Dalkeith and Newtongrange, and in the other direction to Bonnyrigg and Broomieknowe to the borders of Lasswade. There was no real opposition, with one exception. The usual opposition was being offered by the railway company, but the Mid-Lothian County Council, Dalkeith Burgh, and Bonnyrigg were all in favour of the scheme. The promoters had entered into agreements with Dalkeith and Bonnyrigg to provide workmen's cars in the morning. The total length of the line would be practically seven miles, and, at a moderate estimate, the population served would be 39,800, while passengers would be able to travel much more cheaply than by rail. The gross receipts for the first year were estimated at £14,514, and the working expenses £10,160, leaving a surplus of £4,354. The capital of the company would be £25,000. The promoters asked for power to carry goods, subject to the consent of the local authorities. After hearing evidence, the preamble was held to be proven. The following day clauses were adjusted. Opposition was offered by the North British Railway Company and Colonel Gilmour to the clause authorising the carriage of animals, goods, and minerals on the tramway. It was argued by Mr. Cooper, K.C., for the former, that such powers were never granted in Scotland, the only exception being that of the Wemyss tramway, the circumstances of which were peculiar. He suggested that the authority should be limited to parcels of 56lb. Mr. Stephen Sellon, C.E., London, spoke of the practice in England and on the Continent and in America, where the carriage of parcels had proved an immense advantage. The Commissioners intimated that they granted the full powers sought in the matter of goods. Certain protective clauses were adjusted, and words were added leaving the promoters liberty to apply for an electric lighting order at a future date.

London County Council.—At the meeting of the County Council on Tuesday the tramways accounts for the year ended March 31 last were subjected to some criticism by Mr. Gaskell, who complained that there was a great deal of dead capital. Meeting these criticisms, Mr. J. Allen Baker, M.P., chairman of the Highways Committee, said that during the period in which the lines in the South of London had been operated by the Council £208,000 had been paid out of revenue in reduction of capital. He contended that the accounts were on a sound financial basis. The Council agreed to a capital expenditure of £59,394 in respect of the equipment of the tramways from the Strand to Theobald's-road and the Highways Committee was authorised to make arrangements with the North Metropolitan Tramways Co. for the electric working as a through route of the subway tramways and the tramways between Theobald's-road and Islington. The Parliamentary Committee, reporting upon the rejection of the Council's Tramways Bill by the House of Lords, spoke of the "high-handed policy of the House of Lords," and expressed the opinion that "there is great reason for the public to resent the action of a majority of the Upper House in using parliamentary powers which should only be exercised for the benefit of the public, to support individual views and interests." The report was approved, and it was decided to revive the proposals included in the Bill in the next session of Parliament, and to invite the City Corporation to introduce a Bill for the widening of Blackfriars Bridge or the construction of a new bridge. After the summer vacation the Highways Committee will submit plans for new tramways costing £414,160, and involving a further sum of £209,034 in widening streets. The largest item in these proposals is the sum of £190,200 for a line from the Marble Arch to Cricklewood. The Highways Committee propose that the car-shed at Wandsworth be reconstructed at a cost of £36,810, the work to be executed by the Council. It has been decided that the eyesight of all motormen shall be tested so as to minimise risk of accidents. Out of 340 men, 40 were found to have defective sight, but other employment has been found for them. The committee recommended that an agreement be entered into with the County of London Electric Supply Co. for a temporary supply of power at 1d. per unit to operate the tramway subway and the route between the Strand and Islington, the Council undertaking to take at least 500,000 units per annum. It is proposed to expend £12,000 upon single-deck cars for the line from the Strand to Islington.

LIGHTING AND GENERAL.

Long Eaton.—The Urban District Council are raising £3,500 for works of electric lighting.

Cannock.—The Council's application to borrow £13,000 for electric lighting purposes has been granted.

Sales of Land, etc.—Particulars of various sales of land and business sites appear in another column.

Greenock.—The Electricity Department's financial statement for the year ended June 30 last shows a surplus of £1,600.

Poplar.—On Saturday last the employés of the Poplar electricity works took their outing by brake to the Red Lion Hotel, St. Margaret's.

Kingston.—The Lighting Committee have taken active measures to oppose the Administrative County of London and District Electric Power Co.'s Bill.

Grimsby.—The Electric Lighting Committee have handed the Council £890, profits of the electricity undertaking for the year, for the relief of the rates.

Stafford.—An increase of 63 per cent. in the output of electricity compared with corresponding period last year was reported at the last Town Council meeting.

Dunstable.—The National Provincial Electricity Corporation intend to apply for a provisional order to empower them to supply electricity for all purposes within the borough.

Aberdeen.—During the month of July there were generated at the electricity works 291,459 units, as compared with 290,722 in the corresponding period of the previous year.

Wellingborough.—A proposal made by the County of Northampton Electric Power Co. with respect to lighting and destructor has been referred to Mr. Bakewell for his observations and advice.

Court of Common Council.—At the last meeting of the Corporation a letter from the City of London Electric Lighting Co. (which we publish in another column) was read and referred to the Streets Committee.

Cardiff.—The National Telephone Co. have installed instruments for call office purposes in a number of Corporation cab shelters. A fee of 2½. is charged for all communication to subscribers connected to the Barry exchange.

Stirling.—The Water Commissioners have agreed to purchase from a Newcastle firm, at a cost of £500, an engine and electric motor for the purpose of pumping into the mains the water from St. Ninians Well in the Craigs.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the five weeks ending June 30, 1905, were 550,733, compared with 383,457 in the corresponding five weeks of the previous year.

New Issues.—The Urban Electric Supply Co. are issuing 20,000 5 per cent. cumulative preference shares of £5 each at par, and the Buenos Ayres Port and City Tramways are issuing £200,000 6 per cent. first debenture stock.

Watford.—The Uxbridge and District Electric Supply Co. intend to apply for a provisional order for the supply of electricity within the Rickmansworth rural district. The Rural District Council have declined to give their consent.

Brighton.—The Lighting Committee have decided to recommend the Town Council to apply for sanction to borrow £38,500 for works in connection with the electricity undertaking. The extension of the telephone system to Burgess Hill has been put in hand.

Kensington.—A notice from the Notting Hill Electric Lighting Co. relative to a proposed extension of their mains in Campden-hill-square, as well as applications of the General Post Office to lay pipes for telephone wires, has been agreed to under the usual conditions.

Sunderland.—The estimates of the Electricity and Lighting Committee for the half year ending March 31, 1906, are as follows: expenditure for electric lighting, £13,782; gross revenue, £29,439; as against £13,033 and £26,671 respectively in the corresponding half-year.

Metropolitan Electric Supply Bill.—The Metropolitan Electric Supply Co.'s (Various Powers) Bill has passed the Select Committee. Protective clauses have been inserted to guard against the company obtaining powers which they had transferred to the St. Marylebone Borough Council.

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Lancaster.—It is proposed to reduce the price for lighting current from 5d. to 4½d. per unit, subject to the usual discount of 5 per cent. allowed by the Corporation on payment of accounts within 28 days from the date of delivery thereof, the reduction to take place after June meter readings.

Torquay.—Application is to be made for a loan of £8,500 for the electricity scheme, which includes the extension of the generating station referred to in our last issue. The borough electrical engineer (Mr. P. Storey) and the engineer of the Dolter Co. (Mr. E. A. Mitchell, M.I.E.E.) are conferring as to details.

Wimborne.—The Rural District Council have consented to an application of the Bournemouth and Poole Electricity Supply Company to erect standards on the sides of the roads, for overhead wires, in this Council's area, over which they are obtaining powers to supply in their Wimborne and district electric lighting order.

Swindon.—It has been resolved to extend the electric mains as far as the entrance to the isolation hospital at Gorse Hill. The last monthly report of the electrical engineer shows that the number of consumers connected on the 15th ult. was 354, as compared with 208 a year ago. The number of street lamps converted to date was 187, as against 138 a year ago.

Maidenhead.—Approximately, 2,000 units have been sold in the Maidenhead Court extension, which has only been supplied during a part of the quarter. It is a hopeful sign that for several weeks now there has been a considerable day load, and during the present week it has been necessary to run throughout the day. It is expected to secure several power users.

South Shields.—The Electrical Committee propose to rescind the present uniform charge of 2d. per unit for current for heating and lighting purposes and to adopt the following scale of charges for current for power purposes—namely: where the consumption does not exceed 150 units per quarter per each horse-power installed, 1½d. per unit; over 150 and less than 300 units, 1¼d.; over 300 units, 1d.

Faversham.—The accounts of the municipal electric lighting undertaking for the period from June 9, 1904—when the works were opened—up to March 31 last have just been published. The sum borrowed is £18,400, of which £15,771 has been expended. The revenue account shows receipts £862, and includes £532 put down for public lighting. Expenditure totalled £623, leaving a gross profit of £230.

Maidstone.—The accounts of the Urban District Council's electricity department show that at the end of three years' working there is a balance of £466 to the good after the payment of all charges, including principal and interest. The business is steadily increasing. The Council expect in the near future to do the pumping at the sewage works by electricity instead of steam. A reserve fund of £2,000 is to be created.

Railway Directory.—We have received from the Directory Publishing Co., 3, Ludgate-circus-buildings, London, the current issue of the "Universal Directory of Railway Officials," compiled from official sources under the direction of S. Richardson Blundstone. This work, which is published at a price of 7s. 6d. to subscribers and of 10s. after publication, covers the whole globe, and increases year by year in size and in usefulness.

Ripon.—At the last meeting of the City Council a letter was read from the Non-County Borough Association in London regarding the intention of the National Telephone Co. to apply to Parliament for certain powers, among them being the pulling up of the streets for the purpose of laying their wires without first obtaining the consent of the local authorities. The Council agreed to assist other councils by asking the member of Parliament for the division to oppose Clause 9 (5A) in the company's Bill in Parliament.

Derby.—The Electric Lighting Committee have decided to ask the members of Parliament for Derby to oppose the County of London and District Electric Power Bill and the Metropolitan Electric Supply (Various Powers) Bill, now before Parliament, as, in the opinion of the committee, these Bills contain proposals calculated to form precedents fraught with danger to the interests of local authorities throughout the country. The Town Council have granted the sum of £256 for wiring the market hall, butter market, and entrances for electric lighting purposes.

London Gazette.—The partnership between James Carter and John Horsfall, electrical engineers, 33, Manchester-road, Nelson, and motor and mechanical engineers at Holly Bank, Brierfield, Lancaster, has been dissolved by mutual consent. A receiving order has been made out on debtors' petition in the estate of John Weston Martin and John Primmer Poor, jun., electricians, 154, New-road, Buckland, Hants. A second and final dividend of 1s. 4d. in the £ has been declared in the estate of Charles Aubrey Smith, electrician, 23, King-street, Regent-street, London.

Bath.—The electricity department shows a net loss on the year's working of £131, but there has been paid during the current year £289 more in rates and taxes, £722 more to the sinking fund, and extra interest £1,052. The undertaking is making steady progress. From March to June last year 246,091 units were generated, but only 90,641 were sold. During the corresponding period this year 221,498 units were generated and 94,184 sold, showing that the department was losing very considerably less in distribution owing to the introduction of the continuous-current system.

"Wireless" Telegraphy on Railways.—The London, Brighton, and South Coast Railway Company have obtained a license to install a Rochefort wireless telegraphic service at Newhaven to communicate with their steamers and the French Western Railway Company's station at Dieppe. The Midland Railway Company have received sanction to institute a wireless telegraph service, worked on the Lodge-Muirhead principle, at Spondon, near Derby, to communicate with a movable railway van within a radius of 10 miles. This company have also applied to the Postmaster-General for permission to use wireless telegraphy between their new port, Heysham, and their steamers to Ireland and the Isle of Man.

Redditch.—The electricity works manager reported at the last District Council meeting that, compared with the previous 12 months, the progress made by the electric supply undertaking in the past 15 months had been very satisfactory. On Jan. 1, 1904, the total number of consumers was 236. On March 31, 1905, the number was 333. On Jan. 1, 1904, the total lamp connection in 8-c.p. lamps was 15,844; on March 31, 1905, it was 23,345. The gross profit on the 15 months' working was £783, an increase of £323 over that obtained in 1903, and equal to a dividend of 2½ per cent. on the capital expended at the beginning of 1904. The analysis of the works costs showed that in the past 15 months the total cost per unit had been reduced from 2·07d. to 1·67d.

Institution.—The *Journal* of the Institution of Electrical Engineers, Part 174, edited by G. C. Lloyd, secretary (Messrs. E. and F. N. Spon, Limited, 57, Haymarket, S.W.), contains "Stand-by Charges and Motor Load Development," with discussion (Birmingham Local Section) by A. M. Taylor; "Telephone Traffic," with discussion, by H. L. Webb; "Wireless Telegraphy Measurements," with discussion, by W. Duddell and J. E. Taylor; "Low-Tension Thermal Cut-Outs," with discussion (Manchester Local Section), by A. Schwartz and W. H. N. James; "Notes on Heating and Sparking Limits in Variable-Speed Motors," with discussion (Birmingham Local Section), by A. H. Bate; and "Commutation in a Four-Pole Motor," with discussion (Birmingham Local Section), by J. K. Catterson-Smith.

Stock Exchange.—The Stock Exchange Committee have appointed Aug. 15 special settling day for the Hastings and District Electric Tramways Co.'s £125 000 4½ per cent. debenture stock. The committee have also ordered the said securities and the Sunderland District Electric Tramways £160 000 5 per cent. first mortgage debentures of £100 each, Nos. 1 to 1,600, to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Babcock and Wilcox's further issue of 270,000 ordinary shares of £1 each, Nos. 530,001 to 800,000. The committee have also been asked to appoint a special settling day in the Metropolitan Electric Tramways Co.'s 182,181 ordinary shares of £1 each, fully paid, Nos. 1 to 40,785 and 249 912 to 391,337; and to allow the Havana Electric Railway Co.'s 6,975 000dol. consolidated mortgage 5 per cent. 50-year coupon bonds of 1952 for 1,000 dol. each, Nos. 1 to 6,975, to be quoted in the official list.

Aston.—At the last Town Council meeting a statement was made as to the financial result of the working of the electricity undertaking for 18 months. The revenue account for the six months ended March 31, 1904, showed an adverse balance of £4,151, and the account for the 12 months ended March 31, 1905, showed a loss of £4,122. The latter account include £920 written off for depreciation of plant. The loss shown on last year's account was almost entirely incurred in the six months ended September, 1904. A comparison of the figures for the half-year ended March, 1904, and March, 1905, is most encouraging. Whilst the expenditure for the two periods in question remained practically equal the income increased from £1,680 to £6,050. The additional income was produced chiefly by the traction supply. The arc lamps cost £510 per year, and of this only £180 per year was refunded by the Public Works Committee, this involving a loss of £330. In the three months ended June 30, 1904, the Council sold for lighting purposes 25,654 units as against 49 991 in the same three months of this year, for power purposes 29,657 units against 55 575 units, and for traction purposes 85 510 units as against 215 920. In March of 1904 the number of 8-c.p. lamps connected was 11,952, which had gradually risen to 22,443 in June of this year. The total cost per kilowatt installed was £62.

Long Firm Frauds.—The *Daily Chronicle*, in an article on the recent frauds perpetrated on electrical firms, says £40,000 is the sum that is mentioned in connection with what are alleged to be a most ingenious series of frauds that have been perpetrated on a number of electrical firms in the City. The following police notice circulated amongst jewellers and pawnbrokers supplies a key to the nature of the case: "Wanted, —— ——, 35 to 39; 5ft. 8 or 9; hair dark; moustache untrained. Rather long, angular face; swinging gait; slightly stooped. Two false teeth in front of upper jaw; plausible. For fraud." Then follows a list of notes which the "wanted" man is alleged to have in his possession. In order to carry their scheme into execution, the chief actor in the drama and his confederates adopted a *modus operandi* that was ingenious and amazingly daring. Taking premises in the City, they gave themselves a trade name, furnished their offices with all the sumptuousness of prosperity, and held themselves out as suppliers of all kinds of electrical fittings. With his hook thus baited, the moving spirit of the gang, faultlessly attired, would drive up to the warehouses of large electrical firms, saunter into the office, and place an almost impossible order, on account of its large size, for, say, lamps, mentioning just as impossible a time in which it was to be completed. The result was always the same. He would be informed that the order could not be executed. His next move was to suddenly remember that "his own establishment could easily turn out the lamps," and go out, leaving the individual whom he had seen impressed with its wonderful capacity. In this way the men managed to "rope in" a number of orders, along with large sums of money in notes and cheques, which, it is asserted, were exchanged for gold at the earliest opportunity. In a few weeks orders had come in to the tune of £40,000. Inquiries for orders were disposed of by means of all sorts of trade excuses, until several days ago one client, more enterprising than the rest, paid the wonderful electrical engineers a visit, and found that they had gone away. It was found that no fewer than 20 odd houses had suffered, some of them the largest in the trade. About 14 have decided to combine in a joint prosecution. The others have left the matter to run the ordinary course.

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St. Pancras.—The gross revenue of the municipal electric undertaking during the year ended March 31 last amounted to £68,459, a decrease of £7,652 compared with the previous year. The decrease is attributed to reductions in the charge for current. There is a net profit on the year's working of £13,098. Of this it is proposed to devote £3,000 to the relief of the rates of the borough, £10,000 being added to the electricity reserve fund.

Eastbourne.—Mr. J. K. Brydges, the electrical engineer, has issued his annual report. Last year £750 went to the relief of the rates, and this year £725, or an equivalent of a ½d. rate. The number of consumers has increased from 794 in 1902-3 to 977, while the units sold have been advanced from 669,132 to 947,671. A sum of £2 000 has been placed to the depreciation fund as compared with £1,000 in each of the previous two years. The cost of working has also been reduced, the total cost per unit sold being 1·951d., as against 3·57d. when the Corporation acquired the undertaking.

Buxton.—The following estimates are under consideration: gas-engine, dynamos, and foundations, £900; 1,200 yards ·25 feeder, £520; 1,500 yards distributor, £525; 60 meters at £2. 7s. 6d. each, £142. 10s.; 60 demand indicators at £1. 11s. 6d. each, £94. 10s.; 60 consumers' fuse boxes at 13s. 6d. each, £40. 10s.; 900 yards ·035 service cables at 2s. 6d. per yard, £112. 10s.; 900 yards ·022 service cable at 2s. per yard, £90; 60 service boxes and fittings at 21s. each, £63; contingencies, buildings etc., £512; capital account overspent March 31, 1905 (998), say, £1,000—total, £4 000. A resolution to oppose clauses of the telephone agreement has been passed.

Islington.—The Borough Council have now decided that the present rates for the supply of electricity for power, heating, and cooking purposes be altered from 2d, 1½d., and 1¼d. to a uniform rate of 1d. per unit, subject to the consumer entering into an agreement with the Council to take such supply for a period of not less than three years, and that the existing time limit be abolished. The Council will to-night consider a report from the Lighting Committee as to price proposed to be charged to consumers of current of not less than 200,000 units per annum; recommending an expenditure of £2,000 in order to afford the supply of electricity required at the new post office buildings in Upper-street, estimated to be 250,000 units for lighting and 85,000 units for power per annum.

Holidays.—The New Palace Steamers Limited announce that their only alterations in sailings for Bank Holiday will be that the "Koh-i-noor" will leave Old Swan Pier (London Bridge) on Saturday, Aug. 5, at 8 a.m., for Margate, and on Sunday, Aug. 6, at 8.30 a.m., and on Monday, Aug. 7, at 8 a.m., for Southend, Margate, Ramsgate, Deal, and Dover, so as to relieve the likely large numbers on the "Royal Sovereign." The Husbands' Boat will be run on Saturday, Aug. 5, as usual. There will also be an additional sailing by the "Koh-i-noor" on Tuesday, the 8th, leaving Tilbury at 9.30 a.m., special train from Fenchurch-street at 8.27 a.m., St. Pancras at 8 a.m., for Southend and Margate, and intending passengers who wish to have further particulars are requested to write to the office of the company, 50, King William-street, E.C., where their communications will then be promptly attended to.

Beckenham.—The Electric Lighting and Tramway Committee in their last report on the arbitration proceedings with regard to the Crystal Palace district, stated that on the order of the arbitrator the claimants have now sent in a claim under three heads—mains and works at present existing in the district, £6,399; ditto formerly existing but now removed, £725; ditto situated outside the area but which the company claim have been necessarily provided for the service of the Crystal Palace district, £1,638—total, £8,762. The lengths and descriptions of mains and works in the district have been agreed between the engineers of the respective parties, and the officers of the Council have met the company's representatives to examine vouchers, but no separate account as required by the provisional order has been kept, and no vouchers appear to exist. The matter is expected to be before the arbitrator again before the vacation. The accounts of the electric lighting and dust-destructor undertakings for the year 1904-5 show a net loss to the contractors of £426 on the combined undertakings, but a profit of £364 in respect of the electric lighting undertaking.

Dundee.—A sub-committee is considering a report of the electrical engineer on the chance of cultivating a good shipyard load. The engineer says that he has been trying to negotiate with Messrs. Gourlay Bros. and Co., and had made them an offer based on the system of charging now extant for power in Dundee of 1·2d. per unit. They in their turn had offered to give the Council the whole of their power in the whole of their shipyard if not charged more than 1d. per unit, for an experiment for one year, after which time they would be willing to consider the revision of the rate should it not prove satisfactory. The engineer says it will depend entirely upon how far this class of business is developed whether it will pay at that price or not. In a big business of this sort in different shipyards, the maximum demand would be fairly low compared with other forms of load, such as the tramways, and the consumption of units in proportion would be much larger. On this ground there would be a chance of it paying. On the other hand, if they did supply about £1,000 worth of current for one year to Messrs. Gourlay, the loss on this for one year would not amount to a great deal, and would be undoubtedly valuable as an experiment.

Southwark.—The annual accounts of the electric light undertaking for the year ended March 31, 1905, show an ordinary income, after deducting £517 for discounts and allowances and £40 for bad debts, of £12,342, which is an increase of £141 on that of the previous year. To this is to be added £53 for pupil's premium and £17 for commission on sale of motors, bringing the total income for the year up to £12,413. The total working expenses amount to £7,576, being an increase of £297 on last year's expenditure. The gross profit on the year's working is £4,836, being less than that of the preceding year by £114. A special item of £235 has been placed to the credit of net revenue account this year, being the amount retained on settlement of the income tax assessment with the surveyor of taxes, making the total profit for the year £5,132. Against this profit has been charged £2,473 for interest on loans and overdraft, £2,197 for repayment of capital, and £79 instalment of the capital expenditure in excess of borrowing powers at the close of last year. The net profit for the year is, therefore, £382, which together with the balance standing to the credit of net revenue account at March 31, 1904—viz., £224—has been transferred to a reserve account in accordance with the Council's resolution of March 1, 1905.

Manchester.—The annual visit of the Electricity Committee to the generating stations took place on Thursday last week, when a statement was made by Mr. Alderman Bowes chairman of the Street Mains Sub-Committee, who said that there were now nearly 300 miles of main conductors laid in the town, exclusive of services, and that the present area of supply was 20 square miles, the total authorised area being 44 square miles. The sales of current during the year ended March last were as follows: for tramway purposes, nearly 19 million units; for lighting purposes, nearly 10 million units; for power purposes, nearly 4¾ million units; and for public lamps, 81,000 units—the total sales exceeding 33½ million units for the year. The committee had concluded an agreement with the Gorton District Council to take over the lighting of certain streets in Gorton. They would displace about 80 gas lamps, and put up in their stead 45 arc lamps, each of 400 c.p. The cost of the gas system was £6 per lamp per annum, which, reckoning 80 lamps, meant a yearly expenditure of £180. Under the electrical system the cost would be £8 per lamp, or £360 per year, and the illuminating power would be more than double that of the gas lamps. He expressed a strong desire that the City Council would allow the Electricity Committee to light Cheetham Hill-road. The cables were already laid, but they had been lying idle for years.

Poplar.—The Borough Council are taking up a loan of £10,818. The original application was for £12,140. The County Council have declined to sanction the following items: £980 for three spare armatures, and £342 for expenditure under the heading of "buildings" and "office furniture"—£1,322. The reason for the omission of the £980 is that the London County Council are advised that the provision of this duplicate machinery is more a nature of a renewal than spares, and, in accordance with the condition imposed by his Majesty's Treasury upon all borrowers on the 42 year term, the cost of all renewals must be provided otherwise than by loan. The committee consider that such items should be provided out of revenue balances in the same way as stores. The amount of £342 is eliminated because the items which go to make up this sum are for very trifling amounts, and should be defrayed out of revenue account. The revenue account for the quarter ending June 30 shows that the total increase was 128 074 units. There was a large increase in power—viz., 275,678—being an increase of 93 000 over the same quarter last year. This represents an increase of 50·55 per cent., and of 51 per cent. of the total output of the station. The private lighting has also increased by 27,889 units. The money value of the increase was approximately £500 for power and £1,071 on the whole output.

Wolverhampton.—The accounts of the electricity undertaking for the last year show a gross profit of £12,995, or 8·69 per cent. on the capital expenditure (averaged during the year). Out of this amount the following charges have to be met: Interest, £4,305. 2s. 6d., less interest received £104. 6s. 3d., £4,200. 16s. 3d. (2·81 per cent. on average capital); sinking fund and repayment of loans, £4,984. 11s. 2d. +£356. 8s. 10d., £5,341 (3·57 per cent.); balance, being net profit for the year, £3,454 1s. 10d. (2 31 per cent.)—total, £12,995. 18s. 1d. (8 69 per cent.). The committee consider that this result is especially gratifying when it is remembered that very substantial reductions have been made in the price of current for lighting and motive power purposes during the period covered by these accounts, and that a large reduction has also been made in respect of the charges for public street-lighting, the actual diminution in revenue from these causes being about £3,700. There was a continuous diminution in the cost of production, the expenditure on the generation and distribution of electricity—inclusive of all management charges, but exclusive of capital charges—being actually less for the year ended March 31, 1905, than it was for the preceding 12 months, although the output of electricity has increased by 33·3 per cent. During the past year the output of electrical energy to private consumers for lighting and motive power has increased by 11 per cent., and the committee have every reason to believe that this rate of increase will be considerably exceeded during the present year's working. The committee conclude by saying there is a slight improvement in the percentage of electricity sold to electricity generated, the figure of 83·24 per cent. being exceptionally high, representing a standard that it will be somewhat difficult to maintain.

London County Council.—On Tuesday tenders (*a*) for the manufacture, supply, and delivery of double-deck tramcar bodies with roof covers; (*b*) for the manufacture, supply, and delivery of maximum traction swing bolster trucks for electric tramcars; (*c*) for the manufacture, supply, and delivery of electrical equipments for tramcars were referred to committees. It was agreed to lend the Battersea Borough Council £1,934 for street-lighting; the Hackney Borough Council £21,708 for electric lighting and street-lighting extensions; the Hampstead Borough Council £5,100 for electricity meters and £5,000 for housing purposes; the Marylebone Borough Council £150,000 for electric lighting purposes; and the Stoke Newington Borough Council £3,000 for electric lighting purposes. Sanction was also given to the Stoke Newington Borough Council to borrow £13,750 towards the cost of the installation of electric light in the borough. The Highways Committee recommended (*a*) that, subject to the approval of the estimate of £59,394, submitted by the Finance Committee for the equipment of the through tramways route between the Strand and the Angel, Islington, expenditure on capital account not

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exceeding £5,024 be sanctioned in connection with the laying of cable ducts, and the supply of electrical plant and cables required in connection with such work; (b) that the operation of Standing Order No. 23, which requires that all tenders where the expenditure exceeds £500 shall be opened in the Council by the chairman, be suspended, so far as regards the tenders for the several works referred to the foregoing resolution; that the Highways Committee be authorised to arrange for the invitation of tenders either by advertisement or from selected firms for the works in question; that the chairman or the vice-chairman of the Highways Committee be authorised, during the summer vacation, to open any tenders that may be received, and to accept the one in each case which appears to be the most satisfactory.

Croydon.—The annual report of the borough electrical engineer, Mr. Alex. C. Cramb, shows that the gross profit for the year was £24,683, as compared with £21,058 for the previous year, from which (after deducting interest and sinking fund and carrying forward £76 to the next account) a net profit of £6,332 was left. In addition to this amount paid for out of this year's revenue were the following items: conversion to triple expansion of No. 5 engine, £277; building etc., sub-station "H," £221; an amount written off in respect of old rectifiers of £556; cost of issue of debentures, charged to revenue, £1,015—total, £2,071. The first item has resulted in greatly increasing the efficiency of the engine. With regard to the second item, although a small temporary sub-station previously existed close to the site on which the new one is built, the present expenditure has been for a sub-station of capacity to meet all future requirements. The revenue account had been further reduced by about £861, due to reduced charges made to consumers. The capital expenditure during the year amounted to £12,288 on mains, etc., and £22,027 on building and plant, etc., bringing the total capital expenditure for the undertaking to £305,574. The total expenses for the year to £24,992, as compared with £25,538. The generation wages have increased by £494, due to a more liberal scale of payment. The amount paid for coal has been reduced by £417. Stores have been reduced by a sum of £486, and repairs by £482. The distribution salaries were lower by £145, and the repairs have been reduced by £119. With the exception of a small increase in salaries for generation, and a rather heavy increase in wages for both generation and distribution, there has been an actual reduction in the amount paid for all the other items, although 284,689 units more have been sold this year than for the previous one. There was an increase of £344 for rates, and this on top of a very heavy increase under this heading over last year's account. There has been an actual reduction of £71 in general establishment charges. The total expenditure is £566 less than last year, and the total cost, irrespective of interest and sinking fund charges, has been reduced from 1·589d. to 1·444d. per unit, being a reduction of ·145d., which may be taken as a satisfactory result. If it had not been for the rather heavy increase in wages and rates, the result would have been even more satisfactory. The revenue for the year was as follows: year ending March, 1905—private lighting, £28,128. 16s. 11d.; public lighting, £7,627; trams, £13,109; other sources, £809—total, £49,675. The revenue is higher than last year by £3,079. The number of consumers to March, 1904, was 1,721, and to March, 1905, 2,061, showing an increase during the present year of 340. The output from the works is given as follows: units sold, public lighting, year ending March, 1905, 692,485, year ending March, 1904, 656 905, traction 1,573,098 (1,475,656), private consumers 1,652 354 (1,500,687)—total sold, 3,917,937 (3,633,248); used on works, 418,739 (447,780); lost in distribution and used for experimental and testing purposes, etc., 505,398 (382,315); total units generated, 4,842,074 (4,463,343). The percentage of units sold to units generated was 80 9. For preceding year the percentage was 81·4. The committee consider that the amount of plant installed for tramway and direct current supply hardly leaves a sufficient margin for breakdowns. They also say that the greatest obstacle at the present time in obtaining private house consumers is the question of the cost of installation. They had lost the supply of electric light to several hundred houses during the last year owing to the fact that they were unable, in any way, to facilitate the fitting up of the same, and as in many cases the houses were not owned by the occupiers and were held on short leases, it was not to be expected that many persons, however desirous they might be of having electric light, would go to the expense of fitting up other people's houses.

PROVISIONAL PATENTS, 1905.

JULY 24.

15196. **Improvements in systems of telephony.** The British Thomson-Houston Company, Limited, 83, Cannon street, London. (The General Electric Company, United States.)

15266. **Improved construction of electrical resistance apparatus.** Ernest Haertel and Aage Jensen, 173, Fleet-street, London.

JULY 25.

15222. **Improvements in fuse heads for electric blasting.** Frederick Render, 6, Bank-street, Manchester.

15252. **Improved means for operating switches employed in electric traction on the surface-contact system.** Robert Brown, 16, Great George-street, Westminster, London.

15253. **Improvements in switches employed in electric traction on the surface-contact system.** Robert Brown, 16, Great George-street, Westminster, London.

15254. **Improvements in switches for electric traction on the surface-contact system.** Robert Brown, 16, Great George-street, Westminster, London.

15257. **Storage batteries.** William Gardiner and Cornelius Pruyn Stringfield, 65, Chancery-lane, London. (Complete specification.)

15265. **Improvements in electromagnetic vibrators.** Ragnar Carlstedt, 111, Hatton-garden, London. (Complete specification.)

15289. **Improvements in and relating to telephone call registers.** August Meyer, 77, Chancery-lane, London. (Complete specification.)

15290. **Transportable telephone apparatus.** Nicolay Jacobsen, 77, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 16, 1904, being date of application in Norway.) (Complete specification.)

15298. **Improvements in multiple telegraphy.** Sterns Francis Jones, 322, High Holborn, London. (Complete specification.)

15299. **Improvements in multiple telegraphy.** Sterns Francis Jones, 322, High Holborn, London. (Complete specification.)

15301. **Improvements in signalling devices or telegraphs.** De Courcy Beamish, 6, Lord-street, Liverpool.

JULY 26.

15345. **Improvements in electric lifts with electromagnetic control.** Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, "Janus" Works, Queen's-road, Battersea, London.

15380. **An improved process for the electrolytic manufacture of metallic wire or strip.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

15381. **Improvements in the electrolytic production of metallic strip.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

15390. **Improvements in the manufacture of electrical resistances.** Charles Ruzicka, Clun House, Surrey-street, Strand London.

JULY 27.

15397. **An improved electrical signalling apparatus for electric lights or lamps.** Maxwell Telford, Thomas Grier, and George Finlayson Mackay, 82, Gordon-street, Glasgow.

15435. **Improvements in and connected with the employment of telephone meters in common microphone battery system.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Aktiengesselschaft Mix und Genest, Germany.)

15460. **Improved means of keeping constant the voltage of a dynamo-electric machine under variations of speed and current output.** Matthew William Walbank Mackie, 173, Fleet-street, London.

15462. **Improvements in the process of making a metallic connection between the light-emitting bodies and the supply conductors of electric glow lamps.** Hans Kuzel, 322, High Holborn, London.

15464. **Improvements in and relating to electric switches.** John Ward Cook, Cobden-buildings, 67A, Corporation-street, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 17.

1904.

16038. **Telephone system.** Brander.

16059. **Apparatus for the generation of electricity primarily designed for the electric lighting of trains.** Hutchins.

16210. **Electrical winding mechanism and switches connected therewith.** Du Bois.

16255. **Systems of electrical distribution.** Weintraub. (Date applied for under International Convention, July 23, 1903.)

16257. **Operating electric rectifiers, vapour lamps, and the like in systems of electrical distribution.** Weintraub. (Date applied for under International Convention, July 23, 1903.)

16815. **Armature connection for motor electricity meters** Geyer.

17018. **Electro-pneumatic control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

17862. **Electrical conductors specially applicable to overhead conductors for electrical tramways.** Ginders.

18202. **Electric motor control and apparatus therefor.** British Thomson-Houston Company, Limited. (General Electric Company.)

18356. **Electrolysers.** Bartelt.

19109. **Single-phase commutator motors.** Punga.

19540. **Combined rail and road electric tramway system and vehicles therefor.** Dixon and Dixon.

20380. **Electric arc lamps,** Carolan. (General Electric Company.)

20381. **Rectifying alternating electric currents.** Carolan. (General Electric Company.)

20473. **Electric transforming devices.** Carolan. (General Electric Company.)

20548. **Automatic electromagnetic controllers, especially applicable for use in electric metering systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

20550. **Control of electric motors.** Carolan. (General Electric Company.)

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20809. Electric furnaces. British Thomson-Houston Company, Limited. (General Electric Company.)

20810. Electric furnaces. British Thomson-Houston Company, Limited. (The General Electric Company.)

20898. Pipes or tubes for containing underground electrical cables or conductors. Chambers.

22966. Construction of dynamo and like brushes. Chaplin and Chaplin.

27849. Timing devices for turning on and off gas, electric circuits, and other agents. Horstmann, Horstmann, Horstmann, Horstmann, and Edgar.

29187. Electric igniters for explosion motors. Guillou. (Date applied for under International Convention, Jan. 2, 1904.)

1905.

1369 Electro-therapeutic ray tube. Cossor.

1820. Electro-dynamic railway traction systems. Dulait, Zelmay, and Rosenfeld.

2693. Pneumatic devices for supporting, actuating, and controlling the trolley poles of electric cars and the like. Gunyon. (Magney Manufacturing Company.)

5456. Detectors for electromagnetic waves or other weak electric impulses. Thompson. (Ges. für drahtlose Telegraphie m. b. H.)

5863. Electric train signals. Sullivan and Renshaw.

6650. Galvanic cells. Schenk.

8972. Systems of electrical distribution of direct currents by means of vapour rectifiers. Hewitt. (Date applied for under International Convention, May 13, 1904.)

10100. Overhead current collectors for electric railways and tramways. Platte. (Date applied for under International Convention, May 14, 1904.)

12690. Intercommunication telephone systems. Birnbaum and White.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅞-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2⅞-2⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅛-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	92-95
—— 4½ per cent. 2nd Debenture Stock	100	..	77-80
Callender's Cable, Debentures	100	..	106-108
—— Ordinary	5	..	10-11
—— 5 per cent. Pref.	5	..	5-5⅛
Crompton and Co.	3	..	1-2 xd
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1¼-1⅜
—— "A" Shares, 01-017,139	5	..	2-2½
—— 5 per cent. Debentures	100	..	89 94
—— 4 per cent. Deb. Stock, Red.	100	..	83-88
Electric Construction, Nos. 1 to 112,100	2	..	⅜ ⅝
—— 7 per cent. Cumulative Pref.	2	..	1⅜-2¼ xd
—— 4 per cent. Perp. 1st Mort Deb.	100	..	93-96
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-101
W. T. Henley's Telegraph Works, Ordinary	5	..	11½-12½
—— 4½ per cent. Preference	5	..	5⅜-5⅝
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15-16
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	31-33
—— 5 per cent. Bonds	100	..	101-103
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	11⅜-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11¼-12½
—— 4½ per cent. Debenture Stock, Red	100	..	106-108
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	103-106
Brompton and Kensington, Ordinary	5	..	10 10½
—— 7 per cent. Preference	5	..	9⅜-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9 9½
—— Nos. 60,001-80,000	5	..	8⅜ 9⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13⅜
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-8,000	5	..	6⅞-7¼
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	104-106
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— ditto (1903) 40,001-80,000	5	..	4⅜-5
Chelsea Electricity Supply	5	..	6 6½
—— 4½ per cent. Debentures	100	..	108-110
City of London, Ordinary	10	..	10¾-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	105-105
County of London Electric Supply, Ordinary	10	..	8¼-9
—— 6 per cent. Cum. Pref.	10	..	11⅜-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5	..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100	..	105¼-107½
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	88-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	99-102 xd
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	7⅜-8¼
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	..	⅜-⅞
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	11¼-12¼ xd
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	97-100 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10¼
London Electric, Ordinary	5	..	1¼-2⅜
—— 6 per cent. Pref.	5	..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	9¼-10
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	99-101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5	..	7⅜ 8¼ xd
—— do., 57,0 0-75,000	5	..	7⅜-8¼
—— 5 per cent. Pref., 1-57,000	5	..	6 6¼ xd
—— do., 57,0 0-75,0.0	5	..	6-6¼
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6¼-7
—— 4 per cent. Debenture Stock	100	..	98-100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2¼-3
—— 4 per cent. Debenture Stock	100	..	76-80 xd
South London, Ordinary	5	..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1	..	⅜-⅞
—— 7 per cent. Cum. Pref.	1	..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb.	100	..	106-109
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13 14 xd
—— 7 per cent. Pref.	5	..	8-9 xd
—— 3½ per cent. Deb.	100	..	97 99
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5¼-5⅜
Westminster, Ordinary	5	..	11¼-12¼ xd
—— 5 per cent. Cum. Pref., 110,1.1-138,251	5	..	6¼-6⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5⅞-6¼
—— Ord.	5	..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100	..	104-106
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-13⅞
—— 6 per cent. Cum. Pref. Shares, 1-10,000	10	..	9,-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101 xd
—— 4½ per cent. Red. Deb. Stock	100	..	97-102 xd
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3⅜-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	92-96
British Columbia Electric Railway Co., Ord. Def.	100	..	105-108
—— Ord. Pref.	100	..	99-102
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	102-105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	8¼-8⅜ xd
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	121-123
—— 4½ per cent. 2nd Deb. Stock	100	..	97-99
Buenos Ayres and Belgrano Trams	5	..	3-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5 7/16-5 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	106-107
—— Prov. Cert., all paid	100	..	101-104
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	96-98
Calcutta Tramways, 1-102,268	5	..	9-9¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	106-108
Cape Electric Tramways, Nos. 1-480,000	1	..	1⅛-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅞-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	102-104
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13¼-14¼ xd
—— 6 per cent. Cum. Pref.	10	..	15-16 xd
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14¼
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5	..	2⅜-3¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	85-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	98-101
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	102-104
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	¼-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	104-106
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104 xd
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9⅜-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9¼-9⅝
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	90-92
—— 4 per cent. Pref.	100	—	101-103
—— " " deferred	100	—	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	120-123
—— ,, ,, ,, '95	100	119-122
—— ,, ,, ,, '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	98¼-99¼
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	108-10⅞ xd
—— Deferred Stock	100	105-107 xd
—— 6 per cent. Cum. First Pref	10	1¼-1⅜ xd
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-6 xd
—— 3½ per cent. Deb Stock, Red.	100	98-101
—— 4 per cent. Deb. Stock, Red.	100	102½-104½
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1	1¼-1⅜

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 29	1,587	1,625	− 38	− 586h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 29	511	450	+ 61	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 30	1,158	1,156	+ 2	− 479	23·53	25½	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 29	333	355	− 22	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 25	977	999	− 22	+ 602	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,035	7·44
Blackpool Corporation	,, 27	1,647	1,958	− 311	+ 1,282	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 29	930	1,232	− 302	− 693	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13·19	—	7·27
Bolton Corporation	,, 30	2,058	1,929	+ 129	+ 1,175	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 26	1,617	1,164	+ 453	+ 2,629	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 29	4,531	4,800	− 268	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 30	1,203	1,322	− 113	+ 875h	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 23	5,441	5,308	+ 133	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 29	1,032	985	+ 46	—	10 60	10·60	March 31	—	—	—	—	—	—	
Burton Corporation	,, 30	342	421	− 79	− 544	8¼	8¼	,, 31	17,950	3,878 269	454,082	1·07	9 21	2 058	6·76
Cardiff Corporation	,, 22	2,211	2,162	+ 49	+ 637	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 29	236	222	+ 14	− 385	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 29	5,687	5,895	− 208	− 585h	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway.	,, 30	2,270	2,384	− 114	− 252h	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 4	226	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 27	594	565	+ 29	+ 724	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6 64	—	4 69
Darwen Corporation	,, 28	216	210	+ 6	+ 202	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 29	275	297	− 22	—	4½	4½	,, 31	11,250	2,853,900	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 28	139	148	− 9	− 25h	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 28	4,299	4,197	+ 102	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 28	1,265	1,231	+ 34											
Dundee City Tramways	,, 26	1,035	990	+ 45	—	22	23	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 29	860	748	+ 112	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 29	13,506	12,975	+ 531	+ 7,294h	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	June 7	302	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	July 26	1,729	1,569	+ 160	+ 1,301	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 29	1,447	1,312	+ 135	+ 1,220	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 29	2,218	2,270	− 52	—	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 26	126	148	− 22	—	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 26	319	339	− 19	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 29	5,902	5,854	+ 48	—	89	89	March 25	288,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 22	11,401	14,144	−2,743	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 30	1,6 3	1,642	− 9	— h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 15	16,408	14,709	+1,699	+43,398	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 27	149	174	− 25	—	2½	2	—	4,740	850.121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 29	13,223	12,818	+ 411	—	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,239	6·99
Nelson Corporation	,, 22	147	137	+ 10	+ 241	—	2¾	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation.	,, 29	3,794	3,775	+ 19	+ 2,363	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 30	1 631	1,208	+ 483	+ 8,117	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 29	2,366	2,229	+ 137	− 229	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	June 29	670	647	+ 23	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4¼	,, 31	14,881	2 837,110	336,547	1·24	9·24	1,102	7·92
Rotherham Corporation	July 27	443	476	− 33	—	9½	7¾	,, 31	23,563	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 31	4,444	4,586	− 142	—	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	,, 22	343	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 30	4,979	4,735	+ 244	+ 4,356	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 26	1,089	1,043	+ 46	− 178	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	,, 5	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 14	1,044	743	+ 301	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 30	1,609	1,372	+ 237	+ 567	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 19	196	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 29	910	869	+ 41	+ 487	11·85	10 5	,, 31	38,768	7,412.881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	,, 13	342	332	+ 10	+ 175	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6 33
West Ham Corporation	,, 27	1,723	—	—	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 26	825	726	+ 99	—	—	7½	,, 31	—	—	—	—	—	—	—

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Abandoning the Third Rail.—The New York, New Haven, and Hartford Railroad Company have decided to substitute the overhead system for the third rail on its line between Hartford, New Britain, and Bristol, Conn. It will be remembered that this line was one of the pioneers in third-rail construction.

Electrical Resistance.—At the annual meeting of the North of England Institute of Mining and Mechanical Engineers at Newcastle last week, a paper by Mr. G. C. Wood was presented giving the results of a year's work in determining the specific electrical resistance of coal and various ores. The electrical resistance of coal was found to be so high that it may be considered a very fair insulator, a fact of practical value in connection with electrical work underground. It was remarked in discussion that coal had a much higher resistance than Barton ballast, which had lately been discovered by the North-Eastern Railway to be particularly effective in preventing the return of the electric current to earth. In verification of this Mr. Walton Brown, the secretary of the institute, stated that Mr. Barton had sat on the live rail with his feet on his own ballast.

Metropolitan Railway.—The enigmatical "1st of the month," which has been the answer of officials for some time to enquiries respecting the actual start of the electric service on the Inner Circle, we have fairly good authority for believing to be Sept. 1. Still, after past experience, the public may be excused if they "hae their doots," and go on the principle that seeing is believing. For the past two or three weeks the Metropolitan Railway have been running electric trains between Aldgate and South Kensington, and this, coupled with the announcement of the steam rolling-stock of the District Railway being on the market, warrants the belief that at last the days of steam traction in the caverns of the Underground are numbered. In these times, when the cry of British decadence is so prevalent, it may be well to call to mind the fact that the delay respecting the introduction of the improved service on the Circle is not due to English muddling, but to much-vaunted Americanised methods.

New Radioactive Element.—Mr. Oskar Kahn contributes the result of his researches upon a new radioactive element which emits thorium radiation to the *Zeitschrift physikalische Chemie*, and an abstract of same appears in the *Journal* of the Chemical Society. In fractionating a mixture of bromides obtained from thorianite, it was found that whilst the radium accumulated in the least soluble fractions, the radioactivity of the most soluble portions also increased. Finally, a strongly active oxalate precipitate of about 10 mg. was obtained, which glows faintly in the dark and excites the platinocyanide and zinc sulphide screens in a marked fashion. If a current of air is blown through a solution of the substance and directed against a zinc sulphide screen, the illumination of the latter is somewhat similar to that observed in a parallel experiment with emanium. It is shown, however, that the substance cannot be actinium or emanium. The emanation from the substance is almost identical with that of thorium, but the substance itself is from 100,000 to 200,000 times as active as thorium, and is supposed to contain a new radioactive element.

Rubber Production.—A correspondent writes to the daily Press to correct previous statements as to the conditions of the rubber-growing industry in Ceylon, and in so doing he gives some interesting information. The trees are now grown from the seeds of the Para heves, imported by the Indian Government several years ago from the regions of the Amazon, which were introduced into Ceylon with great difficulty, owing to germination setting up during the lengthy voyage. The writer controverts the statement that 100,000 acres can be planted during the forthcoming year, and places the figure at 20,000, as neither seed, labour, nor land is available for the larger quantity. The area so far planted in Ceylon is 36,000 acres, and a similar amount of territory is under cultivation in the Malay States. The writer considers that estimates of the future rubber production of the world which have been published are premature, and he predicts that it will be some 15 years before the quantity of rubber produced increases by 40,000 tons per annum, which would represent an increase of about 65 per cent. on the present production. As the demand for rubber practically doubles every decade, his view that the rubber-producing industry is a promising one for the energetic and scientific planter seems well justified.

A.E.I.—Part 3 of vol. ix. of the *Proceedings* of the Italian Institute of Electrical Engineers contains, besides the reports of the meetings held in March, April, and May in various parts of Italy, the following papers: "Standardisation of Electrical Machinery and Apparatus," by Prof. L. Lombardi, delegate of the association at the St. Louis Congress; "Notes on Bonds for Rails," by D. Spallicci, C.E, Florence; "A Description of the Electrotechnical Laboratory of the Royal Naval College at Genoa and its Facilities for Research Work," by Prof. C. Garibaldi; a note dealing with the possibility of obtaining undistorted transmission of telegraphic messages under more general conditions than those laid down by Heaviside, by G. Giorgi, C E, Rome; "The Effect of Obstructions to Motion with regard to the Flow of Water through Pipes," by the same. There is also a lengthy paper dealing with the proposed hydro-electric power scheme from the Volturno, by J. Ruffolo, C.E., Naples, while Dr. A. Filippini, Genoa, deals with the voltaic arc as an electrical phenomenon. Mr. E. Jona, Milan, describes an electrostatic voltmeter for 200,000 volts. The report of the commission on a national organisation for the protection of industrial property is considered by Mr. M. Capuccio, C.E., Turin. Numerous diagrams and illustrations complement the articles, and from a note in the appendix we see that, nine members having joined the association during the quarter ended June, 1905, the membership now totals 1,135.

Power Economy on Trams.—When presenting his report for the year ending March 25, 1904, Mr. A. S. Giles, manager of the Blackburn Corporation trams, outlined his scheme for effecting a considerable degree of economy in the amount of energy used. He had separately metered the consumption of power on the various sections and logged it each day. It was his practice to calculate the energy used per car mile, and to plot this on a weekly curve against each section of the tramways, in order that he might be able to discern any abnormal fluctuations. He noticed, however, how greatly the energy varied with different drivers, and after allowing for the state of the rails, wind, and weather, this variation was found to amount to as much as 30 per cent., from which he naturally inferred that some drivers did not pay much attention to their instructions. This was confirmed by the results attained when Mr. Giles personally took a turn at driving. He, therefore, proposed that the Corporation should offer drivers a bonus of 1s. per week for every tenth of a unit per car mile they saved below 1·87 units per car mile, which Mr. Giles calculated would still allow a considerable margin of profit to the trams. A glance at the accounts for the year ending March, 1905, shows that this idea was not fruitless, though, apparently, the results were considerably

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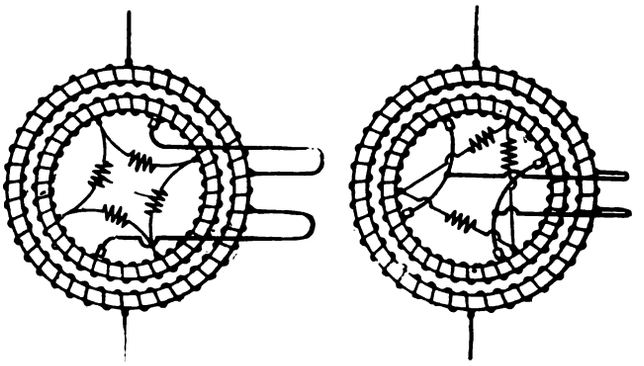
under Mr. Giles's expectations. The economy in current for the year averaged, roughly, ·06 of a unit per car mile. This shows that something appreciable can be done, and the figures seem capable of further improvement.

Iron and Steel Institute.—An attractive programme, to which we have before referred, has been issued for the autumn meeting of the Iron and Steel Institute at Sheffield on Sept. 26, 27, 28, and 29. The meetings will be held in the new university buildings. All the great armour-plate and gun manufacturing firms are opening their works, including Messrs. Firth and Sons, Messrs. John Brown and Co., the Parkgate Iron and Steel Company, Messrs. Vickers, Sons, and Maxim, Messrs. Cammell, Laird, and Co., and Messrs. R. A. Hadfield and Co., and visits will be paid to about 30 other manufacturing establishments in the vicinity. On the entertainment side of the meeting the Dukes of Norfolk, Devonshire, Leeds, Rutland, Portland, and Newcastle have given special facilities for visiting their domains, and foreign visitors will have a good opportunity of enjoying some characteristic English scenery. Some important papers will also be read and discussed. Captain Howorth (of the experimental staff of the War Office) will give some interesting results that have been obtained in the course of the Ordnance Department's endeavours to find the best materials for guns. M. Guillet, of Paris, will contribute an elaborate series of researches to ascertain what is the best kind of steel to use in motorcar construction to ensure safety, finally recommending vanadium steel. Mr. Douglas Upton, of Jarrow, will describe a manipulator for steel bars which will do away with handling; and Prof. Arnold and Mr. McWilliam have again collaborated to throw new light on the thermal transformation of carbon steels. Mr. J. E. Stead and Mr. A. W. Richards will discourse on the effects of overheating steel, and some results of the wear of steel rails will be given. The Lord Mayor of Sheffield and the Master Cutler are co-operating with the local reception committee to give a hearty welcome to the visitors, many of whom will come from America and the Continent.

Telephony in Canada.—The latest report to hand (No. 35) brings the *Proceedings* of the Canadian Telephone Committee down to July 12. It deals with the evidence given by the merchants of the chief cities, whose grievance seems to be the common one that the charges are too high. Apparently they consider that it is not very material whether the telephone system is conducted privately or by the Government so long as cheapness is secured, but most of them incline to the view that this is more likely to be attained under Government ownership, at any rate of the long lines. The Canadian merchants think that the telephone should be an article of general use, much the same as tramways—or more, for one witness stated that people who would not come out of doors to buy would give orders if they could do so over the telephone. In Montreal there are two systems—those of the Bell Company and the Merchants' Telephone Company. The former costs about £7 per annum and the latter about £5, though there appears to be little difference between in regard to efficiency. But the Merchants' Telephone Company has no long-distance connection, and the Bell Company apparently trade upon this fact. The merchants, therefore, urge the need of better facilities over trunk lines. Another grievance of the merchants is that, although subscribers, they are charged the usual 2½d. per call when using the public stations. A witness from Toronto stated that, in consequence of the oppressive restrictions of the Bell Company, the Retail Merchants' Association negotiated with the Stark Company for the installation of a service at £1. 5s. per annum and ½d. per call up to £5. 12s. per annum for private houses, the maximum for business places being £7. 5s. The difficulty, however, was that the service was only a local one, and the association, therefore, considered that the trunk lines should be owned by the Government, who should give facilities to all local companies. This was followed by other evidence of a similar character, after which another adjournment was called.

Repulsion Induction Motor.—A self-starting single-phase commutator motor, which has a speed limit at or near synchronism, has lately been designed by M. Milch, who has obtained a patent for same in the United States. In construction the machine differs inappreciably from a repulsion motor. A slight change is made in the rotor winding so that points symmetrically located thereon are joined together through impedances. These impedances are highly inductive, but contain very little resistance. When the rotor is stationary very little current flows through the impedances, and the machine receives its starting torque on account of its repulsion motor features.



At synchronism, however, the rate of change of current through the impedances is zero, and they act as low-valued resistances to short-circuit the rotor winding, which consequently becomes the secondary to the stator winding, which acts as the primary of a single-phase induction motor. In order to compensate for the exciting current of the induction motor, the circuit to the rotor brushes is opened and there is impressed upon them an E.M.F. of the proper value and time phase position. This E.M.F. is obtained from taps upon the primary winding, as indicated in the accompanying illustrations, which we reproduce from the *Electrical World* of New York. At starting this small voltage is overpowered by the voltage induced in the rotor windings, and the motor acts as though the brushes were short-circuited.

The Passing Locomotive.—A Sydney *Morning Herald* has been sent to us containing an article by Mr. E. Kilburn Scott, which is said to be an electrical sidelight on "The Locomotive Contract." Reading between the lines, we gather that locomotives made in the colony are being called for by a certain contract, and that to construct these new works would need to be established either by the Government or private enterprise. Mr. Scott's article claims that any such expenditure would be wasteful, because the steam locomotive is doomed. After giving examples of recent electrification of railways, he says: "All the elevated railways in New York, Boston, and Chicago have been electrified for some time, and there are literally 'packs' of displaced steam locomotives for sale. A lot of about 800 (some practically brand new) were hawked about England when the New York Elevated changed over to electricity. If they are not now on the scrap heap, that is undoubtedly their destination. Yet with all the loss which scrapping so much plant entailed, the elevated railroads in America are in a stronger and more healthy financial position than ever before. This being the

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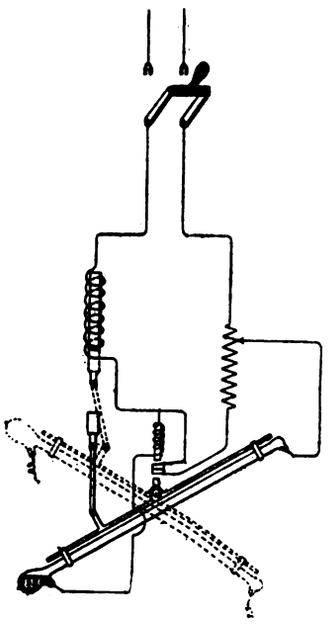
position of affairs, it will easily be seen how great a risk employers, whether they be the Government or a private firm, are taking if they deliberately lay out much money on special plant for making steam locomotives. It appears to the writer to be more like philanthropy than business to accept an order carrying with it such a condition or necessity. Regarding the workmen, the trade which is likely to be hit most is that of the boilermakers, for in an electric locomotive or motorcar much of the framework besides the wheels, axles, etc., are the same, but the boiler inevitably disappears. Bodies of the motorcars are a matter of coach-building, but the motors, controllers, distribution system, sub-station plant, etc., besides a large proportion of the central power station plant, call for a different class of work from any that is now executed in this country. Anyone anxious to erect new or to re-equip old works here should do so with a view to undertaking large electrical engineering contracts. Enough electrical machinery has been imported during recent years to keep a decent-sized works going."

Automatic Starter for Mercury Vapour Lamps. A patent has been granted in the United States to Dr. M. von Recklinghausen for a tilting device designed to start mercury vapour lamps automatically. The apparatus is shown in the accompanying illustration, reproduced from the *Electrical World* of New York. The lamp, in the form of a long tube, is suspended so that in its inoperative position it will be tilted far enough to prevent connection between the electrodes through the mercury. By means of an electromagnet the lower end of the tube is lifted so as to cause the mercury to form a bridge between the terminals, and the tube is then tilted still further to break the connection.



The coil of the electromagnet, after doing its work of lifting the lamp, remains in series therewith as an inductive resistance. An auxiliary switch which serves for completing the circuit through the coil of the lifting magnet when the lamp is in its inoperative position, is opened when the lamp is fully tilted and the mercury vapour has been rendered conducting.

Artificial Abrasives.—A report recently issued by the United States Geological Survey testifies to the rapidly-growing use in the country of abrasive materials, including carborundum, crushed steel, alundum (artificial corundum), and adamite. Of these, carborundum and alundum are manufactured in the largest quantity, and are of the greatest value, carborundum being appraised at from 4d. to 5d. per pound. The total production of these artificial abrasives in 1904 amounted to 11,870,380lb., valued at £167,000, or over one-half the value of the production of natural abrasives, which was some £300,000. The production of carborundum in 1904 amounted to 7,060,380lb., an increase of 2,300,490lb. as compared with the production of 4,759,890lb. in 1903. This is the largest production in any year since the beginning of the manufacture of this abrasive, and illustrates the increasing demand for it. With the exception of one year (1902) there has been a continual increase from year to year in the production and use of carborundum, and in that year the decrease was due to a scarcity of supplies used in the manufacture of the carborundum. The increase in the production of carborundum since the industry was started in 1892 has been indeed remarkable. In that year the production amounted to just 1,000lb., while for 1904 it totalled, as shown above, over 7,000,000lb. The manufacture of artificial corundum from a bauxite which has been developed and put on a commercial basis by the Norton Emery Wheel Company, of Worcester, Mass., at its plant at Niagara Falls, New York, has meet with great success, and this abrasive, which is known commercially as alundum, is giving most satisfactory results. The greater part of this material produced by the Norton Emery Wheel Company is used by the company itself in the manufacture of its various emery wheels, stones, etc. It makes a clean, fast-cutting abrasive, being nearly absolutely free from any kind of impurity, and has proved its excellent qualities in actual use. There is another artificial corundum that is being used as an abrasive, but it is only obtained in small quantity, as it represents a by-product of the Goldschmidt thermit process of the reduction of many of the metals. At the present time none of this corundum is made or put on the market in this country, but at the German factories where the Goldschmidt thermit process is employed it is utilised as an abrasive. In 1904 there were 4,020,000lb. of alundum manufactured, only a small portion of which was put on the market in the crude form, the average price being 3½d. per lb.

Electro-Chemistry.—Messrs. H. N. Morse and L. S. Taylor recently contributed to the *American Chemical Journal* an article describing an electrical method for the estimation of carbon and hydrogen in organic compounds, of which an abstract appears in the *Journal* of the Chemical Society. The advantages claimed for this method are that the apparatus is small and compact, the waste of heat energy is much smaller than that of the ordinary method, and the time required in preparing for and carrying out a combustion is considerably reduced. Two forms of apparatus are described. The first of these consists of a thin glass combustion tube, 350mm. long, 15mm. in internal diameter, and closed at one end. The open end is fitted with a caoutchouc stopper, through which pass a porcelain tube, 250mm. long and 6mm. in diameter, a glass tube conveying the products of combustion to the absorption apparatus, and a thick platinum wire. The platinum wire is connected inside the combustion tube to a finer platinum wire, which surrounds the porcelain tube in a spiral coil and finally passes down through the porcelain tube to the exterior, the lower part being composed of thicker wire. The oxygen or air is led into the combustion tube through a glass side tube, which is attached to the porcelain tube outside the stopper by means of indiarubber tubing. In carrying out a combustion, the boat containing the substance is placed at the closed end of the tube, a roll of copper gauze about 60mm. long is placed next, the indiarubber stopper carrying the tubes and platinum wire is inserted, and the glass delivery tube is attached to the absorption apparatus. Pure dry oxygen is passed slowly

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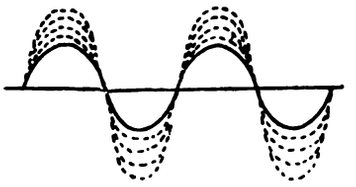
through the tube, and the electric circuit is closed through a regulating rheostat. The current is increased until the wire becomes red hot, and the roll of copper gauze and the boat containing the substance are then heated by means of a gas flame. The time required for a combustion is usually about half an hour. The amount of electrical energy consumed is about 3·6 amperes at 54 volts during the time when the highest temperature is maintained. The second form of apparatus described differs in being composed of a somewhat longer combustion tube, which is open at both ends. Both forms of apparatus are fully described with the aid of diagrams. The results of a series of combustions are quoted for the purpose of illustrating the applicability and accuracy of the method, and an account is given of the precautions which must be observed in the combustion of substances containing nitrogen, halogens, or sulphur.

7,500-kw. Turbines.—The New York Edison Company has concluded negotiations for two 7,500-kw. turbo-generator units for the illumination of the city. This plant is to be installed in one of the largest and most up-to-date American central stations—Waterside station No. 2, which, it is stated, will ultimately contain 10 units of the same size. The compactness of the new unit is evidenced by the small space it requires. Roughly, its over-all dimensions are: length 50ft., width 17ft., height 15ft.; floor space 850 square feet per unit net, or ·113 square feet per kilowatt, this being less than a half of the area occupied by the engine-type units. A condenser of the surface type will be located beneath the turbine in the foundations proper. The makers state that this arrangement is in all respects equivalent to that claimed as the special property of the vertical type of turbine, which, the makers of the latest type state, needs considerable extra space for condenser and turbine auxiliaries. The new turbines will operate at 175lb. steam pressure approximately, 28in. vacuum, and 100deg. superheat, the normal speed of the unit being 750 r p m. Under these conditions the economy of the new unit is calculated at about 16lb. per kilowatt-hour at full rated load. There will be a minimum overload capacity of 50 per cent., or each unit will be capable of developing full rated load without the use of a condenser. A distinctive feature is that the turbine gives its best economy at about full rated load, although a large overload capacity is at all times instantly available when required without material sacrifice of efficiency. At this maximum load each turbine will develop over 15,000 h.p. at the shaft, which is reckoned as being the greatest amount of power ever developed in a single prime mover in stationary service. The direct-connected turbo-generators will be of standard Westinghouse construction, delivering 6,600-volt three-phase current to the high-tension network at a frequency of 25 cycles per second. The generators will follow the new enclosed construction, thus eliminating the hum associated with high-speed turbo-generators. The efficiency at full rated load approximates to 97½ per cent. Each generator will be capable of sustaining for several hours an overload capacity of 50 per cent. within reasonable temperature rise. As illustrating the rapid advance of the turbine, it may be mentioned that when, only a few years ago, Waterside station No. 1 was equipped with Westinghouse vertical three-cylinder compound reciprocating engines of 3,500 kw. capacity, these were probably the highest type of large engine construction. It may be noted that simultaneously with the action of the New York Edison Company, three Westinghouse turbine units of the same size have been adopted by two large Brooklyn power stations, the Brooklyn Heights Railway Company having ordered two of these units and the Brooklyn Edison Company another.

Long-Distance Telephony.—The *American Telephone Journal* published recently an article by Mr. Newton Harrison on the loading of telephone lines for long-distance service. The article is a description of the system of Prof. Pupin of introducing inductance into a telephone line in order to secure the transmission of speech over long distances. The amusing feature of the article, however, is that the illustrations are absolutely contradictory to the text. The author explains how the characteristics of a musical note depend upon the instrument producing it. He says: "In other words, if the note C is heard from the piano, violin, or cornet, although it is exactly the same number of vibrations per second from each instrument, the overtones or harmonics, as they are also called, unerringly point to the different sources of sound. The number of overtones and the character of them produce the distinguishing difference. 'Timbre' (variations in voices and sound) is thus due only to overtones, and not to the necessary vibrations which constitute the note itself. And in this respect it is possible to understand the peculiarities of the human voice; why, in a sense, personality is associated with it; why the voice is the means of identifying the owner. The number of overtones are the distinguishing feature in connection with the volume of sound produced. A rich voice has magnitude and many harmonics. A thin voice, a piping treble, is without volume or sufficient overtones to make it pleasant. It is this which marks the difference between voices, and for that reason telephony cannot consistently succeed unless the preservation of such tones becomes one of its greatest object." The author would seem to have then given his article to an untechnical artist in order to illustrate these overtones. The result is as shown in the accompanying



WAVE SUPPLIED WITH OVER-TONES OR HARMONICS

illustration, in which the overtones are shown as vibrations of the same frequency as the principal tone but of increased amplitude. The other illustrations showing how the amplitude is reduced in long-distance transmission are also drawn with the same idea, and there is nothing in them to explain that certain high-frequency vibrations are more apt to be damped down on telephone lines than other notes with a lower frequency.

Electrical Progress in Mexico.—We have previously alluded to the rapid expansion that has lately taken place in Mexico in the use of electricity for various industries, the abundant water supply of the country enabling electrical energy to be employed in cases where the cost of steam would be prohibitive. One of the largest industries to benefit by this state of affairs is mining. Recently an electrical plant has been installed to supply the important regions of Necaxa and El Oro. The transmission line is 100 miles in length, and the station is designed for a capacity of 80,000 h.p. Apparently, it is proposed to run electric railways from the mining regions for the conveyance of the ore. The Rosa Amarilla copper mines, in Gaudaljara, which have suffered in the past through the cost of power, now contemplate the erection of a large hydro-electric plant to be used both for operating the mine machinery and also for a railway to the Pacific port of Navidad. It is noticeable that an American concern is again to the fore in this con-

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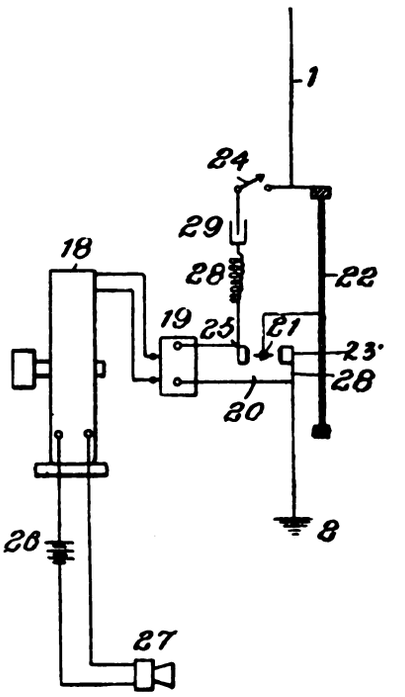
nection, a company from the States which has an interest in the mines having applied to the Federal Government for a concession to build the plant and railway. Another concession for power development for mining, irrigation, and railroad is that obtained by a company in the State of Jalisco. The inland mountain lake of Chapala holds sufficient water to irrigate 300,000 acres of fertile soil in the valleys below, and to furnish several hundred thousand horse-power for industrial purposes. A power plant is to be constructed on the Santiago River near by, and transmission lines will run through the richest mining regions in the vicinity. The Santiago River has a variable fall of 20ft. to 30ft. per mile, and the utilisation of its water for electric transmission is rapidly being appreciated by mining companies. The famous Perez concession for using the waters of this river has recently come into the hands of a company that is constructing a power plant to transmit electricity to the city of Aguascalientes, a distance of 110 miles. It is proposed to develop 30,000 h.p. at once. This will be sold to mining and irrigation companies along the route, and also to street railway companies in the terminal city. At Velardena, in Durango, extensive hydro-electric improvements are being made by American engineers to operate new smelters and to drive mining machinery, the mountain streams furnishing the power. In many other parts of Mexico schemes are being devised to turn to good account the energy stored in her mountain streams. The aim of the companies is to combine transportation, lighting, and mining operation in one enterprise. In a few instances the grouping of mines in one locality has justified the investment of large capital in hydro-electric enterprises independently of other uses; but in some districts the transmission lines have their terminals in distant cities where electricity can be sold in bulk for industrial and lighting purposes. The effect of this policy upon mining interests in Mexico has already been demonstrated in a number of instances. Rich mining regions that were formerly neglected have gained a new value, and are being developed with great rapidity. Mining camps are springing up all along the transmission lines, and several of the pioneer companies have had to enlarge their electrical plants to keep pace with the demand for power in mining. It is tolerably evident from this that there will be a good demand for electrical machinery and equipment, and though, from their contiguity, our American cousins must have a certain advantage, it behoves English manufacturers to see that Brother Jonathan does not appropriate the whole of the prize.

Fessenden's Wireless Telegraphy.—Some patents recently granted in the United States to Mr. R. A. Fessenden, of Washington, relate to improvements in his system of wireless telegraphy. Several interesting phenomena have been observed in connection with systems of wireless telegraphy such as this. One is that under certain conditions, not yet fully understood, the pitch of the transmitted speech may be raised, sometimes one octave and sometimes two octaves. This only occurs, however, with certain methods or with certain adjustments, and may in most cases be obviated by altering the adjustments, but it does not in any case seriously affect the distinctness of the speech. Another point of interest is the extreme clearness and sharpness with which the speech is transmitted, the sound arriving at the receiver as though a person at hand were speaking, except where a transmitter is used for varying the field excitation. One cause of this clearness of articulation is found in the fact that the capacity effect, which is so prejudicial to good speech, is absent in the transmission of electromagnetic waves, and the higher harmonics of the voice are transmitted without distortion. An apparatus shown in the accompanying illustration, which we reproduce from the *Western Electrician* of Chicago, is employed, consisting of a high-frequency generator (18) and a transformer in connection with the generator in order to raise the voltage. A double spark-gap is used, one of the terminals (25) being connected to the transformer and the sending conductor, the latter connection being formed, if desired, by switch (24). The other outer terminal (23) is connected to earth and to the opposite terminal of the transformer. The intermediate terminal (21), which is electrically connected to the sending conductor, is attached to a diaphragm (22)—as, for example, the diaphragm of a transmitter. On exciting the transformer a discharge may be caused to pass from the terminal 25 to the terminal 21, and thence to terminal 23. The potential across the terminals 25 and 23 may be made to have any desired value by regulating the potential of the transformer (19) or the current flowing in the field circuit containing battery (26) and adjusting the resistance (28). If the switch (24) be



left open, the potential of the intermediate terminal (21), and, therefore, that of the upper portion of the sending conductor, will vary with the position of the terminal 21, and on the vibration of the diaphragm — caused by sound waves—the intensity of the radiation from the sending conductor will be caused to vary in a manner corresponding to the sound waves. The apparatus may be used for the transmission of words by closing the switch (24) and adjusting the terminals of the spark-gaps, so that no discharge passes between terminals 25 and 21, but mainly between terminals 21 and 23. This arrangement is stated to give good results, as the radiation from the sending conductor will vary as the gap between the terminals 21 and 23 varies with the movement produced in the diaphragm by the sound waves. The resistance (28) may be so constructed as to form a flexible support for the terminal 25. We observe that another patent granted to Mr. Fessenden relates to a form of receiver called a "liquid barretter," in which both the highly oscillatory currents to be detected and the constantly flowing current from a local source flow through a constricted conducting fluid path, and the highly oscillatory currents produce a change in the amount of current flowing through the local circuit.

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ELECTRIC 100-TON CRANE AT DUBLIN.

The illustrations herewith show the general construction and electrical details of a new crane recently completed for the Port and Docks Board of Dublin. The crane, which is of the revolving tower type, is built for a normal load of 100 tons, and has been successfully tested with 150 tons. It was built and erected by the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nuernberg A.G., whose works are at Nuremberg, Bavaria, and was started to work in the middle of last June. The electrical equipment was supplied by Messrs. Siemens Bros.

The rotating part of this gigantic crane (Fig. 1) consists of a vertical crane post with a double cross-arm. The lower part of the crane post rests in a cylindrical bearing, whilst the weight and horizontal pressure is borne by means of 30 rollers on a bearing fixed to the trestle surrounding the crane post. The gear for hoisting and for working the traveller (Fig. 2) is in the machine

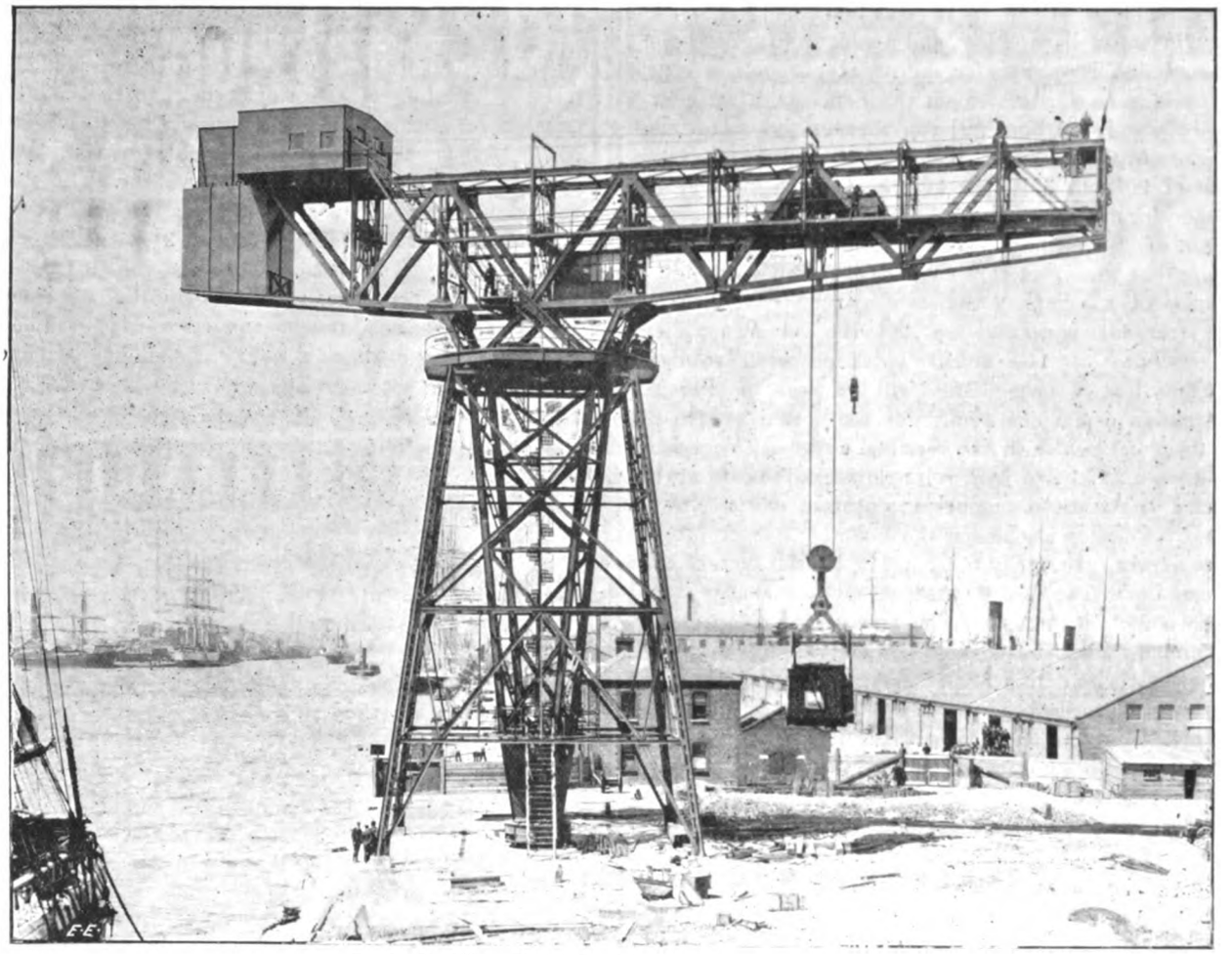

FIG. 1.—The 100-ton Electric Revolving Crane as erected at Dublin.

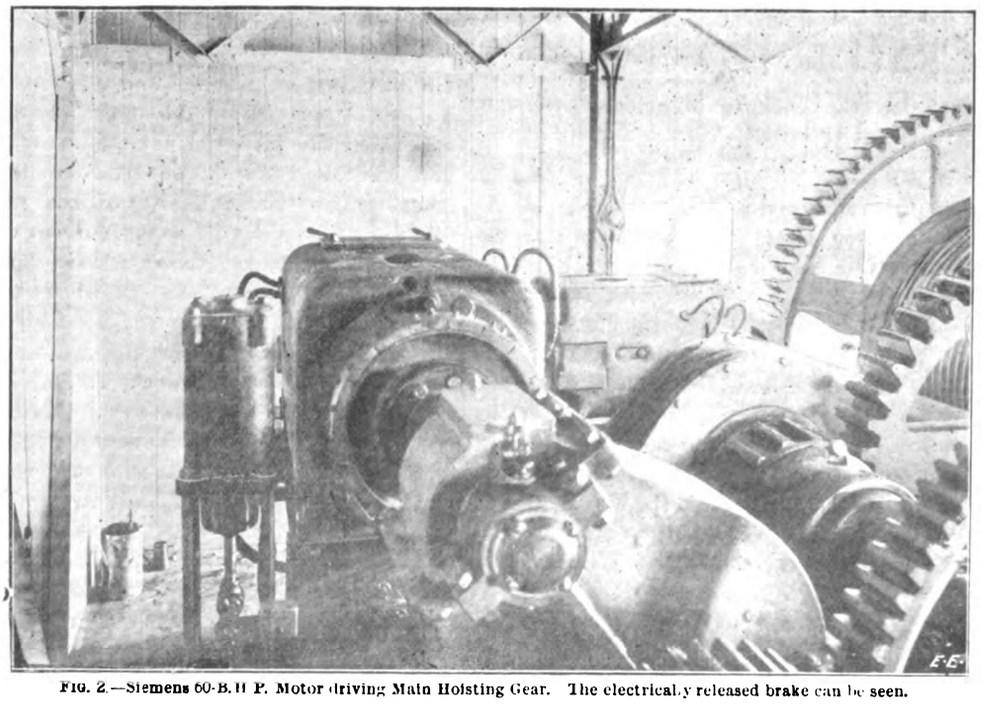

FIG. 2.—Siemens 60-B.H.P. Motor driving Main Hoisting Gear. The electrically released brake can be seen.

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room, which, together with the counter-weight, is erected on the short cross-arm. The traveller (Fig. 3) runs on the long cross-arm between the two main supports which are connected to each other by a horizontal bracing; this arrangement ensures a greater rigidity of the sides than the usual construction. An auxiliary hoisting

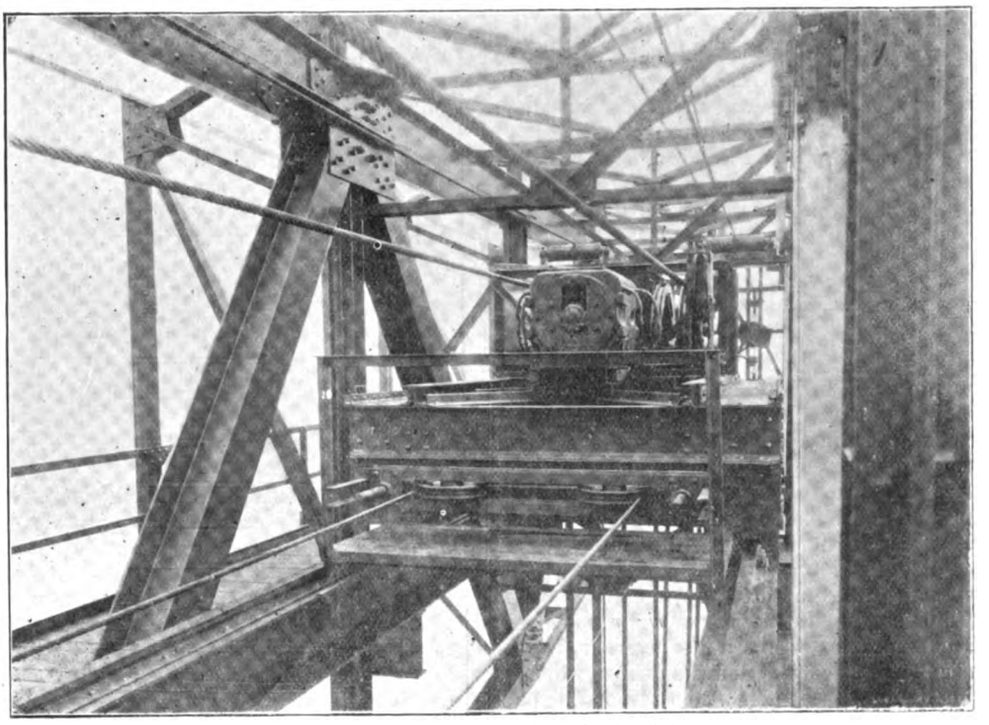

FIG. 3.—View of the Travelling Gear, showing Motor.

apparatus of 20 tons working capacity and 30 tons maximum carrying capacity is erected on the traveller. The slewing mechanism (Fig. 4) is arranged on the upper platform, at the junction of the crane post and the cross-arm. The driving cab from which the crane is operated, by means of the controllers, is situated between the main supports of the cross-arm, near the centre. From this spot

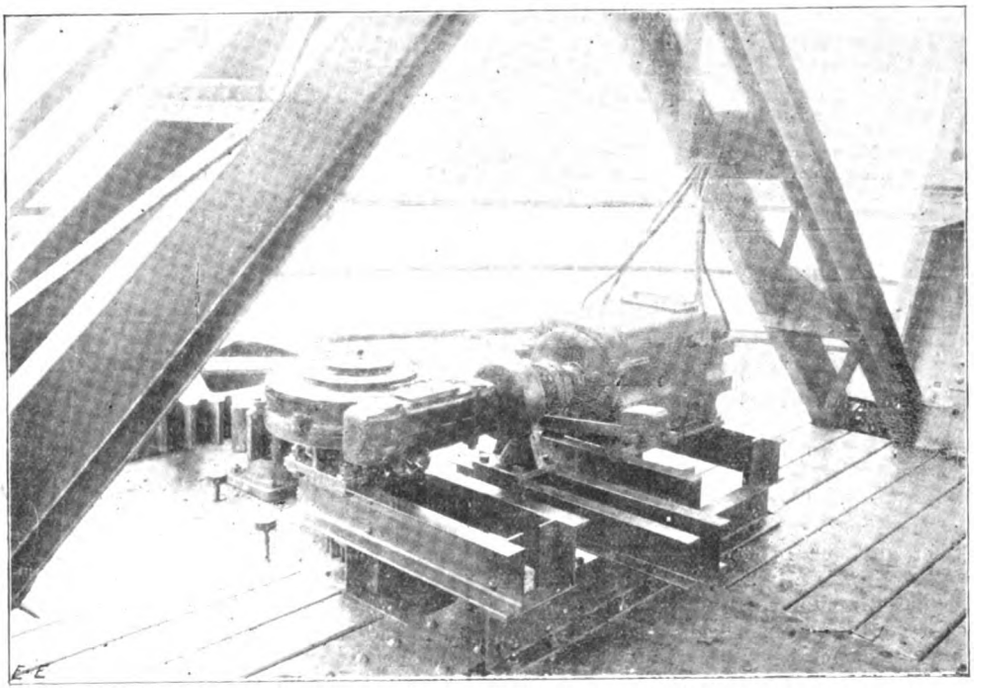

FIG. 4.—Motor-Driven Slewing Gear for Dublin 160-ton Crane.

the driver has a good view over the working field of the crane. Conveniently arranged staircases lead to the machine-room and to the platforms on the cross-arm, as well as to the driving cab. The chief dimensions of the crane are as follows: greatest height of the load hook above quay wall, 70ft.; greatest hoisting height, 100ft.; greatest radius for 20 tons, 80ft.; greatest radius for 150 tons, 75ft. The working speed is when hoisting 150 tons, 5ft. per minute; 50 tons, 10ft. per minute; 20 tons, 20ft. per minute; speed of traveller, 28ft. per minute. Time taken for a complete rotation, eight minutes. The crane is used for loading large and heavy articles—for instance, boilers, machines, guns, etc. The trial movements made singly and in combination, with the loaded crane, were carried out to the complete satisfaction of the purchasers. The ports of Hamburg and Emden possess already five cranes of the same type, which were also supplied by the same makers.

The electrical equipment supplied by Messrs. Siemens Bros. is of the 500-volt continuous-current type, and the motors are specially designed for crane work. The horse-power of the motors and their speeds are as follows: The main lifting motor is of 60 b.h.p., and runs at 650 r.p.m. This motor, with its gear and electrically-controlled band brake, is shown in Fig. 2. The auxiliary lifting motor is placed on the traveller itself. This motor is of 40 b.h.p., and runs at 650 revolutions. Its position on the traveller

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is shown in Fig. 3. The travelling motion motor is of 30 b.h.p., running at 750 revolutions, while the slewing motion is worked as shown in Fig. 4, and is a 15-b.h.p. motor running at 570 revolutions. The controllers are of Messrs. Siemens Bros. and Co.'s standard M. C. complete reversing type, fitted with hand-wheels, indicating the "off" position. The lifting controllers have a greater number of points of control on the lifting side than on the lowering side. The slewing and travelling controllers have the same number of points on each side. The regulating resistances for the main lifting motors are of the grid type, but all the other motors are equipped with resistances of Messrs. Siemens's brick type. The electrically-controlled brakes on each motion are series wound, and are designed to hold the loads should the current be accidentally interrupted. The switchboard is simple in design, with an iron frame and a double-pole switch and two single-pole fuses for each motor.

The supply of motors for crane work is a speciality of Messrs. Siemens Bros., who have adopted a new system of rating based on their experience in such electric driving. A few words as to this rating will be of interest. It is, of course, clearly understood that with cranes, hoists, capstans, and other machinery of this class, the work demanded of the motor is of a very intermittent nature. The actual size of the motor required for any particular motion of a crane depends entirely upon how intermittent this work may be. It is evident that the controlling factor is the ratio between the period during which the motor is giving out power and the period for which it is remaining idle. In the case of the lifting motor of a jib crane handling general cargo out of ship into truck or *vice versâ*, Messrs. Siemens Bros. find that this ratio, on the average, is about 1 to 8. That is to say, for every minute during which the motor is exerting its full power there is a corresponding pause of seven minutes during which the motor is at rest. These figures are in the nature of an average taken over a whole day's work. It is evident, therefore, that a motor which will work under these conditions without overheating or sparking from the electrical point of view is amply large enough for the work required, and such a motor should be selected from the column in the firm's motor tables headed "one-eighth load factor." For the convenience of sub-division, they have arbitrarily taken a period of 12 minutes as being the time taken for one complete cycle of operations, so that, upon this basis, a motor which was rated to give out its full power for 1½ minutes and then allowed to rest for 10½ minutes would be working at a one-eighth load factor—that is, one-eighth of 12 minutes' working and seven-eighth of 12 minutes' resting.

Load factor.	Minutes working.	Minutes resting.
⅛	2	10
¼	3	9
⅓	4	8
½	6	6

The above period of 12 minutes can be varied within very wide limits without materially affecting the final result, the limit as to the maximum time of working depending on the size of machine. In crane work generally, the time for a complete cycle of operation is almost invariably considerably under 12 minutes, being more of the nature of a one or two minutes' cycle. In some cases, however, of crane and other intermittent working, a motor may have to work at full load continuously for much longer periods than the limits of the load factor rating would permit. For instance, it is possible for a machine to have to work for two hours continuously and then rest for 14 hours, thus calling for a machine to work at apparently a one-eighth load factor, whereas another motor may have to work for 1½ minutes continuously and rest 10½, this also being a one-eighth load factor. Taking as an example motors to give 23 b.h.p. at about 400 r.p.m., with a temperature rise at no time to exceed, say, 80deg. F., to satisfy the first case it would be necessary to use a Siemens 15·2 size motor, whereas the second could be met by a 11 C. size—that is, a machine three sizes smaller. In the first example the period of work is so long that the motor has ample time to heat up before it has an opportunity to cool down during the rest, whereas in the second case the heat generated during the short run has time to dissipate itself during the pause which follows. From the above it will be seen that, although the apparent load factor under which the two machines have to work is the same, the length of run is an important consideration, and bears very largely upon the size of machine required. It should be noted that the smaller sizes of motors attain their full heating limit much more quickly than the larger sizes, owing to the greater weight of material in the latter and the rather higher efficiency. On the other hand, however, the radiating surface per watt lost is rather greater in the smaller motors than in the larger, and, therefore, although they heat more quickly, they also cool down more quickly. It will be seen, therefore, that in selecting crane motors two factors must be considered—firstly, the actual intermittency of the load; secondly, the period for which the motor may be called upon to do its full work without stopping.

Regarding the rating at which the firm usually put forward motors for crane work, providing the speed at which the various movements of a crane or other piece of apparatus working intermittently are required to work is definitely known, it is fairly easy to calculate approximately the load factor at which the motors will have to work. For instance, taking a jib crane lifting and slewing by separate motors, a complete cycle of operations would be as follows: adjusting and hitching on the load, raising the load, slewing, lowering the load, unhitching the load, raising the empty hook, slewing back, lowering the empty hook. As a matter of fact, raising and lowering the load and slewing are frequently performed together, but, as far as the motors are concerned, this is immaterial. By adding up the total periods of time during which the motors are called upon to give out their full load—of course, making due allowance for the time they are on light load raising the empty hook, etc.—and dividing the total time of a cycle by this figure, the load factor will be obtained. Lifting motors almost invariably have to work at lower load factors than slewing, as the latter are practically always working at full load while in operation. For lifting motors the load factor may vary from about one-third for grab coaling cranes down to one-twelfth, or less, for general merchandise cranes, and the slewing motors respectively one-half down to one-eighth. These figures naturally depend upon circumstances. It is, however, inadvisable to assume a lower rating than about one-eighth load factor, as mechanical considerations regarding the spindles and possible sparking at the commutator then becomes important. For shop and overhead travelling cranes a one-sixth load factor for lifting and cross traversing, and one-fourth load factor for travelling, suitably meets the conditions of average practice, and for capstans and winches one-sixth to one-fourth load factor is a fair allowance. Only in very rare instances do conditions demand a higher rating than one-third.

The tables supplied by Messrs. Siemens Bros. show how the maximum horse-power of their different motors can be varied according to the load factor.

THE COOPER HEWITT MERCURY VAPOUR LAMP.

Not so many years ago the transmission of electric current through gases was merely a scientific experiment which, although an interesting study for electricians and physicists, had no actual value from the commercial point of view. As far back as 1860 it was known that electric light could be generated by passing current through mercury vapour, but it remained for Mr. Cooper Hewitt to construct a lamp which would be at the same time serviceable and efficient. When the lamp was first shown at the commencement of this century it aroused the greatest interest throughout the world (it was described in our columns in January, 1903, vol. xxxi., p. 87). Since then it has been developed on commercial lines with great success.

The latest type of lamp (Fig. 1) consists of a glass tube to which is sealed a condensing chamber. Into the glass tube the current is led through platinum wires sealed into the glass. Mercury is always used for the negative electrode, and either more mercury or any other metal like iron or copper for the positive. The tube is

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exhausted to a high degree and sealed. The length of the lamp is about proportional to the voltage—*i.e.*, the 50-volt type is about half the length of the 100-volt type. The current passes through a small inductive resistance consisting of several hundred turns of wire round a laminated core. From this coil it passes through a regulating resistance to the lamp. The other pole goes direct to the lamp. When the line potential is put on, the lamps do not immediately start burning. This is due to the great reluctance of the negative. In order to reduce the resistance, Hewitt uses a disintegrating electrode such as the mercury itself, which is the best material for the purpose. It steams away from the surface, condenses again on the walls of the tube, runs back to the negative, and can, therefore, be used over again. To bring the electrode to a state of disintegration, it can either be connected to the positive and then separated from it, or else by putting a high tension on this negative electrode. Physically expressed, the mercury has an extremely high starting but a very low running potential. The starting potential, or it may be called the breakdown potential, is a good many thousand volts, possibly 6,000 or 8,000 in some cases, or even 15,000 to 30,000 volts, whilst the running potential—that is, the drop across the negative electrode in a burning lamp—is only about five. Once the lamp has been made conductive by means of the breakthrough of the dielectric on the surface of the negative—that means when the negative has been brought to a state of disintegration—the lamp conducts extremely well. The usual method of starting the lamp is by tilting it until

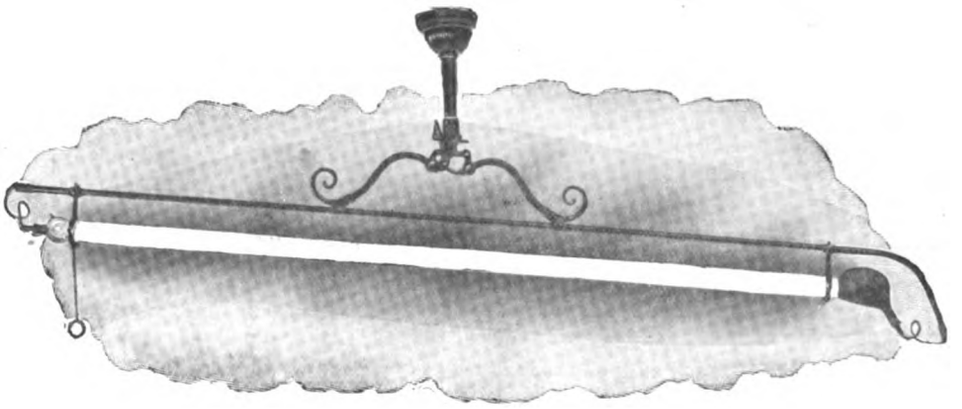

FIG. 1.—The latest form of Cooper Hewitt Mercury Lamp.

there is a thin stream of mercury all along the tube, thus directly connecting the two electrodes, as mentioned above. This starts the disintegration of the negative, and when the lamp has been returned to its original position it will burn without further attention. The actual process which takes place when the lamp is burning is extremely difficult to explain. Dr. von Recklinghausen describes it as follows: "The most plausible explanation of the process, although perhaps not tenable from a physical point of view, is that the current enters the lamp at the negative electrode, and then passes after disintegrating the mercury into the vapour, and thus up to the positive electrode." Another method of starting the lamp was shown by Cooper Hewitt in 1902. The negative electrode is brought to disintegration by means of an auxiliary positive electrode. With a suitable voltage the current then jumps over to the main positive electrode and the auxiliary is then cut out.

The Cooper Hewitt lamps burn without flickering, but a certain movement is noticeable at the negative electrode. The cause of this is that the current passes from the surface of the mercury into the vapour by means of exceedingly small bright particles which move about the surface like will-o'-the-wisps. Small pits or depressions of about $\frac{3}{16}$in. to $\frac{1}{4}$in. in depth are also visible on the mercury surface. It seems as if the vaporised particles of mercury are searching for spots having suitable surface voltage or temperature only to destroy them when found. By adding suitable elements to the mercury these particles can be collected in a ring round the glass, or they will adhere to a platinum wire placed on the surface of the mercury, but after a few hundred hours the section of the wire decreases to a very great extent, which shows how great the reaction of the disintegration is. The size of the disintegrating particle depends apparently upon the amount of current passing into the vapour. In lamps of large diameter a dark space can be seen above the negative. This space, apparently, increases as the pressure of the gas in the lamp decreases and its temperature is lower than that of the luminous vapour. This is evident from the decidedly increased condensation of that portion of the walls of the lamps when burning at a low amperage. The vacuum in the lamp must be good, as otherwise the efficiency will be reduced. Under normal conditions, the drop in voltage at the negative terminal amount to five to seven volts, and at the positive terminal to about seven to nine volts. If mercury is used as the positive electrode, the drop will be increased by a few volts. As this is always greatest when the lamp is cold, the starting curve of the lamp is, in consequence, rather exceptional. It rises first, then drops, then rises again, and finally remains steady. This variation is caused by the rising curve of gas potential affecting the descending potential curve of the positive electrode.

The efficiency of the lamp is very great, amounting to about ·33 to ·45 watt-candles, or about eight times the efficiency of incandescent lamps. Further, the extent of the lighting surface obviates the use of reflectors, shades, etc., as there are no deep and accentuated shadows. The most important point about the lamp is that it emits rays which do not fatigue the eye. The light is exceedingly actinic, and is, in consequence, of great value to photographers and lithographers. Experiments have been carried out with the view of making the colour of the light more pleasing. This can be done either by adding red rays from the sources of light, such as incandescent lamps, or by fluorescence—*i e*, by transforming some of the mercury light waves into red wave-lengths. Rhodamin on silk is very suitable for that purpose. There is, of course, a certain amount of light lost in this modification, but by expending about 25 per cent. for this purpose a very pleasant illuminant is attained.

Many attempts have been made to manufacture other lamps similar to the mercury vapour type but using different metals. The difficulties encountered, however, were too great. Mercury is an ideal electrode as far as disintegration and regeneration is concerned. If other metals are used, difficulties arise in the regeneration of the negative, for they do not run back to the negative, as is the case with mercury. The glass also becomes affected, especially in the case of alkali metal, and the resistance of the gases makes it problematical as to whether a commercially successful lamp can be made except with mercury. Some lamps have been made lately of fused quartz glass, which allow all the ultra-violet rays of mercury vapour light to pass through instead of absorbing them, as is the case with incandescent lamps. This feature should be of very strong importance for the Finsen medical treatment.

With good treatment the life of a Cooper Hewitt lamp is very long; some have been used for over 15,000 hours. The decrease of light in good lamps amounts to about 20 per cent. during the first 1,000 hours, after which the candle-power remains constant. It is important not to burn the lamps with excessive pressure. This can be regulated by the resistances, of which the induction coil forms the most important part. The function of the coil

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can be explained as follows: There is a disinclination on the part of the negative electrode to remain in a state of disintegration. This is shown by the increase of resistance and the consequent decrease of the passing current. The momentary decrease of current causes an increase in pressure in the induction coil, which in its turn increases the process of disintegration in the electrode. The small variations are not noticeable at the ammeter for the reason that they take place so very rapidly. For 110-volt circuits the best practice is to use 75 to 80-volt lamps; the remainder of the voltage is absorbed in the resistance.

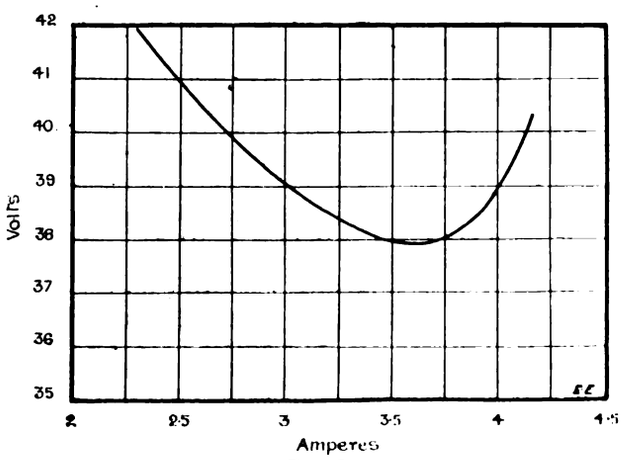

FIG. 2.

If smaller lighting units are desired, two lamps each of 40 volts are connected up in series. Smaller units using less than three amperes are, on account of the difficulties with the electrodes, not practicable. Larger lamps offer difficulties to the glassblowers.

With the old types of lamps great difficulties were experienced with the heat produced by the current and the consequent increased density of the vapour. If the lamps were not water-cooled, they burned very unsteadily. They were affected to a very great degree by the temperature of

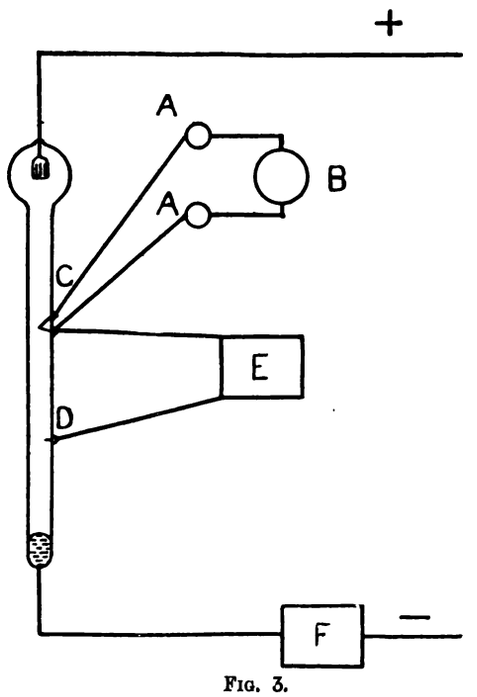

FIG. 3.

the surrounding atmosphere as well as by the voltage variations in the circuit. In consequence, the strength of the light varied considerably, and the lamp went out and could not be easily started again. This could have been corrected by the use of large resistances, but the commercial efficiency of the lamp would have been greatly reduced. Cooper Hewitt paid particular attention to the construction of a lamp which could be highly efficient and burn steadily with a very small resistance in circuit. He found that it was necessary to maintain the vapour at a fairly constant degree of density, and effected this by adding a cooling chamber of suitable dimensions to the lamp. The cooling chamber operates at the condenser for the disintegrated mercury and influences at the same time the density of the vapour. As the conductivity of the vapour is dependent on the density, the condensing or cooling chamber plays a very important rôle in the lamp.

The curve (Fig. 2) is that of an ordinary 50-volt lamp, such as is used when two are run in series on a 110-volt circuit. The efficiency of the lamp is highest when the current amounts to about three to four amperes. But apart from this, it is important to regulate the lamps for this current, as they are less affected by variations of the supply voltage or by the temperature changes of the surrounding air. If the lamps are used with excessive current, there is a visible contraction of the luminous column. This is also noticeable (with large lamps) when the current decreases. In fact, the section of the luminous vapour column increases when the current increases, and decreases when the density increases. If proper terminals are provided, the current can be increased until the high temperature melts the glass.

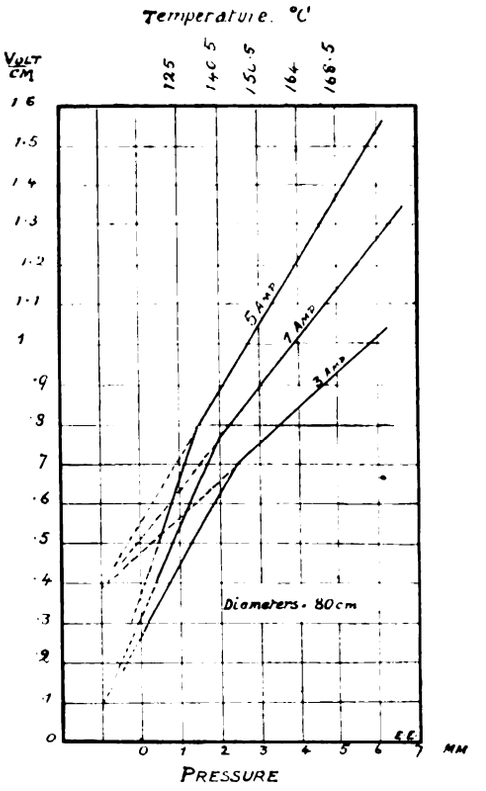

FIG. 4.

In order to determine the influence of density on conductivity, Cooper Hewitt made, with the assistance of A. P. Wills, the following experiment: A lamp was placed in an equally-heated air-bath, the temperature of which was then varied until the vapour in the lamp reached the desired density. The current was switched on, and simultaneously the drop of voltage between the point D and C (Fig 3) measured. In order to avoid new "negative electrodes," this measurement had to be made by means of a static voltmeter, E. All the experiments showed that the vapour density did not immediately change under the influence of the electric current; in fact, there was sufficient time to measure the drop of voltage in the vapour which had been produced by the air-bath. The pressure—*i.e.*, the density of the mercury vapour—was obtained from tables, and they were found to correspond with the temperature readings of the lamp and air-bath, which were measured by thermometer at C and galvanometer at B. The readings indicated that the pressure per centimetre was directly proportional to the density of the vapour, and inversely proportional to the diameter of the tube. With a given density vapour and given current the section of the luminous column assumes a certain dimension, which decreases as the density increases. The curve (Fig. 4) shows the pressure in volts per centimetre with different vapour pressures and different currents. With smaller tubes similar curves are

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obtained, with the exception that the rise is steeper and the curves come somewhat higher. It is evident that for vapour pressures above ½mm. the curve of voltage per centimetre and of vapour pressure is represented by two straight lines forming an obtuse angle. The position of this point of intersection is dependent on the diameter of the tube and also on the current. The pressure at this point is

$$\Delta_q = \frac{\sqrt{J}}{\sqrt{D}} \text{ approximately,}$$

where J = amperes,
D = diameter in centimetres.

From this point onwards the walls of the tube do not seem to affect the section of the vapour column. But, as previously mentioned, the diameter of the luminous column decreases as the pressure increases. The accompanying curves (Fig. 4) shows the relation between the volts per centimetre and the current with 1mm. pressure. It indicates clearly that by increasing the current the conductivity is also increased. Probably the explanation of this is that by increasing the current more heat is produced in the vapour column. The heat drives some of the vapour out out the column, and increases thereby the conductivity of the latter. It is, of course, assumed that there is sufficient space in the lamp to hold those particles of vapour which are not acted upon by the current. The next curve shows the relation between the voltage per centimetre and the diameter of the tube, the pressure remaining the same—namely, 1mm. From this curve it can be seen that the effect of the walls of the tube on the section of the luminous column is greater with tubes of small diameters than with those of large diameters. Although these laws which Hewitt has discovered apply only to the mercury vapour, it is more than probable that they will also hold good for other vapours.

It is not the purpose of this article to deal with the actual application of the Cooper Hewitt lamp. Photographers and lithographers have found that, instead of using 25 to 50 amperes with arc lamps, they only need about three amperes with the Cooper Hewitt lamp, and at the same time can obtain better results on account of the light being so evenly distributed all over the tube. The diffusion of the light and the absence of red rays, which are well known to fatigue the eyes, make the lamp especially suitable for machine shops and drawing offices. The Cooper Hewitt Electric Company (represented in this country by the British Westinghouse Company) supply lamps for general illumination or for special purposes.

NOTES ON AERIAL POWER LINES.

BY CHE.

The probable introduction of overhead high-tension power transmission lines in this country brings into prominence the necessity for the consideration of several important factors in the design and construction of aerial lines, with which very few engineers have had experience, and in these notes it is proposed to consider the problems underlying the elementary principles of the construction of line wires and their supports.

Obviously, the supports and lines are subjected to various stresses for which provision must be made when designing the same. These stresses are: (1) stresses due to the weight of the conductors and any accidental overload, such as accumulation of snow and ice; and (2) stresses due to the lateral pressure of the wind on the poles and wires. In addition to these stresses, the poles are more or less affected by the effects of vibration.

Dealing with the design of the poles first, and considering only poles of wood, it is clear that the former stresses introduce a compressive or crushing force, whilst the tension in the wire due to its weight and sag, as well as the wind pressure, introduce a flexing strain. If the pole is sufficiently strong to withstand the flexing stress, there is not much danger due to the compressive or crushing force, especially as a very large factor of safety is introduced. Then, again, when the track is a straight line and the spans are equal in length, the longitudinal tensions on any support balance each other, so that the poles have only to resist the weight of the wire and the wind pressure. It is also clear, from first principles, that a pole subjected to a horizontal force tends to bend in the direction of the force, one side being in compression whilst the other side is in tension. In practice the shape of the pole is that of a truncated cone, and it may be shown that the taper for a conical pole to satisfy ordinary working conditions should have the relation

$$d_2 = \tfrac{3}{2} d_1,$$

in which d_1 and d_2 are the diameters of the top and bottom of the pole. If the diameter of the pole at the point of application of force is equal or greater than two-thirds of the diameter of the pole at the surface of the ground, the point of rupture would occur at the surface of the ground, whilst if the diameter at the bottom of the pole is less than $\frac{3}{2}$ times the diameter at the top, the pole will tend to break above the ground line, and be inferior to the strength indicated by the diameter at the top of the pole.

In dealing with the forces acting on the pole, it is best to treat the problem as if the pole were a beam fixed at one end and loaded at the other, and if

I = the moment of inertia of the section $= \frac{\pi d_2^4}{64}$;
T_1 = resistance to rupture per unit section of the material;
h = height of the point of application above the ground;
c = distance from the centre to the fibre under maximum stress $= \frac{1}{2} d_2 = r$ (radius);
F = the horizontal force or the resultant tension in the wires which a pole will support at the instant of rupture, when it occurs at the ground level;

the moment of resistance, M, is given by

$$M = \frac{T_1 I}{c} = \frac{T_1 \frac{\pi d_2^4}{64}}{\frac{1}{2} d_2} = \frac{\pi d_2^3 T_1}{32} = \cdot 7854\, r_2^3\, T_1.$$

The moment of the force applied is

$$M = F h$$

$$\therefore F h = \cdot 7854\, r_2^3\, T_1$$

and $$F = \frac{\frac{\pi}{4} r_2^3 T_1}{h} \text{ or } \frac{\pi d_2^3 T_1}{32 h}$$

and $$T_1 = \frac{4 F h}{\pi r_2^3} \text{ or } \frac{32 F h}{\pi d_2^3}$$

and $$d_2 = \sqrt[3]{\frac{32 F h}{\pi T_1}} = \sqrt[3]{\frac{10{\cdot}18 F h}{T_1}}.$$

The generally accepted values of the tensile strengths, T_1, for the woods most commonly used for poles are as follows: chestnut, 7,000lb. to 13,000lb.; cedar, 11,500lb.; yellow pine, 5,000lb. to 12,000lb.; redwood 11,000lb. In practice only a fraction of these values are taken, so that in the above formulæ $\frac{1}{n} T_1$ should be substituted for T_1, and n, which is the "factor of safety," is usually taken as 10. We thus have for working values of F, T_1, and d_2

$$F = 0{\cdot}00982 \frac{d_2^3 T_1}{h}$$

$$T_1 = \frac{101{\cdot}8 F h}{d_2^3}$$

$$d_2 = \sqrt[3]{\frac{101{\cdot}8 F h}{T_1}}.$$

For corner posts, as when there is a change in the direction of the line—*i e*, when the track is not a straight one—the resultant of the line tensions is not zero, and an additional force is introduced tending to deflect the post, the magnitude and direction of which are readily determined by application of the principle of the parallelogram of forces. Also, when two adjacent spans are not of equal lengths, although the track is a straight one, there is an unbalanced tension. The graphical solution in the case of corner posts is given in Fig. 1, in which O R is the resultant of the equal but inclined tensions, O A and O B or T_2, and if θ be the

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supplement of the angle contained by the wires we have—

$$OR = T_2 \frac{\sin\theta}{\sin\frac{180-\theta}{2}}$$

$$= T_2 \frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cos\frac{\theta}{2}}$$

$$= 2\,T_2 \sin\frac{\theta}{2}.$$

To counterbalance this effort, the pole must be either stiff enough to stand the bending moment, or else the top of the pole must be anchored in an opposite direction to the resultant stress by means of a guy-wire or rod. If the track is on a slope, so that there is a difference of level between the two supports of a span, there will also be an unbalanced tension to take into account. Should a wire on one side of a post become ruptured, an additional tension is introduced on the other side.

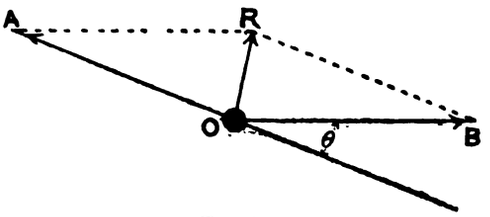

FIG. 1.

The Board of Trade regulations (Clause 17) for securing the safety of the public under the Electric Lighting Acts, 1882 and 1888, set forth that "Every support for an aerial line shall be of a durable material and properly stayed against forces due to wind pressure, change of direction of the line, or unequal length of span. The factor of safety shall be for aerial lines and suspending wires at least 6, and for other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow."

Dealing with the tension of aerial wires, it is well known that when a wire is stretched between two points, A and B (Fig. 2), situated at the same level, the curve A D B, known as the catenary, is formed, and the horizontal distance, A B, is termed the *span*, while the vertical distance, C D, between the lowest point of the curve and the horizontal line, A B, is the *deflection*.

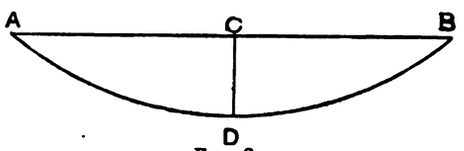

FIG. 2.

Let l = distance between the supports;
s = the sag at a standard temperature;
L = actual length of the wire at the standard temperature;
w = weight of unit length of the wire at the standard temperature;
w_s = weight of snow per unit length of the wire;
θ = standard temperature in degrees C.;
F = horizontal tension of the conductors at the standard temperature at the centre of the span;
d = diameter of the bare wire;
α = coefficient of expansion of the wire per degree C.;
n = factor of safety;
F_u = ultimate tensile strength of the wire.

Then from the properties of the catenary we have, to a close approximation, for ordinary conditions

$$s = \frac{l^2 w}{8F} \quad . \quad . \quad . \quad (1) \qquad F = \frac{l^2 w}{8s} \quad . \quad . \quad . \quad (2)$$

$$L = l + \frac{8s^2}{3l} \text{ or } \frac{L}{l} = 1 + \frac{8}{3}\frac{s^2}{l^2} \quad . \quad . \quad (3)$$

the ratio $\frac{s}{l}$ being the *ratio of deflection*.

Combining equations (1) and (3) we have

$$L = l\left(1 + \frac{l^2 w^2}{24\,F^2}\right) \quad . \quad . \quad . \quad . \quad (4)$$

The tension at either support is given by the equation

$$F_s = F + ws \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

in which ws is a quantity equal to the weight of the wire for a length s equal to the deflection; except in cases, however, where the deflection is very great, F_s does not sensibly differ from the horizontal tension, F, at the lowest point, and no serious error would be introduced by using F instead of F_s. Now, equation (5) may be written

$$F_s = \frac{l^2 w}{8s} + ws = wl\left(\frac{1}{8}\cdot\frac{l}{s} + \frac{s}{l}\right) \quad . \quad . \quad (6)$$

If we denote $\left(\frac{1}{8}\cdot\frac{l}{s} + \frac{s}{l}\right)$ by k, then $F_s = wlk$; wl is obviously the total weight of a wire equal to the span in length, and k consequently denotes the *tension per unit span weight*. k may be obtained experimentally for all ordinary proportionate deflections, and from a curve plotted from these results the total tension at the supports and sags may be determined for all practical cases. Introducing the factor of safety, n, and the ultimate tensile strength of the wire, F_u, we have

$$wlk = F_s = \frac{F_u}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

but F_u may be expressed as c times the weight of the wire used, consequently

$$wlk = \frac{F_u}{n} = \frac{c \times 5{,}280\,w}{n} \quad . \quad . \quad . \quad . \quad (8)$$

If w is the weight per foot, and l in the above equations is given in feet, therefore

$$nlk = 5{,}280\,c \quad . \quad . \quad . \quad . \quad . \quad (9)$$

but if the mile be the unit of length in the above equations,

$$nk = c \times \frac{1}{l} \text{ or } n = \frac{c}{k} \times \frac{1}{l} \quad . \quad . \quad . \quad (10)$$

in which $\frac{1}{l}$ = number of poles per mile. Equation (10) is a simple relationship connecting the factor of safety, the tensile strength and density of the material, the value of k, and the number of poles per mile. The weights of one mile of copper and aluminium one square inch cross-section are respectively 20,371·878lb. and 6,178·54lb., so that if the tensile strength of a given wire be known, c is readily determined.

Coming to the question of wind pressure, one is met with some very contradictory results made by different investigators. Semenza, for instance, gives the maximum effort due to the wind as 280 kg. per square metre of plane surface, and the effective surface of the wire as its length multiplied by half of its diameter. He also gives the formula

$$P = 3 \times 10^{-5}\, d\, v^2,$$

in which P = kilogrammes per centimetre length, d = diameter of the wire in centimetres, and v = velocity of the wind in metres per second, as being more nearly in accordance with observed values. In this country the Board of Trade fix it as 50lb. per square foot, and in no case should be taken at less than 40lb. per square foot. To determine the area of the plane surface acted upon by the wind, it is usual to take the pressure per foot length on a cylindrical surface, whose diameter is d, as being from 0·5 to 0·75 times the pressure due to the wind per foot length on a flat surface of width, d, and as a mean between these two extremes two-thirds of the pressure expressed by the flat surface may be taken as a satisfactory value for cylindrical wires. Since the weight of the wire acts vertically downwards, whilst the wind acts horizontally, the resultant of the weight of the wire and the wind pressure is given by the relation

$$p = \sqrt{p_1^2 + p_2^2},$$

in which p_1 and p_2 denote respectively the forces due to the weight of the wire and the wind pressure.

(To be continued.)

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ARTIFICIAL DRAUGHT FOR BOILER PLANTS.

BY F. H. DAVIES.

Up to a comparatively recent date, artificial draught as a substitute for the chimney in boiler installations was looked upon chiefly as a means for obtaining a higher duty out of fully-loaded steam-raising plant, or as the only possible alternative where æstheticism forbade the erection of a chimney. Now, however, the true facts of the case are daily becoming more fully recognised, and there is a growing tendency among engineers to regard properly-applied artificial draught as a very valuable adjunct for securing both capital and revenue economy. The objects of a draught are to supply the boiler fires with a sufficient quantity of air to allow of proper combustion of the fuel, and to carry off the resultant gases. Setting aside chimney draught, which is foreign to the subject, this may be done in one of three ways, with several variations of each.

Steam Jet.—Perhaps the earliest, and certainly the least efficient, system of artificial draught from the point of view of power consumption, is that known as the steam jet. In its nature it is a somewhat unscientific application, and rather wasteful; it is, however, in large use, and under certain conditions, despite its failings, appears to be doing good work. In principle it is very simple. The ashpit of the boiler is closed by an airtight door, and the steam jet is conducted to the underneath side of the furnace through properly-shaped nozzles. By the aid of a simple injector arrangement the steam in its flow is allowed to draw in a certain quantity of air, and the two together create a pressure in the ashpit higher than that of the atmosphere. The result is a draught through the fires, which may be regulated in intensity by the aid of valves in the steam and air pipes. The system has this to commend it: it is simple, very convenient, and decidedly the cheapest to instal; in addition, it is credited with preventing the formation of clinker to a certain degree by keeping the bars cool. On the other hand, there is much to be said against it—enough to put it beyond consideration in many cases. Unless the jets are most carefully distributed they are apt to cause excessive centralised heat in places on the firebars, with resultant burning of the latter; and if the steam is at all wet, the boiler will probably suffer harm. The great charge against the steam jet, however, is its wastefulness as compared with any other form of artificial draught producer. Under the most favourable conditions it will absorb approximately 3 to 5 per cent. of the total steam generated by the boiler to which it is attached; and in bad cases this amount may be increased to 10 or even 20 per cent. The steam jet may thus be looked upon as undesirable in any installation where high-priced fuel is used and economy is a desideratum. Only in situations where fuel may be obtained at an almost nominal figure, or where refuse is to be destroyed by the aid of forced draught, should it receive consideration, and then chiefly because of its low initial cost. Furnaces fitted with this type of forced draught have been proved capable of burning coal of the lowest calorific value and dust which in the ordinary way would be quite useless.

Mechanical Draught.—Mechanical draught has many advantages over what is termed the natural draught produced by a chimney. In the first place, the capital outlay is very much less, for although with any artificial draught something in the way of a chimney is necessary to carry off the products of combustion, it need be only comparatively small, and built of steel upon light foundations. Mechanical draught renders the plant entirely independent of atmospheric conditions, which have a very marked effect upon the efficiency of a chimney. In addition, it gives the fireman a thorough control over his draught, which, if properly taken advantage of, is of great value in securing high fuel economy. This adaptability to circumstances, which the chimney lacks, means that all classes of fuel, even those of the lowest quality, may be burnt efficiently and thoroughly, and that sudden calls for steam, such as are common in electrical work, may be met with ease by an increase of the draught pressure. Extensions, too, are much simpler and cheaper, as an increase in boiler plant which may be sufficient to overload a chimney calls merely for the installation of another fan. In this connection it should be mentioned that there is in total an economy of floor space, since higher evaporative duty may be obtained from the boilers with artificial than with natural draught. The temperature of the exit gases with chimney draught must not be less than about 400deg. F., as upon the temperature of the gases in the chimney the draught depends. With artificially produced draught this necessity for considerable heat in the chimney is, of course, absent, and consequently the furnace gases may have practically all their heat taken out of them and utilised for economical purposes. Methods of subtracting this heat and turning it to useful account will be dealt with later.

Mechanical Forced Draught.—Mechanical forced draught is obtained by the aid of fans which supply air under pressure to the boiler fires. There are two methods of doing this. That usual in marine practice is to close all air inlets to the stokeholds excepting that through the fan, which, according to the speed at which it is run, maintains the pressure in the stokeholds slightly or largely over that of the atmosphere. At the best of times a ship's funnel is a poor draught producer compared with a land chimney, and hence, if high speed and consequent boiler forcing is a necessity, as in the case of warships, mechanical draught has to be resorted to. On shore it is practically impossible to render a boiler-house airtight, and neither is it necessary, since better results may be secured by closing the ashpits, as in the steam-jet system, and leading the draught into them through special channels, regulated each by dampers.

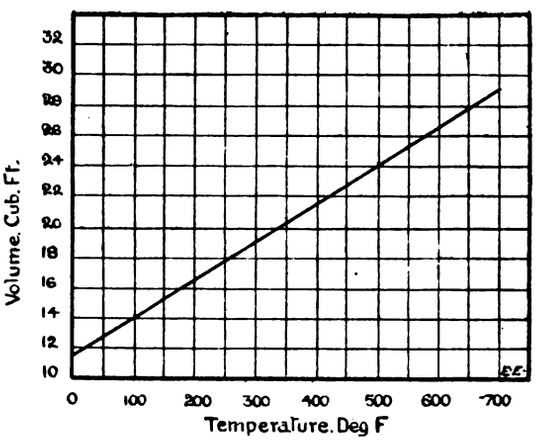

FIG. 1.—Curve showing the Volume of 1lb. of Air at atmospheric pressure at various temperatures.

The Howden system of forced draught is an extremely efficient one, and representative of the best practice. By the arrangement of first passing the air through tubes placed in the path of the furnace gases a large proportion of the heat of the latter is made useful, and the draught, before it is delivered to the fires, attains a temperature of from 150deg. to 170deg. F. The advantages arising from this use of heated air are an increased average furnace temperature, and, therefore, higher evaporation and a smaller excess of air, owing to the facilitated combination of the oxygen with the fire gases. In the Howden system the heated air is supplied both below and above the fires by an arrangement of air-boxes placed on the front of the boilers, and its quantity may be regulated by valves. A closed ashpit is not necessary in this system. The danger of a careless stoker opening the firedoors without first shutting off the draught, and so causing the flames to come out of the front of the boiler with the risk of severe burning, is one which has frequently been advanced as an objection to forced draught. In this system, however, such an occurrence is impossible, as the doors cannot be opened until the draught is completely shut off. A further objection, that forced draught is apt to blow holes in the fire, is easily got over by a careful regulation of its intensity with the thickness of the fire, and a proper distribution of the draught over the incandescent surface.

Induced Draught.—Induced draught is comparable to natural chimney draught, in that it is caused by the maintenance of a lower pressure in the flues than that of the atmosphere. This difference in pressure may at times amount to as much as 4in. of water. With induced draught

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the fan is situated in the flues or at the base of the chimney, and it is thus exposed to the full heat of the furnace gases, and to the destructive action of the grit that is carried over from the fires. In early days this was considered an almost fatal objection to the system, but experience has proved that although the wear and tear of the fan is certainly greater than in the case of forced draught, there is no

manner in which the power required to run the fan mounts up with the heat of the gases. The induced-draught system lends itself very well to the thermal economy obtained by heating the air prior to its being drawn into the furnace. This is effected in much the same manner as that described above; horizontal or vertical tubes are placed in a favourable position in the flues, and the air passes first through

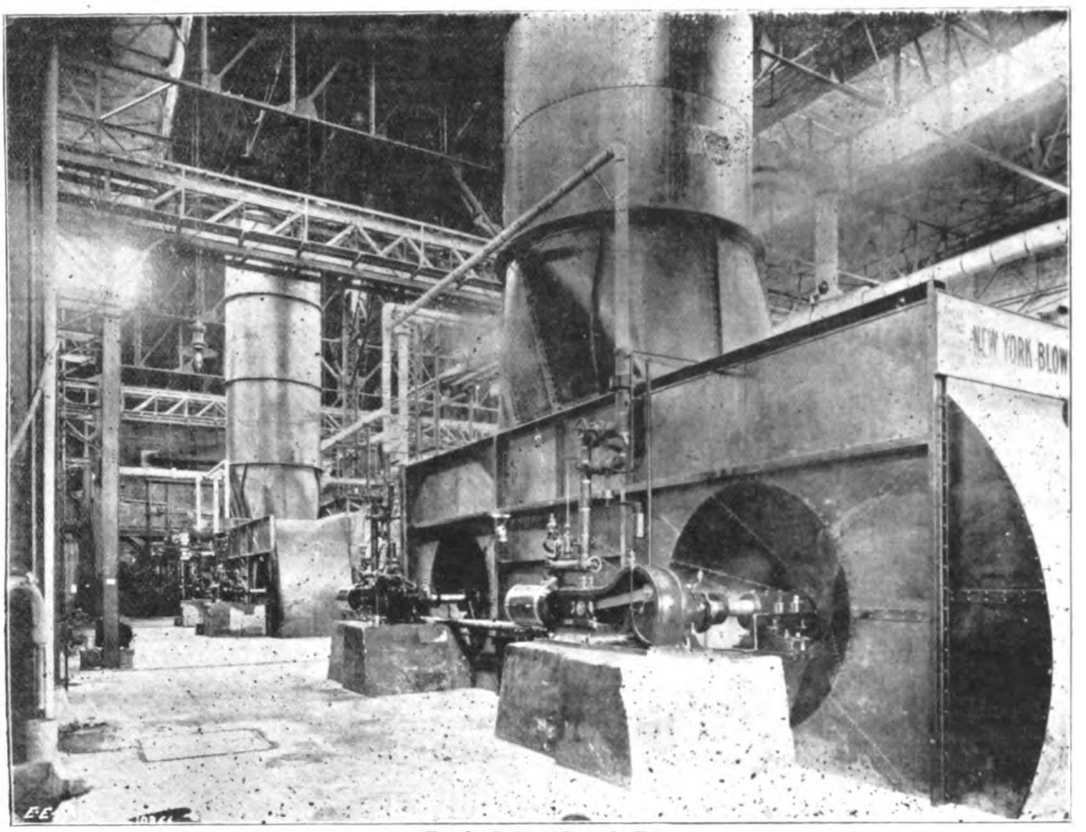

FIG. 2.—Induced Draught Fans.

difficulty whatsoever in successfully working fans in flue gases up to and even exceeding 500deg. F. In the case of all but the smallest installations the fans are always provided with water-cooling gear attached to the bearings, which entirely prevents overheating. An open ashpit is, of course, used with induced draught, which possesses all the advantages of forced draught in the ease and convenience of control. The fan, however, takes rather more power to drive it (from 1 to 2 per cent. of the boiler output), and the system is consequently not quite so economical. The reason of this is that, although the weight of air dealt with is the same as in the case of forced

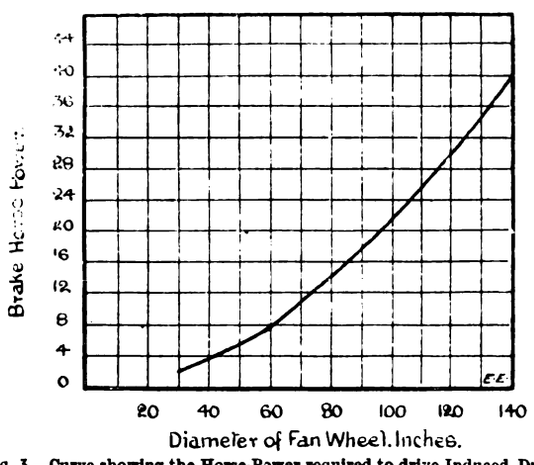

FIG. 3.—Curve showing the Horse-Power required to drive Induced Draught Fans of various sizes in a flue temperature of 550deg. F.

draught, its volume is much greater, due to the fact that it is at a high temperature, and consequently, to remove the same weight of air and to create the same draught, the fan must be larger or must revolve at a quicker speed. The increase in the volume of air with temperature is shown in curve form in Fig. 1, which will convey an idea of the

them before reaching the fires. A good example of an induced-draught installation is shown in Fig. 2. In this case economisers were not installed, as the plant was only a temporary one; their use, however, is highly desirable, not only because of the saving in fuel effected by them, but in order to reduce the temperature of the gases in which the fan works, and, therefore, the power required to operate it.

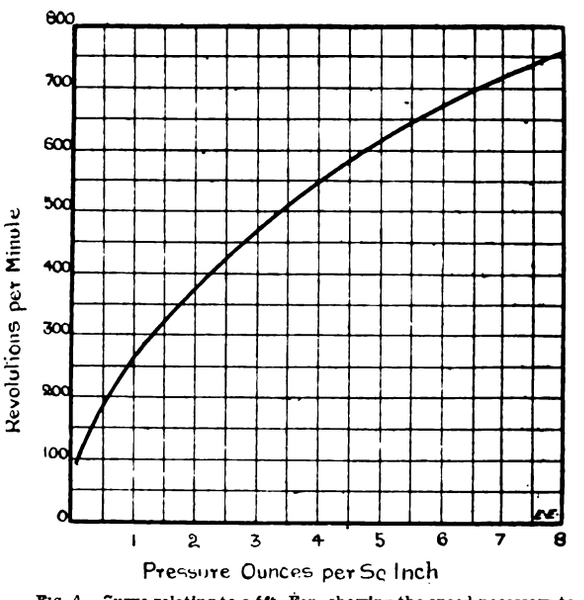

FIG. 4.—Curve relating to a 6ft. Fan, showing the speed necessary to maintain various pressures over a suitable area.

Fans.—The fan being the integral part of all mechanical draught systems, some few details of its nature and operation may not be out of place. There are two classes of fans which may be used for creating a draught—the type something akin to a propeller, which throws the air off in a direction at right angles to the blades, and the centrifugal

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class, which, drawing the air in at the centre, discharges it at the ends of the blades in a tangential direction. This latter is practically the only form used for the purpose in question; the propeller type may therefore be neglected. The curves shown in Figs. 3 and 4 speak for themselves They are based upon the published figures of the American Blower Company and the Sturtevant Company respectively. The air pressure which any given fan will generate depends upon its peripheral velocity, varying as the square of its speed. The velocity of the air discharge with a free outlet is practically equal to the peripheral velocity of the wheel, and the power absorbed varies as the cube of the speed. It is, therefore, preferable to use large vans at low velocities than small ones running at a high speed. The actual performance of a fan will vary considerably from its theoretical performance with the size and shape of its casing. General rules, therefore, are not of very much practical value for application to every class of fan, and only serve to outline the performance. In the same way the effective draught at the chimney base with any given fan will depend largely upon the nature of the passages provided for the air. If these are small and tortuous they will naturally give rise to a considerable loss, and increase the percentage of the boiler power required by the fans. As a rule, air flues are built of brick, which should be glazed or thoroughly painted to prevent leakage. In some cases, however, iron or earthenware pipes are used, great care being given to their jointing for the above reason. All things being considered, the installation of a fan draught to obtain the best results is by no means a simple matter, and requires a fair amount of special knowledge. This is particularly the case as regards the fan itself, little being known of its relative performance under different circumstances outside the ranks of specialists.

WIRELESS TELEGRAPHY MEASUREMENTS.*

BY W. DUDDELL, MEMBER, AND J. E. TAYLOR, ASSOCIATE MEMBER.

In spite of the very large amount of matter that has been published on the subject of wireless telegraphy, there is very little quantitative data available. The object of the present tests was to measure the R.M.S. value of the current in the receiving air wire and to determine as far as possible how this current depends on the arrangement of the transmitting and receiving apparatus and the distance between them. The following preliminary tests were officially carried out by the authors for the Postal Telegraph Department, at the instance and under the control of the engineer-in-chief, Mr. J. Gavey, C.B., in Bushy Park, in June, 1904. The tests were made between a transmitting station which could be easily and quickly moved to any part of Bushy Park as required and a receiving station which was set up in a fixed position for about one-half of the tests, and was then taken down and reset up in a fresh position and many of the former tests repeated. All the transmitting apparatus was fitted up inside a large Post Office temporary telegraph van, behind the driver's seat of which a bamboo mast was fixed. The vertical wire—a $^{7}/_{22}$ G.P. (cable core)—was suspended from a spar on this mast, and could be raised or lowered as required. The earth connection was made to the centre of a piece of galvanised iron wire netting 76ft. long and 3ft. 10in. wide, fixed flat on the top of the grass alongside of the van.

In all the experiments given in this paper the vertical wire was directly connected to the closed oscillating circuit, as shown in the diagram of connections (Fig. 1). The method of operation is based on the excitation of oscillations in the antenna by directly connecting it to a closed oscillating circuit, some other point of which is connected to earth. There are thus two distinct resonant systems; one a closed circuit, consisting of a condenser and inductance spiral, L, and the other the antenna, inductance spirals, H and L, and the wire netting or surface of the ground. When made to have the same period of electric vibration, oscillations are communicated to the antenna. Adjustment for this purpose was made by altering the self-induction, H, until the current in the air wire was a maximum, as indicated on the thermal ammeter, A. A well-defined maximum was readily obtained in this way, though sharper tuning could have been reached by reducing the amount of coupling between the two resonant systems. It was found, under the conditions of working, that there corresponded to each combination of self-induction and capacity a spark-length which gave the required current in the transmitter air wire. The frequency of the oscillations was altered when required by changing the size and number of the jars used, and the vertical wire was always tuned to suit the oscillating circuit by altering the number of the turns of the self-induction, H, in series with it. This adjustment was made by observing the current by the Duddell thermo-ammeter, A, and adjusting the number of the turns of the self-induction till this current was a maximum. The self-induction, H, consisted of 71 turns made by winding two No. 16 tinned copper wires side by side, touching one another in a shallow screw thread on a wooden cylinder 4in. diameter and 18in. long. The jar or jars, F, were charged by an induction coil, I, through two choking coils, intended to protect the induction coil from the oscillatory currents. The induction coil (a 30cm. spark size instrument) was supplied by 15 accumulators, a resistance being used in series with the coil. Two different interrupters were used: (1) a mercury turbine interrupter; (2) a Grisson interrupter.*

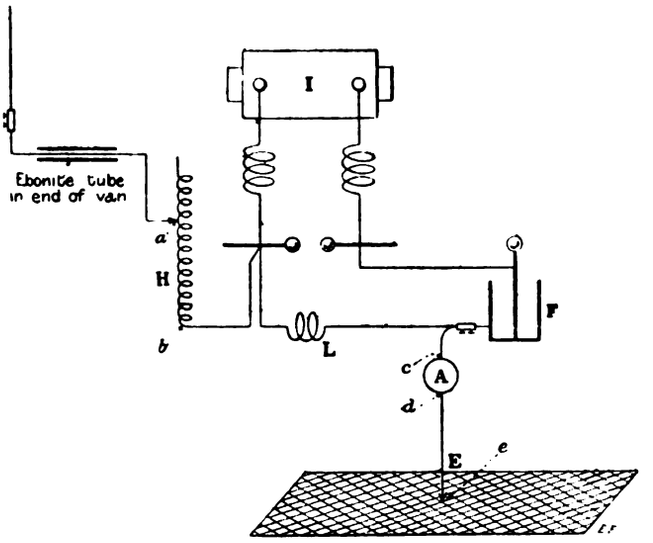

FIG. 1.

The mercury turbine interrupter was driven in all the tests at a speed of 1,070 r.p.m., giving 17·9 trains of oscillations per second; and the latter was run at 1,500 r.p.m, giving about 100 trains of oscillations per second. Signals lasting 30 seconds, with an equal time interval between them, were regularly sent from the transmitter, and during each signal an observation of the current in the vertical receiving wire was made. In general from eight to twelve such observations were taken for each experiment. In most of the tests the height of the top of the vertical transmitting wire from the ground was 42ft., the length of wire from the top to the terminal of the self-induction being 48ft. 6in. The length of the earth connection was 28ft. 4in., and about 4ft. 6in. of wire was used in making the connections between the self-induction, spark-gap, jars, and ammeter inside the van. Three different wave-lengths were used in the tests, obtained by altering

* Paper read before the Institution of Electrical Engineers.

* The Grisson interrupter is used with a special induction coil or transformer having a connection made to the middle point of the primary, so that a current flowing in at this point and dividing equally between the two halves produces no magnetic field. This point is connected to one pole of the battery, the other two terminals being connected alternately with the other pole of the battery by means of a revolving commutator. The following series of actions takes place:

1. Current through first half of primary, magnetising core.
2. ,, ,, both halves, no magnetisation.
3. ,, ,, second half of primary, core oppositely magnetised
4. ,, ,, both halves, no magnetisation.

In action it is necessary to regulate the speed of the commutator so as to produce a resonance between the secondary circuit and the rate of reversal in the primary.

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the capacity in the oscillating circuit and tuning the vertical wire to suit. In each case the self-induction, L, in the oscillating circuit, which consisted of two turns of stranded conductor wound on a wood core 127mm. diameter, 7mm. pitch, was kept the same. The stranded conductor consisted of 19 No. 22 copper wires, each separately silk covered.

Wave No. 1.—The capacity, F, consisted of one four-pint jar half covered with tinfoil. Wave-length, about 375ft. With this wave-length and the vertical wire 42ft. high, the following data were always worked to unless stated to the contrary: Spark-length, 5·29mm. Current in vertical wire, about 0·36 ampere with mercury interrupter. Number of turns of self-induction in series with vertical wire, 12

Wave No. 2.—The capacity, F, consisted of one four-pint jar completely covered with tinfoil. Wave-length, about 400ft. With 42ft. vertical wire, unless stated to the contrary, the other data are: Spark-length, 7·08mm. Current in vertical wire, about 0·50 ampere with mercury interrupter. Number of turns of self-induction in series with vertical wire, 18.

variable self-induction the same size as that used in the transmitter circuit (H, Fig. 1), and the other end of this self-induction was connected to earth through a Duddell thermo-galvanometer, which was used to measure the received current. The earth connection was made to the centre of a piece of wire netting 77ft. long by 3ft. 10in. wide. The vertical height of the air wire from the ground was in most of the tests 56ft., the total length of wire from the top to the terminal of the self-induction being 65ft., and the length of the earth connection 19ft. 3in. The receiving circuit was tuned by altering the number of turns in the self-induction until the current as shown by the thermo-galvanometer was a maximum. Observations were generally made both with the circuit tuned as above and also with the air wire connected direct to earth through the thermo-galvanometer without any self-induction in series; this arrangement will be called "untuned." In the thermo-galvanometer the current to be measured flows through a fine resistance about 3mm. long, and the heat given out by it falls on a small thermo-junction fixed to the moving part of the instrument. The sensibility can

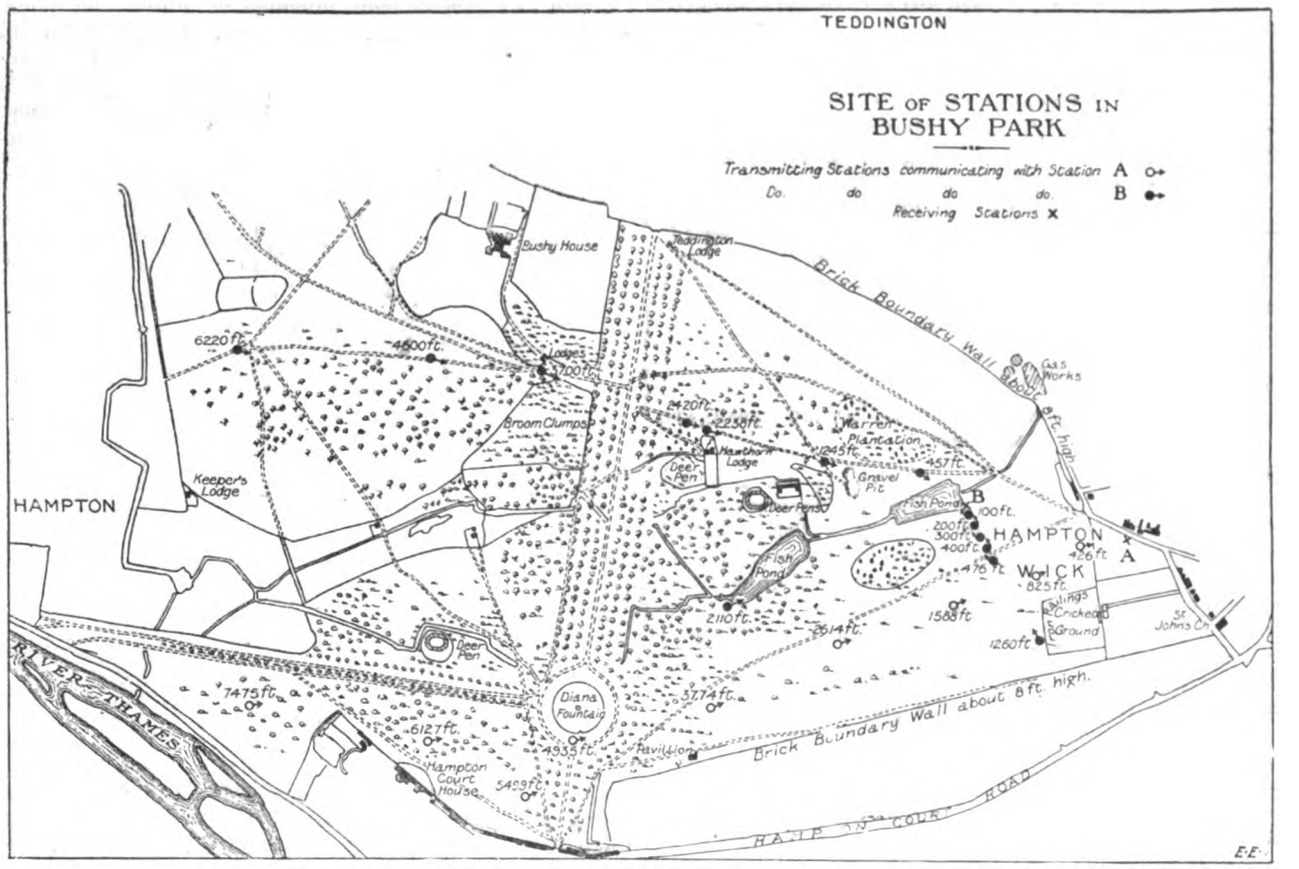

FIG. 2.—Reproduced from the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office.

Wave No. 3.—The capacity, F, consisted of two four-pint jars completely covered with tinfoil used in parallel. Wave-length, about 500ft. With 42ft. vertical wire, unless stated to the contrary, the other data are: Spark-length, 4·55mm. Current in vertical wire, about 0·50 ampere with mercury interrupter. Current in vertical wire, about 0·70 ampere with Grisson interrupter. Number of turns of self-induction in series with vertical wire, 40.

The receiver was first set up in a paddock at the point marked A on the accompanying map (Fig. 2). The vertical wire was suspended from a spar fixed to the top of a terminal pole belonging to the telephone system; the overhead telephone wires ended at this pole, and were taken down the side of the pole and under the park in a cable. The terminal pole was stayed with stout stranded iron wire. To make certain what effect these telephone wires and stays were having on the results, the receiver was moved to point B on the map (Fig. 2), near the fishponds. In this position the vertical wire was hung from a light bamboo tied to the top of a London County Council fire-escape. The receiving instruments were, in each case, set up inside a small wooden contractor's office. The vertical air wire—a $^{7}/_{22}$ G.P. (cable core)—was connected to a

be altered either by varying the resistance of the heater or by altering the distance between the heater and the thermo-junction. The resistance of the heaters used was about 100 ohms, and the sensibility was adjusted by changing the distance between the heater and the thermo-junction, so that throughout each series of tests both the resistance and the lengths of wire used in the measuring circuit remained constant.

Height of Transmitting Air Wire Varied.—Three different lengths of wire were used so as to make the vertical height of the transmitting air wire 21ft., 31·5ft., and 42ft. The arrangement of the closed oscillating circuit, and consequently its own frequency of oscillation, was not altered: the air wire being retuned to the same frequency as the oscillating circuit by altering the number of turns of the self-induction in series with it. When the height of the air wire is increased, we may keep the power supplied to the coil and the length of the spark-gap constant, in which case the current in the air wire will also increase though not in the same proportion; or we can keep this current constant by altering the spark-gap and the power supplied to the coil. Both these arrangements were tested. The results are given in Table I. The tests were repeated with

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two different wave-lengths. Of course, during the tests the arrangements at the receiver end were kept constant. Taking first the figures for the receiver tuned to the same frequency as the transmitter, and the current in the transmitter air wire kept approximately constant, it is seen that the receiver current is very closely proportioned to the height of the transmitter air wire. In the results, where both the height and the current in the transmitter air wire varied (spark-length constant) the received current is nearly proportional to the product of the height into the current in the transmitter. So that calling the vertical height of the transmitter air wire h, and the current flowing into it A, we may write the received current, in micro-amperes, $k\,h$ A, where k is a constant which has the value 16·6 for wave No. 1 and 20 for wave No. 2, h being in feet and A in amperes. Using these two constants, a column of calculated currents has been worked out for comparison with the observed values. Turning next to the results with the plain air-wire receiver (untuned), it is not possible to find values for the constant k which will fit the results at all satisfactorily. The nearest values are $k = 5{\cdot}3$ for wave No. 3, and 16·7 for wave No. 1. These observations require to be extended on a larger scale before it can be said what the exact relation is between the height of the transmitting antenna and the current in the receiving air wire, though it appears to tend towards a simple ratio.

TABLE I.—Height of Transmitting Air Wire Varied. Receiver in paddock, distance 1,588ft. Height of receiver air wire, 56ft. Mercury interrupter.

Vertical height of transmitter air wire—feet.	Turns of self-induction in series with transmitter air wire.	Spark-gap length. Millimetres.	Current in transmitting air wire. Amperes.	Receiver. — Tuned. — Current observed. Micro-amperes.	Tuned. — Calculated current if $k=16{\cdot}6$. Micro-amperes	Air wire only. — Current observed. Micro-amperes.	Air wire only. — Calculated current if $k=5{\cdot}3$. Micro-amperes
Wave No. 3 (500ft.).							
21	66	5·21	0·351	121	122	38·5	39·1
31·5	52	3·86	0·355	188·5	185·5	60	59·3
42	40	3·48	0·352	246	246	81·5	78·5
21	66	3·48	0·286	100	99·5	30·5	31·8
31·5	52	3·48	0·334	174·5	174·5	55	55·7
42	43	3·48	0·359	250·5	250	82·5	79·9
Wave No. 1 (375ft.).							
—	—	—	—	—	$k=20$	—	$k=16{\cdot}7$
21	26	10·04	0·352	140	147·5	109	123
31·5	18	8·26	0·351	223	221·5	183	185
42	12	6·35	0·360	315	302·5	272·5	252
21	26	5·39	0·305	126	128	103	107
31·5	18	5·39	0·339	213	213·5	182	178
42	12	5·39	0·355	308	298	270·5	248·5

Arrangement of Transmitter Air Wire Varied.—The results obtained are given in Table II. The main point to be noted is that, taking a constant length of transmitter air wire and reducing its vertical height to one-half, by rolling up half of it at the top, or by carrying it out horizontally for half its length and then fixing the remainder vertical, or by forming a vertical loop, the current in the receiving air wire is reduced to approximately one-half the value it has for the whole transmitter wire vertical. So that reducing the vertical height by any of these methods has the same effect as cutting off the wire from the top as found in last section. Taking the air wire having a vertical height of 21ft., we have found that if an additional 21ft. be added to the top so as to make the vertical height 42ft. the received current is doubled; if, however, the extra 21ft. be added horizontally to the top, so as not to increase the vertical height, the received current is still increased by 50 per cent. Thus an air wire 21ft. high with 20ft. of wire connected to it in a horizontal position at the top produced more current in the receiver than an air wire 31ft. 6in. high.

Earth Connections Varied.—In all the tests given in this reports, except those detailed in this section, the earth connection at each station consisted of about 76ft. of wire netting flat on the grass. The tests given in Table III. show that only the centre part of the netting near where the earth wire was fixed to it was effective, the two extreme ends of the netting appear to make no appreciable effect on the result. This seems to indicate that it would be better to use a circular piece of netting for the earth with the wire connected to the centre rather than a long strip, as was used in these experiments. An attempt was made to obtain a better earth by connecting the earth wire to the lead sheathing of the telephone cable, which is under the park, but the received current with this connection was only about 60 per cent. of that obtained with the netting earth. This telephone cable is armoured and laid direct in the earth. An earth was also made on the iron stay of the terminal pole, and a slightly better result obtained than with the connection to the lead sheath of the cable. The question of the earth connection for wireless telegraphy is a most important one, and requires very thorough investigation. It was several times noticed that the current into the transmitter air wire was slightly diminished at the commencement of a shower of rain. Thus, after the weather had been dry for about a week, a heavy rainstorm reduced the current by about 2 per cent. This appeared to be due to altering the conditions of the earth rather than to any effect on the air wire. Retuning did not reproduce the original current.

TABLE II.—Arrangement of Transmitter Air Wire Varied. Receiver in paddock, distance 1.588ft. Height of receiver air wire, 56ft. Spark-gap, 4·55mm. Mercury interrupter. Wave No. 3 (500ft.).

Arrangement of transmitter air wire.	Current in transmitter air wire. Amperes.	Current in receiver — Tuned. Micro-amperes.	Current in receiver — Air wire only. Micro-amperes.
Straight transmitter air wire; vertical height from ground, 42ft.	0·484	315	105
L-shaped air wire, same total length; vertical height, 31·5ft.	0·485	208	69
Same vertical height, 21ft.	0·473	159	51
⌐-shaped air wire; vertical height of horizontal part, 22ft.; length of horizontal part, 20ft. Horizontal part pointing towards receiving station and on same side of van as netting.	0·50	238	73
Same, but horizontal part on opposite side of van to netting.	0·466	224	72
Same, but horizontal part at right angles to line of transmission	0·457	229	73
Half air wire rolled up at top; vertical height, 21ft.	0·441	158	48
Loop air wire, ⌐⌐; vertical height, 22ft.	0·455	148	47

TABLE III.—Earth Connections Varied. Receiver in paddock, distance 428ft. Height of receiver air wire. 56ft. Height of transmitter air wire, 42ft. Spark-gap, 4·55mm. Grisson interrupter. Wave No. 3 (500ft.).

Receiver Earth Altered. (Transmitter netting all flat on earth.)	Current in transmitter air wire. Amperes.	Current in receiver air wire, tuned. Micro-amps.
Wire netting earth; 77ft. of netting flat on earth	0·696	2,042
Earthed to outer of cable	0·696	1,246
Earthed to stay on terminal pole	0·696	1,346
¼ of wire netting rolled up from one end	0·698	1,968
¼ of netting rolled up from each end	0·696	2,016
½ of netting rolled up from one end	0·702	1,797
½ of netting rolled up from each end—*i.e.*, all rolled up, but resting on the earth	0·696	1,530
½ of netting rolled up from one end and ¼ of netting rolled up from the other	0·700	2,026
Transmitter Earth Altered. (Receiver netting all flat on earth.)		
½ of netting rolled up from one end	0·611	2,031
½ of netting rolled up from each end—*i.e.*, all rolled up, but resting on the earth	0·392	1,129

(To be continued.)

PERSONAL.

The West Bromwich Town Council have appointed Mr. W. A. Jackson borough electrical engineer in the place of Mr. J. H. Wray, resigned, at a salary of £300 per annum.

Mr. Walter J. Bache, borough electrical engineer of Gloucester, has been appointed borough electrical engineer of Cheltenham at a salary of £400 per annum, in place of Mr. M. H. Kilgour, resigned.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE TELEPHONIC QUESTION.

Most people are utterly tired of the telephonic question, as indeed we are, but it is necessary for the sake of historic continuity to refer to the action of the House of Commons on Mr. Lough's motion relating to the agreement. We presume the discussion in the House of Commons was necessary in order that the Postmaster-General might have the opportunity of saying that practically he accepted the suggestions of the committee as far as they could be accepted. He pointed out that there were two parties to an agreement, and modifications could not be made unless with the consent of both parties. In our last issue we stated that the suggestions of the committee with regard to the employés to be taken over were satisfactory. They have been accepted by the Postmaster-General with certain necessary modifications to make them workable. It will be well, perhaps, to put on record in these pages the terms as read by Lord Stanley in the discussion. They were as follows: (1) "Subject to the other provisions of this memorandum the Postmaster-General will take into the service of the Post Office the servants and officers of the company who have been not less than two years continuously in the service of the company on Dec. 31, 1911, and such officers and servants shall enjoy the advantages and be subject to all the conditions of the rank or grade to which they are admitted in the same manner as other officers and servants of the Post Office in that rank or grade. This undertaking does not apply to the general manager or to officers of the company in receipt of £700 per annum or upwards. (2) The Postmaster-General has already by his agreement with the company conceded that officers or servants who have been continuously in the service of the company from Aug. 15, 1904, until Dec. 31, 1911, and who then became established servants of the Post Office, entitled to pension, shall be so entitled, though they may retire before they have served ten years under the Crown. (3) He is also willing, in the case of officers who do not participate in the pension scheme of the National Telephone Company, and who on the transfer of the company's business become established servants of the Post Office entitled to pension, to allow them to count for purposes of pension their continuous service with the company subsequent to Dec. 31, 1909, as service under the Crown. (4) As regards medical examination, the Postmaster-General cannot undertake to examine candidates for the Telephone Company's service, but he is willing to dispense in 1912 with the medical examination of any officer or servant, if such officer or servant has been in the service of the company continuously for two years on Dec. 31, 1911, and has had no abnormal amount of sick leave during that time. (5) The pension fund of the company is in the hands of trustees, and its administration depends upon a private trust deed. The provisions of the deed are so different from the conditions of the Civil Service pension system that (apart from other difficulties) it would be impracticable for the Postmaster-General to administer the fund or to continue the same system for individuals. For instance, under the trust deed no pension can be granted to an officer who retires under the age of sixty-five, whereas under the rules of the Civil Service an officer may be called upon to retire at sixty, and if retiring at sixty, either compulsorily or voluntarily, is entitled to a pension. The fund must, therefore, be closed, and officers and servants entering the Post Office must be subject to the Civil Service rules as to pensions (subject to the provisions of this memorandum) If, however, it be shown that by the closing of the company's pension fund and the substitution of the system of Civil Service superannuation the general

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body of the participants in the pension scheme of the company will be placed in a substantially less favourable position, the Postmaster-General will consider the expediency of adding a period (not exceeding in any case two years) to the service which under the rules of the Civil Service the officers affected are entitled to count for purposes of pension. (6) These arrangements cannot be fully carried out without the authority of an Act of Parliament, and this declaration is made subject to the passing of such an Act. An Act will be necessary to provide the money for the purchase from the company, and provisions on this subject will be included in that measure." The only other point to be mentioned is that the Postmaster-General was emphatic against granting any more licenses before 1911 to municipalities, because the National naturally would not give way on the question of time extension of its privilege to run correspondingly with the time such licenses would run. He said: "The committee urged that no corresponding extension should be granted to the company. The company would not agree to that, and he was bound to say he thought their refusal was justified. What were the circumstances? The agreement of the Act of 1898 was that, when a municipality obtained a license, and was in competition with the National Telephone Company, a license extending to the same period should be granted to the company. It was the late Mr. Hanbury, who was always quoted as a friend of the municipalities, who imposed this condition. The proposal of the committee was a practical infringement of a statutory right. There was a further condition—that there should be intercommunication at once and without charge between the municipalities to whom was granted a license and the company. That meant that if the company had worked up a business of, say, three hundred subscribers in a town, a municipality entering the field would at once enjoy the advantage of having those three hundred members, not indeed as subscribers, but as communicants. He thought that a most unfair condition, and he was not surprised that the company would not agree to it. If the House insisted on that condition, the agreement fell to the ground. If the hon. member's motion were carried, the agreement would cease to exist. He thought hon. members ought to think twice before they sacrificed the advantages that would come from the agreement." In the end Mr. Lough's motion was lost by a majority of seventy-seven. We thus come to the position that this agreement, with the modifications accepted by both parties, will hold; that no more municipal licenses will be granted; and that in 1911 the telephonic system of the country reverts to the State on what are known as tramway terms, and that due consideration is given to the employés existing at the time of the take over.

THE POST OFFICE REPORT.

The fifty-first annual report of the Postmaster-General has just been issued, and deals with the business of the year ending March 31, 1905. With the development of the postal business we are not concerned editorially, but the results show a steady increase both in the public services rendered and financial returns. Considerable extensions have been made in the use of motor vans for the conveyance of mails, and Lord Stanley is able to report a substantial advance in the reliability of the services already established. On some services the results have been highly satisfactory, but on others the motor vans employed have not yet shown themselves to be so trustworthy as horse vans. The use of such motor vans is being extended.

The returns of the Telegraph Department show that during the year ended March 31, 1905, 88,969,000 telegrams passed over the Post Office wires, as against 89,997,000 in 1903-4, a decrease of 1·14 per cent. The decrease in private telegrams was over 1¾ million messages. The decrease in the number of ordinary inland telegrams is perhaps due partly to trade depression; but as it is coupled with an increase of 5·1 per cent. in the foreign telegrams, it may be attributed largely to the growth of the telephone system. The number of foreign telegrams is the highest on record. The average number of words per week in Press telegrams during the year was 15,531,332, against 14,588,458 in 1903-4. During the year 193 new telegraph offices have been opened in country villages and the suburbs of the large towns. Guarantees have been given for 154 of these new offices—66 by local authorities and 88 by private persons. The telegraph offices now open in the United Kingdom number 10,172 at post offices and 2,354 at railway stations and other public places. The delivery of telegrams by cycle instead of foot messengers has been further extended, and 3,898 bicycles are now employed for this purpose. About 150 bicycles have been issued for the use of linemen engaged in the maintenance of the telegraph lines.

The system of providing direct communication between provincial towns has been pursued as in previous years. Amongst other direct lines may be mentioned new circuits between Manchester and Southampton, Dublin and Cardiff, Liverpool and Waterford, Liverpool and Londonderry, Birmingham and Cork, and Preston and Glasgow. Cambridge has been placed in direct communication with Ipswich, Norwich, and Peterborough; and the communications in the Eastern Counties have generally been improved. The underground line from London to the North has been extended, as foreshadowed in the last report, by the provision of a cable containing 97 wires between Warrington and Carlisle, and the laying of 76 miles of pipe, which, together with the section laid in the previous year over the Beattock incline, complete the pipe line from Carlisle to Glasgow. It is proposed this year to provide wires over the latter section, and communication will then be possible between London and Glasgow by means of underground wires solely. The next extension of the underground trunk telegraphs is to be the establishment of underground communication with the West of England. A pipe is being laid to contain 137 wires between Hanwell and Slough, and during the present year it will be extended from Slough to Reading. The provision of a pipe and cable between London and Chatham is also being put in hand as a beginning of an underground route to the south east coast, the point of departure of many of the submarine cables. The use of pneumatic tubes laid under the streets for the conveyance of telegrams between the head and branch offices in large towns is being gradually increased. Tubes have recently been provided at Edinburgh, Belfast, and Southampton, and it is proposed to serve several of the West-end branch offices in London by this means upon the completion of the new power station at Blackfriars, from which they will be worked.

On the vexed question of wayleaves Lord Stanley says: "It is my constant endeavour to minimise the inconvenience which my works must inevitably cause to those who use the streets under which telegraphs are being laid, and I am convinced that my officers zealously second my efforts in this respect. I think also that I go no further than is absolutely necessary in erecting overhead telegraphs along the country roads, though I am aware that in this matter also my action is in some quarters unwelcome. I am bound to emphasise the fact that, in the present state of electrical science, I cannot maintain an efficient telephone service over long distances without keeping the wires overhead; and I cannot even in the case of telephone exchange wires set up an adequate system in the suburbs and the country at any reasonable cost if I am to carry isolated lines underground. I regret to note increasing objections both from certain local authorities and from private landowners to the necessary extensions of my lines. Appeal was made during the last year on four occasions to the courts, two of the cases being further referred to the Railway and Canal Commission. In each case the final decision was in favour

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of my department. The necessity for these proceedings frequently delays the connection of subscribers with the Post Office telephone exchanges."

Promising experiments with various high-speed automatic type-writing telegraphs are being continued at the Post Office. The Postmaster-General remarks that British makers of electric plant are now devoting more of their attention than formerly to the manufacture of telephone apparatus, though he cannot yet dispense—or nearly dispense—with the services of foreign makers. As regard foreign telegraphs, a small direct line is to be provided between London and Cologne, and also between London and St. Malo. The cable about to be laid to Iceland *vid* the Faroe Islands is also referred to in the report.

On the question of wireless telegraphy, the report states that some difficulty has been experienced in dealing with the applications for commercial licenses, owing to the fact that, in the present state of electrical science, it is impossible for the stations of rival undertakings to work in the same neighbourhood without danger of mutual interference. During the interruption of the cable to the Scilly Islands in March last communication was restored by means of wireless telegraphy between the Admiralty station on the island and the Marconi Company's station at Poldhu; and arrangements have been made for utilising the service in any future case of interruption. The international conference on wireless telegraphy, which was to have been held in April last, was postponed owing to the political situation.

As regards telephones, the number of trunk wire centres open on March 31 last was 443, an increase of 47 in the year. The new trunk circuits provided during the year numbered 186, and the total number in use was 1,604, as compared with 1,418 in the preceding year. The total length of the trunk circuits in use was 56,400 miles, containing about 112,800 miles of wire. The capital expenditure on the purchase and development of the trunk wire system up to March 31 last was £2,537,288 including an expenditure during the year of £337,246. The conversations over trunk lines by telephone totalled nearly 15½ millions, and the increase was nearly two millions, which is more than the decrease in private telegrams. The average value of each conversation was 5·9d.—just under the cost of one telegram.

Last year the Anglo-French telephone service was extended to the principal provincial towns in England and France. The service has since been extended to certain other English provincial towns, and the Anglo-Belgian telephone service has similarly been extended during the year. There are now four circuits between London and Paris, one between London and Lille, and two between London and Brussels, the latter carrying an increasing amount of traffic. A still further development of these services may be expected now the new agreement with the National Telephone Company has been approved by Parliament, as under that agreement the lines will become available for use by subscribers to the company's system. Experiments have recently been made in telephonic communication between London and Rome by way of Paris. It was found possible to exchange speech when the conditions were exceptionally favourable; but, in spite of the partial success of the experiment, a public service between the two capitals is not at present practicable. No less than 75 small telephone exchanges have been opened by the Post Office during the year, most of which are in places where no telephone service was previously available.

The number of telephones in connection with the Post Office London telephone system increased during the year from 15,632 to 24,351, and additional subscribers are being connected at an average rate of about 150 a week. A new exchange was opened at Hampstead during the year under review, and two others have been opened since March 31. The accommodation at the Central Exchange is now almost exhausted, but a new exchange, to be called the City Exchange, with a maximum capacity of 18,000 lines, is expected to be ready for opening in a few months. The length of the underground pipes which had been laid in the London area on March 31 last was 1,251 miles, 105 miles having been laid during the year. Cables containing 162,216 miles of wire have been provided, including 35,572 miles rented by the National Telephone Company pending the transfer of the company's system to the Post Office. The lines of the present subscribers and the junction lines between exchanges have absorbed 66,821 miles, and 59,823 miles of wire remain available for the future development of the London telephone system.

The average cost of construction per mile of double wire has decreased since last year from £18. 16s. 10d. to £16. 18s. 6d., and the average cost of constructing an exchange circuit (including the installation of telephone instruments and of exchange apparatus, but excluding the provision of spare plant) has been £38. 18s. 9d., as against £41. 9s. 8d. in the previous year. Taking into account the whole system, including spare plant of all kinds, the capital expenditure per station—*i.e.*, per telephone connected with an exchange—stands now at £64, as compared with £86 in 1902-3, and £73 in 1903-4. It is hoped that the expenditure per station will still further diminish as the very large amount of spare plant provided comes into use.

An account of the receipts and expenditure relating to the London service for the year ended March 31, 1905, shows a balance of £93,298, a sum nearly sufficient to meet the charge for interest on capital and to provide for depreciation of plant. This balance is rapidly increasing as more of the plant comes into use and begins to earn revenue.

The report, on the whole, is a most satisfactory one.

THE ADMINISTRATIVE COUNTY OF LONDON AND DISTRICT ELECTRIC POWER BILL.

(Continued from page 166.)

On Friday last Mr. A. C. MORTON, chairman, Streets Committee, City Corporation, stated that the Corporation objected to the Bill on the score of monopoly. As it was, there were two companies in the City, which was entitled to the benefit of the competition between them.

Sir RALPH LITTLER, K.C., presenting the case for the City generally, held that the purchase clause was quite illusory and impracticable.

The Hon. J. D. FITZGERALD, K.C., said that, having regard to the lateness of the session, he would only deal with the salient features raised in the criticisms against the Bill. Numerous objections had been taken to various clauses as though they represented some departure, but they were just the clauses that had been inserted in other Power Bills. Counsel emphasised the fact that the promoters could only enter the area of an existing authority with the consent of the Board of Trade. The suggestions that large power consumers would benefit at the expense of the small users were quite unjustified, as the same maximum applied to all. The opposition of the Metropolitan Company was due to an attempt to obtain a better bargain than was agreed upon before the Lords' Committee. Counsel then urged strongly the claims of industrial London to a cheap power supply. The present undertakings supplied only 4 per cent. of the horse-power used in London for such purposes. The talk about a monopoly was a mere bogey. Parliament had shown in the past that it was capable of dealing with any attempts of that nature, there was the competition of other forms of power, and Colonel Crompton had stated that consumers could generate for themselves, under certain conditions, at ·65d. per unit. Dealing with the proposed purchase clause, he stated that it was substantially on the lines followed in the Electric Lighting Act of 1888, except that the term was 50 years instead of 42, and he thought that the restrictions the promoters were under regarding capital charges and dividends quite justified this extension. He concluded by appealing to the committee to find the preamble proven on grounds of public expediency.

The committee then adjourned for the interval, and subsequently retired again for a short period, after which the CHAIRMAN stated that, owing to the momentous issues involved, the committee could not arrive at a decision that day. It would be necessary for them to know the precise terms of the purchase clause.

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The Hon. J. D. FITZGERALD appealed to the committee, on the grounds of urgency and expense, to come to a decision that day, as otherwise it would be almost impossible for the matter to be dealt with in the present session of Parliament. He read the following additional clause in regard to the acquisition of the promoters' undertaking: "Notwithstanding anything in this Act contained the company may, before ascertaining the clear profits of the undertaking available for the payment of dividend, set aside such sums as they think fit to form a sinking fund, which shall remain the property of the company in the event of any purchase of the undertaking, provided that the sums so set aside in any year shall not exceed an amount equal to 1 per cent. per annum on the paid-up capital of the company for the year, and the aggregate of such sums shall not at any time exceed an amount equal to one-third of the paid-up capital of the company for the time being."

The CHAIRMAN intimated that, while the committee appreciated the promoters' difficulties in regard to time, the great interests at stake necessitated further consideration. The committee would, however, proceed with the matter at 11 o'clock on Monday.

On Monday the committee sat from 11 a.m. till 7.30 p.m. in hopes of finishing the clauses, but the new proposals were so numerous that the matter had to be again adjourned. At the opening of the proceedings the CHAIRMAN announced the decision of the committee, which by a majority was that, subject to the consideration and approval of clauses and amendments, it would report to the House that the preamble of the Bill was approved.

The consideration of the clauses in the Bill was then commenced, proposed new clauses being left until afterwards. Many of the objections to the clauses were thrown out. Thus on Clause 3 West Ham asked that words should be inserted which would give protection against the generating station of the promoters becoming a nuisance as regards the emission of smoke.

Mr. FITZGERALD, K.C., pointed out that the clause in the Bill followed exactly the recommendations of Lord Cross's Joint Committee of both Houses to the effect that the liability in common law in the case of persons exercising statutory powers and duties was sufficient. It was simply nonsense to say that under such a clause a smoke nuisance could not be dealt with.

The committee, after hearing evidence, passed the clause unamended.

On Clause 5 further protection for the tramway undertakings of the London County Council and West Ham was asked for, but this was not granted. Clause 18 was altered to prevent the company from dividing premiums on shares as profits. The altered paragraph reads: "All moneys raised under this Act, whether of shares, or debenture stock, or premiums obtained from the issue thereof, shall be applied only to purposes to which capital is properly applicable." The use of Greenwich Tunnel for mains was deleted from Clause 33, and the question of laying mains by agreement with the London County Council in Blackwall Tunnel was deferred for the parties concerned to make terms with each other.

Mr. FREEMAN, K.C., asked the committee to transfer the boroughs of Camberwell, Deptford, Woolwich, and Poplar from the industrial to the non-industrial area. Counsel for Hackney, Shoreditch, and Ilford proposed similar amendments.

The CHAIRMAN said the division of the area could not be altered.

Sir R. LITTLER, K.C., asked that an amendment should be made to prevent the company from carrying mains through the City. He complained that behind the backs of the Corporation an agreement had been come to with one of the companies supplying the City.

Mr. FITZGERALD denied that this was so. The mains must pass through a certain but not a large part of the City.

The committee by a majority decided against the amendment.

Proposals to omit Ilford and West Ham from the area of supply were rejected by a majority. A number of other amendments were debated and rejected. One of these provided that electricity for lighting should be supplied through separate meters, which would be open for inspection by the local authorities, so that it would be possible to know the proportion of energy which was being used for lighting purposes. While the amendment was disallowed, Mr. Fitzgerald agreed to the insertion of a proviso that where any person supplied by the company used a supply for lighting except in accordance with the provisions of the Act, the company should, on becoming aware thereof, discontinue the supply for lighting, and be liable to a penalty of 40s. for each day's default. An amendment was, moreover, accepted giving power to the local authority to inspect works with the view of ascertaining the amount of electricity used for lighting purposes.

Clause 63 was amended so that any 20 consumers could demand a revision of prices every five years. The Board of Trade will then consider the matter.

The question of the powers of the company to purchase complete undertakings was deferred. An amendment was accepted by which the company cannot purchase any undertaking within the city of London without the consent of the Corporation, which consent is not to be unreasonably withheld. After consideration this amended clause was made applicable to all local authorities within the proposed area.

On Clause 74 the London County Council obtained the right to be heard before any Board of Trade enquiry as to delay in the carrying out of the proposed works and consequent withdrawal of powers.

The purchase clause, which sets out the terms on which the company's undertaking might be acquired, after a period of 50 years by some board or authority authorised by Parliament, was altered so that the period should be 42 years.

Several new clauses proposed by the opponents of the Bill were considered and not accepted, and the committee then adjourned.

The new purchase clause as amended reads as follows:

In the event of any public authority or body of trustees (hereinafter called the "purchasing authority") being authorised by Parliament to acquire the undertaking at the expiration of a period of 42 years from the passing of this Act, and of subsequent periods of 10 years thereafter, the following provisions shall apply and have effect—that is to say:

1. Not less than 12 months' notice in writing shall be given to the company by the purchasing authority intimating their intention to acquire the undertaking.

2. Such purchase shall be made upon the terms of the purchasing authority paying to the company in respect of the undertaking the then value thereof as determined in accordance with the provisions of Section 2 of the Electric Lighting Act, 1888.

3. As from the date of purchase the undertaking shall be transferred to and vested in the purchasing authority, and such authority, to the exclusion of the company, shall have and may exercise all the rights, powers, authorities, and privileges of the company, and shall be subject to all the duties, obligations, agreements, and liabilities of the company in like manner as if they were the company, except the debts due by the company at the date of purchase, and the liabilities with respect to the debenture stock and mortgage debt of the company.

4. For the purposes of this section "the undertaking" means all lands, buildings, works, materials, and plant of the company suitable to and used by them for the purposes of their undertaking, but shall not include any insurance fund, reserve fund, or sinking fund authorised by this Act, or cash in hand or at bankers, securities for money, or any debts due to the company.

In consideration of the reduction of the period for purchase from 50 to 42 years, the following section was added to the Bill:

Notwithstanding anything in this Act contained, the company may, before ascertaining the clear profits of the undertaking available for the payment of dividend, set aside such sums as they think fit to form a sinking fund, which shall remain the property of the company in the event of any purchase of the undertaking. Provided that the sum so set aside in any year shall not exceed an amount equal to 1 per cent. per annum on the paid-up capital of the company for the year, and the aggregate of such sum shall not at any time exceed an amount equal to one-third of the paid-up capital of the company for the time being.

On Tuesday last a number of new clauses for the protection of the city of Westminster were discussed and

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rejected. One of these asked that all mains should be laid on the cut-and-cover system, so that they would afterwards be accessible. The company were also asked to erect street boxes on land purchased for the purpose, but they had no power in the Bill to buy land for the purpose. Another proposal was that all vehicles used by the company in connection with their work should be under the regulation of the Westminster City Council.

The committee, with one dissentient, rejected the clauses.

Some clauses held over from Monday were then considered. It was agreed that "in respect of all electric lines laid down by the company in any street in the administrative county of London, the London County Council shall for the purposes of this section have all the rights, powers, and privileges of the local authority." This was introduced to protect the interests of the London County Council tramways and sewers. An agreement was announced between the company and the London County Council as to the laying of mains through the Blackwall Tunnel. At the same time the company agreed to accept the modified sliding scale suggested by the Council's expert. This now reads: "The dividend which the company is authorised to pay in that year may be increased in the ratio of one-eighth per centum," etc., instead of one-quarter. The clause, after discussion, was agreed to, the effect being that when the average price per unit drops to ½d., the dividend will only be 11 per cent., instead of 15 per cent., but, on the other hand, if the price averages 1d., the dividend will be 4 per cent., whereas before there could be no dividend.

Other special clauses were refused, but Battersea was promised that mains should not be laid in St. John's hill and Lavender-hill if alternative routes were found available.

Sir RALPH LITTLER, on behalf of the City Corporation, asked the committee to insert a clause which read as follows: "The company shall not, either directly or indirectly, oppose the preamble of any Bill which may hereafter be introduced to supply energy in any area within the company's area of supply." This was not accepted, and the same fate met a proposal from Mr. CLODE on behalf of the London County Council. He explained that by the purchasing clause nobody had an absolute right to purchase, and such a right must hereafter be acquired by the parties coming to Parliament and obtaining a right by an Act of Parliament. This proposed clause was to prevent the present company opposing such a proposal if made, and was really to make the purchase clause substantial.

Mr. FITZGERALD said this would be legislating for 40 or 50 years hence. Such a Bill might contain matters most prejudicial to the company, and it was unreasonable to ask for such a clause.

The CHAIRMAN said the committee were unanimous that they could not accept such a clause. He was glad to say their last decision on the Bill was unanimous. They ordered that the Bill be reported to the House.

ELECTRIC WINDING MACHINES.*

BY PROF. PAUL HABETS, OF BRUSSELS.

(Concluded from page 161.)

The motor, M (Fig. 12), is a separately excited continuous-current machine; its rated power is 320 h.p. at 64 r.p.m., and at 500 volts. It will carry an overload of 40 per cent. for half an hour, and of 100 per cent. for five minutes. It will reverse without moving the carbon brushes, and gives no sparking even when the voltage is considerably reduced. The terminals of the haulage motor are electrically connected with the generator, G^1 (Fig. 12), of the Ilgner motor-generator, M^1—G^1, and a maximum current release, which

See also Fig. 11

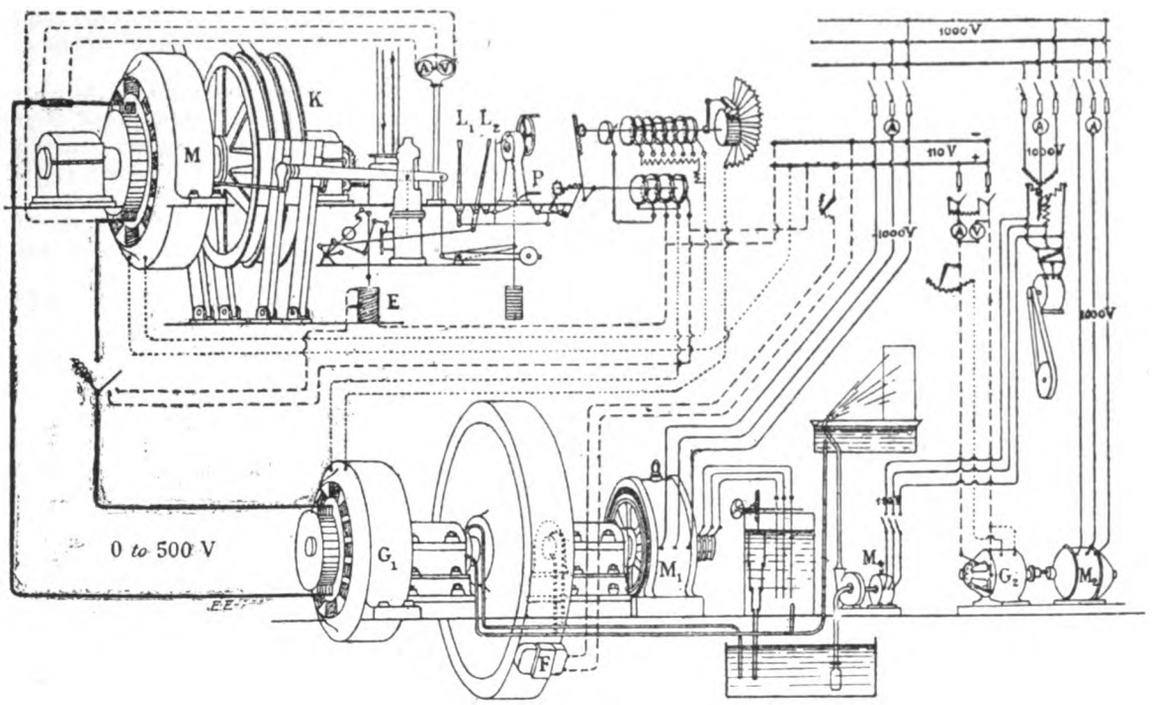

FIG. 12.—Diagram of Installation.

acts when the current reaches 1,500 amperes, is inserted in one of the leads. The output of the continuous-current generator, which is separately excited, is 650 kw. at 500 volts when making 285 r.p.m.; the rise of temperature, measured by the increased resistance, does not exceed 45deg. The carbon brushes have no lead even when the machine is generating the maximum current required by the motor. The machine will also generate the current without sparking at voltages varying between zero and ± 500. These results are due to the large proportions of the generator, whose power is more than double that of the haulage motor. The generator and the haulage motor are of similar design. The cast carcass carries the pole-pieces of laminated iron, which are fixed by bolts in such a manner that they can be removed laterally without dismounting the armature. The field coils are protected by the carcass, and the bobbins are divided into sections for the purpose of ventilation. The armature is a drum, the conductors being tooled and placed in the grooves of the sheet-iron core; the openings between the conductors allow of an effective cooling by circulation of air. The haulage motor, M, and the generator, G^1, are both excited by a small motor-generator, M_2—G_2, which

* Paper read before the Institution of Mechanical Engineers (translated from the French).

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supplies a continuous current at 110 volts. This motor-generator consists of a 27-h.p. asynchronous motor, M_2—supplied with current from the power station and making 820 r.p.m.—and an 18-kw. continuous-current shunt generator, G_2. The armature of the main generator, G^1, is mounted on the end of the shaft, which also carries, between its two bearings, a flywheel of cast steel, 4m. (13ft. 1½in.) in diameter and weighing 40 tonnes (39·3 tons). The rotor of the asynchronous motor, M^1, which drives the Ilgner group, is mounted on the other end of the shaft; it will exert 250 h.p. at a continuous run af 285 r.p.m. For the purpose of inserting a liquid rheostat in the rotor circuits, on starting the machine, the rotor is provided with slip-rings. An electromagnetic brake, F, when excited, will generate eddy currents in the flywheel rim, and will stop the motor-generator in about a quarter of an hour. Without this contrivance, it would take several hours to bring the machines to a standstill on account of the large amount of energy stored in the flywheel. The bearings of the motor-generator are lubricated by means of rings; the steps are cooled by circulation of water from a vessel at a higher level. The water flows into the grooves of the bearings and into the reservoir of the starting rheostat, and falls into a cistern. A small centrifugal pump, worked by a 2-h.p. asynchronous motor, M_1, takes the water back to the high-level vessel. The pump can lift five litres (1·1 gallon) of water per second through a height of 15m. (49ft. 2½in.), and forces the water as a spray against a cooling screen. The reversing of the haulage motor is brought about by manipulating the lever, L_1, of a controller. According to the position of the lever, the following will take place: (1) simultaneous reversing of the field current of the generator, G^1, and the haulage motor, M; (2) reducing the field current of the haulage motor and interrupting the field circuit of the generator, when the motor is stopped; (3) increasing the field current of the generator progressively, by cutting resistances out and thus causing the voltage of the generator as well as the speed of the motor, M, to increase progressively. While the lever, L_1, is turned back towards the position "stop," the counter E.M.F. generated in the haulage motor (driven by the inertia of the moving masses) will become higher than the E.M.F. generated in G^1. The motor will become a generator and will act as a brake, thereby reducing the period of retardation. The Koepe pulley, K, is provided with two brake rims. The brake, which is worked by compressed air, is only used by the driver for holding the pulley during the standstill of the machine, and is manipulated by means of a lever for admitting the compressed air into the cylinder. It also acts as a safety brake when the three-phase circuit is interrupted. An electromagnet, E, excited by the field current, will then be demagnetised, a counterpoise will be released, and the brake will be brought into action. The brake will also act when the maximum release breaks the circuit, as the field circuit will also be interrupted. When the cage overshoots the landing stage, the indicator, showing the travelling of the cages, will cause the maximum release to break the circuit, and the brake will consequently be brought into action. The brake may also be applied by working the pedal, P, which will release a counterpoise. The retardation is also brought about by the indicator, which causes the lever, L_1, to be moved towards the position "stop" as the cage approaches the pit bank. This automatic movement is often limited, so as to allow the driver to finish the "lift" and to manipulate the machine. The compressed air required for the brake is supplied by a small compressor driven by a 5-h.p. three-phase motor at 120 volts. The different machines and apparatus, as well as the electrical connections, are shown in Figs. 11 and 12.

2. *Description of the Trials and the Results.*—The haulage machine just described has been submitted to a series of trials with the object of giving an account of the performance of the Ilgner system; also of testing the consumption guaranteed by the contractor, and finally of determining the consumption of energy under actual working conditions. The trials were made on Jan. 8, 10, 29, and 30, 1905.

(*a*) *No-Load Trials.*—The difficulty of starting the heavy flywheel, which squeezes the oil out from the bearing surfaces, makes it necessary to keep the Ilgner machine group in permanent motion, as the haulage machine does not stop for very long. The consumption of energy while the Ilgner group is working on no load has an important bearing on the economy of the system, and it was, therefore, decided to determine this consumption. A Siemens wattmeter and an electricity meter were inserted in one of the motor leads, M^1, and readings were taken every five minutes during a period of 35 minutes, the machine making 313 r.p.m. According to the readings of the wattmeter, which had been specially standardised, the consumption was 31·94 kilowatt-hours. The electricity meter showed a consumption of 30·85 kilowatt-hours. The temperature of the oil on the bearings was 30·8deg. C. (87·4deg. F.). By stopping the circulation of the water for 4½ hours the temperature of the oil on the bearings rose to 45·5deg. C. (113·9deg. F.). Under these circumstances, and the shaft making 315·5 r.p.m., the consumption according to the wattmeter and the electricity meter was 30·55 kilowatt-hours and 29·82 kilowatt-hours respectively. According to another trial, repeated on Jan. 29, the consumption was found to be 28 kilowatt-hours at a speed of 314 r.p.m. The temperature of the oil was 35·7deg. C. (96·3deg. F.). The latter consumption corresponds to that guaranteed by the contractor. The efficiency of the motor at this reduced load was 0·6; the windage of the Ilgner group and the friction between the journals and the bearings absorbed, therefore, about 17 kilowatt-hours.

(*b*) *Passive Resistances in the Pits and in the Haulage Motor.*—These resistances were determined by giving the masses a certain velocity and measuring the height through which the useful load was lifted. The energy consumed by the passive resistances would then be equal to the kinetic energy stored in the moving masses minus the work done on the useful load. The suspended loads were:

	Kg.	About
460 + 400 = 860m. (2,820ft.) of rope at 5·6 kg. per metre (3·76lb. per foot)	4,800	(10,600lb.)
2 cages with attachments at 2,100 kg. (4,630lb.)	4,200	(9,260lb.)
8 empty tubs at 250 kg. (551lb.)	2,000	(4,408lb.)
4 loads of coal at 535 kg. (1,180lb.)	2,140	(4,720lb.)
Total	13,140	(28,988lb.)

The diameter of the Koepe pulley (reduced by wear) was 2·88m (9ft. 5⅜in.). The moment of inertia of the suspended loads was $= \frac{13{,}140 \times 1{\cdot}44^2}{g} = 2{,}780$kg.-m.^{2} (65,970 lbs.-feet^2).

The moments of inertia of the rotating masses were:

		Kg.-m.^{2}	Lb.-ft.^{2}
1.	Moment of inertia of the Koepe pulley	630	(14,950)
2.	,, ,, motor armature	250	(5,932)
3.	,, ,, head pulleys	675	(16,018)
		1,555	(36,900)

The moment of inertia of the masses was thus I = 2,780 + 1,555 = 4,335 kg.-m.^{2} (65,970 + 36,900 = 102,870 lbs.-feet^2). The kinetic energy corresponding to a speed of 8m. (26ft. 3in.) per second equals $\frac{I\,\omega^2}{2}$ $\omega = \frac{8}{1{\cdot}44} = 5{\cdot}55$, and, therefore, $\frac{\omega^2}{2} = 15{\cdot}4$ hence the kinetic energy $= \frac{I\,\omega^2}{2}$ = 66,759 kg.-m. (482,900 feet-lbs.) The loads travel through a height of 29m. to 30m. (95ft. to 98ft.) after the current has been cut off from the motor. The work done by the non-balanced load was thus 2,140 × 29 = 61,060 kg.-m. (441,647 feet-lbs.) to 64,200 kg.-m. (464,400 feet-lbs.) The kinetic energy of the masses is between $\frac{66.759}{64,200} = 1{\cdot}04$ and $\frac{66,759}{61,060} = 1{\cdot}095$ times the work done in raising the non-balanced loads—*i.e.*, the useful work. The resistances in the pits and in the machine are, therefore, only 4 to 9½ per cent. of the useful work. We shall see that these figures, which may at first seem rather small, agree with other tests.

(*c*) *Guaranty Trials.*—The object of these trials is to determine whether the consumption in kilowatts per useful horse-power developed by the machine comes within that guaranteed by the contractor. The guaranty had been fixed by assuming a haulage of 30 up and down journeys per

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hour; each journey included a loading at the bottom landing stage at a depth of 368m. (1,207ft.), and a stoppage on the way at one of the intermediate loading stages, at depths of 342m., 288m., and 185m. (1,122ft, 945ft., and 607ft.). Three series of trials were made on Jan. 10 and repeated on Jan. 30; each trial included 10 up and down journeys made as quickly as possible. Series I. comprised journeys with loadings at 368m. and 342m. (1,207ft. and 1,122ft.); series II. comprised journeys with loadings at 368m. and 288m. (1,207ft. and 945ft.); series III. comprised journeys with loadings at 368m. and 185m. (1,207ft. and 607ft.) At each of these trials the following observations were taken every 10 seconds: (1) Readings of the Siemens wattmeter (the same as used at the no-load trials) which was inserted in the joined circuit of the Ilgner group and the motor-generator, M_2-G_2. These readings were plotted with time as abscissæ, and the integration of the curve gave the total electric energy spent during the test. This energy was also determined by means of the electricity meter by taking readings at the beginning and at the end of the tests. The results obtained by these two instruments differ only 1 to 3 per cent. (2) Readings of a Weston ammeter and voltmeter which were connected to the same circuits. From these data we may plot the curve of apparent alternating watts; and by dividing the watts found by the wattmeter by the apparent watts, we obtain a curve representing the variations of cos of the installation. (3) Readings of the ammeter in the field circuit. The latter was maintained at 110 volts. Recording instruments give an account of the volts and amperes of the continuous current which drives the haulage motor. By multiplying the simultaneous volts and amperes, we obtain the watt curve of continuous current, which represents the power spent at any moment during the haulage; and by integrating the corresponding parts of the curve, we determine the energy spent during the different parts of the journey. The variation of speed of revolution of the Ilgner group was shown by a recording speed indicator. The variation of kinetic energy of the group from the beginning to the end of each trial had to be added (algebraically) to the consumption of the electric energy, found by means of the electricity meter or the Siemens wattmeter, in order to determine the total expenditure of energy.

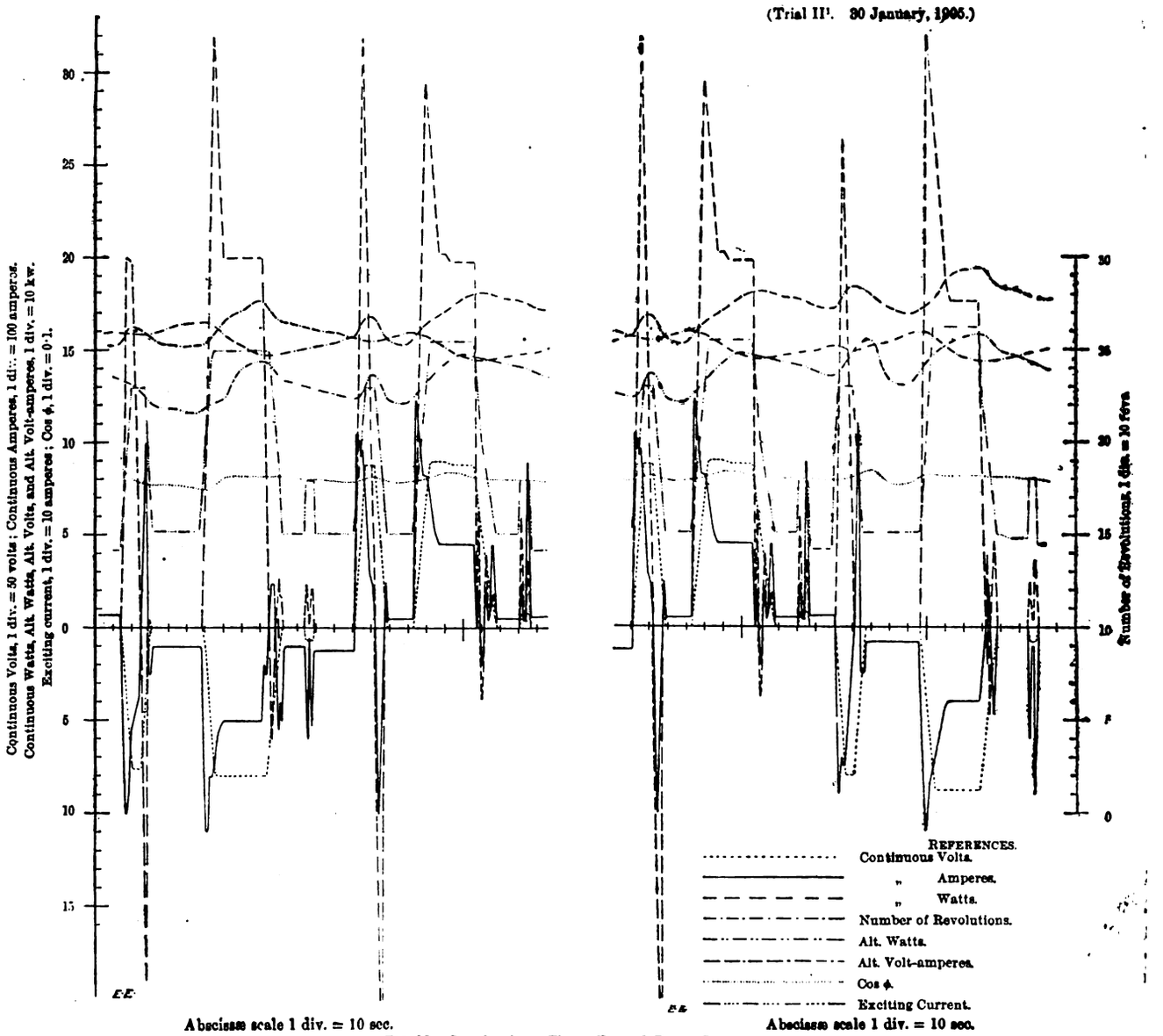

FIG. 13.—Results from Three Up and Down Journeys.

	Kg.-m.²	Lb.-ft.²
The moment of inertia of the rotor of motor, M^1...	65	(1,543)
The moment of inertia of flywheel	1,000	(23,730)
The moment of inertia of the armature of generator, G^1	160	(3,796)
The moment of inertia of shaft	5	(118)
Total.....	I = 1,230	(29,187)

The variation of kinetic energy

$$= \frac{(\omega_1^2 - \omega_2^2)}{2} \times I = \frac{(n_1^2 - n_2^2)\ 2\ \pi^2}{3,600} \times I,$$

where n represents the number of revolutions of the Ilgner group as indicated by the recording speed indicator.

The author does not consider it necessary to publish all the figures and curves obtained by these trials, as their number is very considerable. Fig. 13 represents the results from three up and down journeys of trial II¹ made on Jan. 30. The trials comprised 10 complete journeys from landing stages at depths of 368m. and 288m. (1,207ft. and

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945ft.). The performance of the Ilgner system is indicated by this diagram. It will be noticed that the power absorbed by the haulage motor (continuous watts) varies considerably—viz, from zero to about 300 kw., then falls to 200 kw. and returns to zero. The power supplied by the power station (alternating watts) varies only between 110 kw. and 160 kw. The results which may be deduced from these trials will be found below, and from these we have determined the efficiency R_1 = ratio of useful power to power supplied to the haulage motor (continuous watts) and efficiency R_2 = ratio of useful work to the sum of the energy spent by the alternating current and the kinetic energy stored in the Ilgner group. The watts consumed per useful horse-power spent in drawing coal is determined by dividing 746 watts by R_2. The consumptions given above are slightly smaller than those guaranteed by the contractor. The consumption at the power station of Espérance is 11 kg. (24¼lb.) of steam per kilowatt-hour; the consumption at the trials would, therefore, be between 17·75 kg. and 20·3 kg. (39·1lb. and 44 75lb.) of steam per useful horse-power hour, which is very small for a winding machine. It is possible to produce a kilowatt-hour by a much smaller consumption of steam; the consumption guaranteed for a steam turbo-alternator working at a pressure of 6·5 kg. (14·3lb.) and superheated 300deg. C. (572deg. F.) is 8·05 kg. (19 73lb.). Adopting this figure, we should require 14 40 kg. to 16·5 kg. (31·74lb. to 36·37lb.) of steam per useful horse-power hour, and we may even go below these figures. The electric winding machine can, therefore, compete with the very best steam winding machines. Mr. Henry, engineer to the Hasard Collieries, has not succeeded in reducing the consumption below 18·94 kg. (41·7lb.) of steam per useful horse-power hour, notwithstanding the best known improvements. It will be noticed that the efficiencies, R_1, are very high. If the mean value of R_1, 0 855 (from the trials on Jan. 30), be divided by the efficiency of the haulage motor, the reciprocal of this quotient will be the factor by which the useful power must be multiplied in order to obtain the power required by the haulage motor to overcome the useful loads and the passive resistances. If the efficiency of the haulage motor (neglecting the field current) be taken as 0·95, then we have $\frac{0·855}{0·95} = 0·90$ and $\frac{1}{0·90} = 1·11$; the passive resistances, therefore, do not exceed 11 per cent., which agrees fairly well with the figure already found above.

Trial.		Number of up and down journeys per hour.	R_1.	R_2	Mean useful work per hour in H.P.	Consumption per useful H.P. in kw.
		Haulage from stages at depths of 368m. and 342m. (1,207ft. and 1,122ft.).				
I	Jan. 10	28½	0·80–0·89	0 4513	81·25	1 63
I¹	Jan. 30	28¼	0·855	0·453	80 00	1·61
		Haulage from stages at depths of 368m. and 288m. (1,207ft. and 945ft.).				
II.	Jan. 10	25	0 73–0 80	0 413	67·50	1·78
II¹	Jan. 30	29	0 85	0·429	76 75	1·715
		Haulage from stages at depths of 368m. and 185m. (1,207ft. and 607ft.).				
III.	Jan. 10	28¾	0 68–0 88	0 399	64·25	1·845
III¹	Jan. 20	28¼	0 86	0·406	63·00	1·81

(*d*) *Consumption of Energy under Working Conditions.*—For the purpose of determining the consumption in kilowatts per useful horse-power, the haulage machine at the pits of St. Nicolas has been submitted to a permanent set of trials, lasting from Jan. 17 to March 1, 1904. The consumption was measured by the electricity meter, inserted as in the guaranty trials. The readings were taken every day at 6 and 8 a.m., and at 3 and 6 p.m. The number of revolutions made by the Ilgner group were read off simultaneously with the readings of the electricity meter, and a record was made of the coal and stones drawn during the different intervals of time. By means of these data the useful work done by the machine may be determined, as well as the mean work per hour. The consumption of electric energy, to which is added or subtracted the kinetic energy of the Ilgner group, admit of determining the consumption in kilowatts per useful horse-power. The large number of results from the trials, which lasted over a period of one month and a half, have been plotted (Fig. 14) by taking as ordinates the consumption in kilowatts per useful horse-power, and as abscissæ the mean useful horse-power given off by the machine. The points lie evidently on an hyperbolic curve. During the night, when the haulage is less, the ordinates are longer, on account of the permanent consumption of the Ilgner group. The ordinates will be shorter as the haulage becomes more active, and

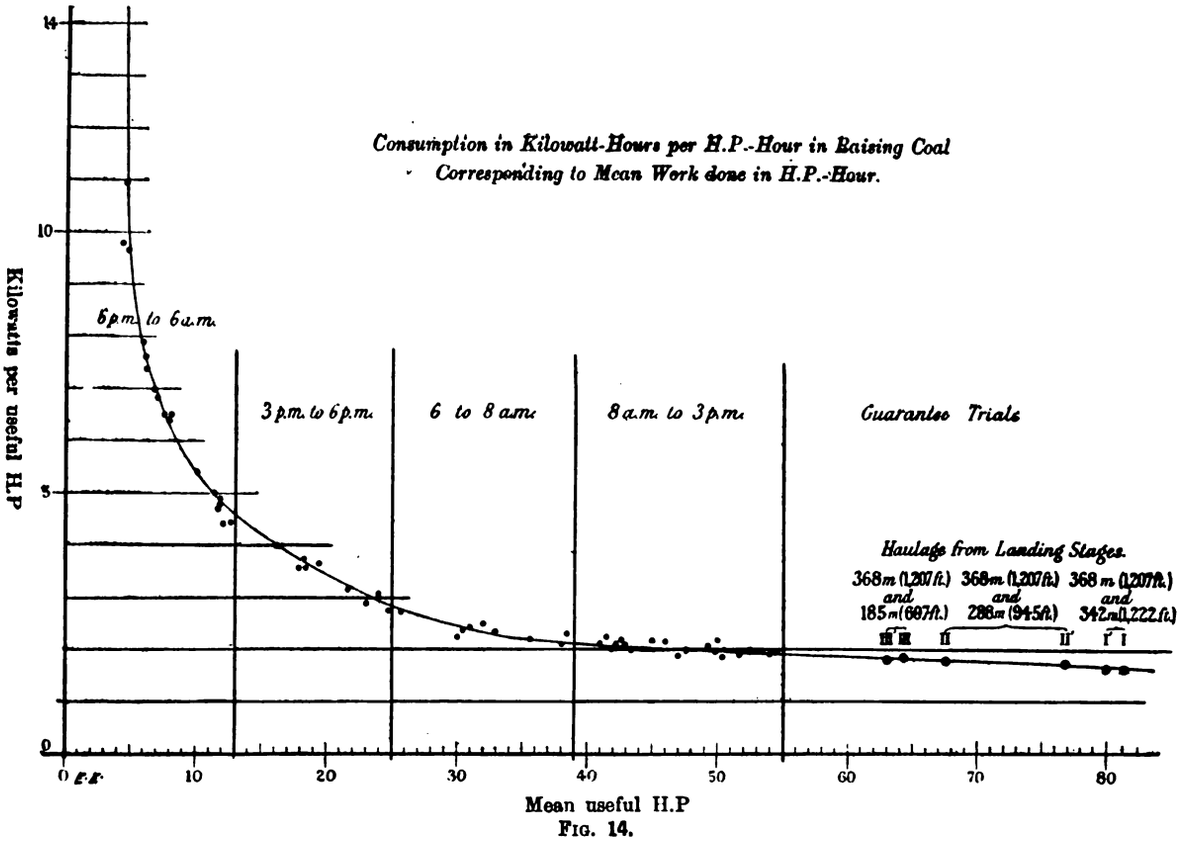

FIG. 14.

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will be about 2 kw. per horse-power between 8 a.m. and 3 p.m. The results from the guaranty trials have also been plotted; these points lie on the continuation of the curve. It may be remarked that the hyperbolic curve is similar to that representing the consumption of a steam-driven winding machine. The high consumption during the night may be attributed to the Ilgner system, and would, therefore, not take place if the winding machine were driven by an asynchronous motor; but then one would have to take into account the consumption of energy required to keep a dynamo at work at the power station, which should be large enough to generate the maximum power required for starting the winding machinery. At the instance of the machine at pit No. II. Preussen the author has shown that the variation of consumption of a winding machine driven direct by an asynchronous motor follows also an hyperbolic law. The electric winding machine at St. Nicolas has replaced a steam-driven machine, which was put down in 1874. According to trials made on Feb. 17, 1903, the steam-driven machine consumed 53·1 kg. (117lb.) of steam per useful horse-power hour during the period of maximum haulage from 8 a.m. to 3 p.m. By installing the electric machine, a battery of six boilers, working at a pressure of five atmospheres, has been abolished. These boilers were in such a bad state that they would soon have had to be replaced by new ones. Besides being economical in consumption, the electric machine has also caused a reduction in wages, as the stokers who were dismissed from St. Nicolas have not been taken into service at the power station. As the electrically-driven machine is much simpler to manipulate than the steam-driven machine, the drivers (two in number) needed very little instruction before taking over the new machine. The consumption of the accessories is very small. The rope is a flat steel rope. The two ropes which were used at first consisted of six hawsers of four strands each, on a core of hemp; each strand contained seven wires of 2mm. ($\frac{5}{64}$in.) diameter. The ropes were 92mm. ($3\frac{5}{8}$in.) wide and 20mm. ($\frac{51}{64}$in.) thick, weighing about 5·7 kg. per metre (3·8lb. per foot). The wires were of steel with a breaking strength of 140 kg. to 150 kg. (320lb. to 330lb.), and would bear 14 bendings over a mandrel of 5mm. ($\frac{1}{5}$in.) and 30 torsions on a length of 200mm. ($7\frac{4}{5}$in.) before rupture. The total breaking strength of the rope was 77,750 kg. (76·5 tons). The first rope was removed after only three months of service, on account of unnecessary precaution. It was found by a tensile test that the total breaking strength of the weakest part of the rope was still 66,000 kg. (145,504lb.). The second rope lasted $4\frac{1}{2}$ months. It was replaced by a rope consisting of seven hawsers of four strands each, on a core of three wires of 1·2mm. ($\frac{1}{32}$in.) diameter, each strand containing seven wires of 1·8mm. ($\frac{5}{64}$in.) diameter. The rope, being 110mm. ($4\frac{21}{64}$in.) wide and 18mm. ($\frac{45}{64}$in.) thick, weighs about 5·75 kg. per metre (3·8lb. per foot). The wires are of steel, with a breaking strength of 130 kg. to 135 kg. (286·6lb. to 297·6lb.); the 1·8mm. ($\frac{5}{64}$in.) wire would bear 18 bendings over a mandrel of 5mm. ($\frac{3}{64}$in.) and 30 torsions on a length of 200mm. ($7\frac{7}{8}$in.). The 1·2mm. ($\frac{1}{32}$in.) wire would bear 36 bendings and 30 torsions on a length of 150mm. ($5\frac{29}{32}$in. or 5·9in.). The total breaking strength of the rope is 77,000 kg. (75 8 tons). On account of the small diameter of the Koepe pulley, it was desirable to give the new ropes more flexibility by making them thinner and of finer and more ductile wire. It is interesting to compare the expenses, with regard to ropes, of the Koepe machine with those of the old steam-driven machine with bobbins and flat aloes ropes. The latter ropes weighed about 4,600 kg. (10,141lb.), and cost during later years from 1·65fr. to 2fr. per kilogramme (7d. to 8·71d. per pound). Let us adopt the lowest figure: a rope will then cost 7,600fr. (£304), and two ropes will, therefore, be 15,200fr. (£608). These ropes last about 26·32 months—say 30 months on an average. The rope expenses per month would, therefore, be 500fr. (£20). The ropes which were rejected cost 2,250fr. (£90), which for a period of $4\frac{1}{2}$ months is 500fr. (£20) per month, the same as we found for the aloes ropes. One may, however, expect to find the steel ropes more economical, as their construction is more suitable for the purpose, and may, therefore, last more than $4\frac{1}{2}$ months. A rejected haulage rope may be used as counter rope.

It may safely be concluded from these trials that the electric haulage machine, even if it is not more economical than the best steam-driven machine, is certainly not more expensive. The greater facility and safety with which it can be manipulated, the smoothness with which it works, and its much greater flexibility, will often make it preferable to the steam-driven machine, even in the case where transmission of energy is not required. There can be no hesitation in the choice between the two systems when the power has to be transmitted from a distance, or, as in the case of the pits of St. Nicolas, where the production of energy can be centralised at one power station.

TRADE NOTICES AND NOVELTIES.

A Novel Sample Cabinet.

The accompanying illustration represents a novel sample cabinet which has been prepared by the Simplex Steel Conduit Company, Limited, Westinghouse-building, W.C., with the idea of supplying on loan to station engineers, architects, lecturers, etc., a set of samples for inspection, as they are far more convenient loose than mounted on a board. The cabinet contains four trays, so that the samples can be classified into main groups, and as each tray is subdivided, the groups can be further arranged in sections. If the trays containing the

Simplex Sample Cabinet.

samples are placed out on a table with the tools from the bottom of the box, an excellent idea of the completeness of the Simplex system of conduit wiring can be obtained. A detailed description of the cabinet and its contents is given in a leaflet recently issued by the company.

A Useful Draught Gauge.

The "Phœnix" indicating and recording draught gauge is a useful device which not only shows on a dial, but also automatically registers on a chart, the exact draught in a boiler or other furnace, thus enabling the stoker to adjust the dampers in order to obtain the best results possible, and at the same time affording the engineer a reliable means to check the work of his men. Details are contained in a new pamphlet just issued by Messrs. Sanders, Rehders, and Co., 108, Fenchurch-street, London, E.C. Two charts taken at an electricity works, before and after installation of the apparatus respectively, are included to illustrate its usefulness. These charts lead one to the conclusion that a considerable saving of fuel may be effected with the aid of the instrument.

A New Brush-Holder.

Messrs. Veritys Limited, Deansgate, Manchester, have sent us particulars of the "Aston" worm-feed brush-holder just introduced by them. This holder, which we illustrate herewith, is of the "box" type, though the principle of "worm-feed" can equally well be applied to the "finger" type of brushes. The former type, however, is coming more and more

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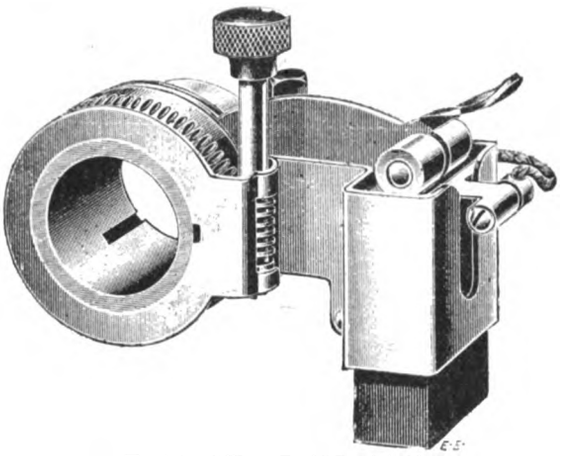
into favour with engineers, we are told, owing to the fact that vibration is not so readily transmitted from armature to brush gear by this type as is the case with the more rigid "finger" type. "Box" type holders fail where the attempt is made to obtain a tight contact between carbon and box. In the Aston brush-holders the carbon is a moderately loose fit in the box, and ample contact is provided by a flexible copper connection between carbon and holder. The carbon is fed down without friction by the pressure of two small rollers, which are connected by means of a lever to the "worm-feed" adjustment.

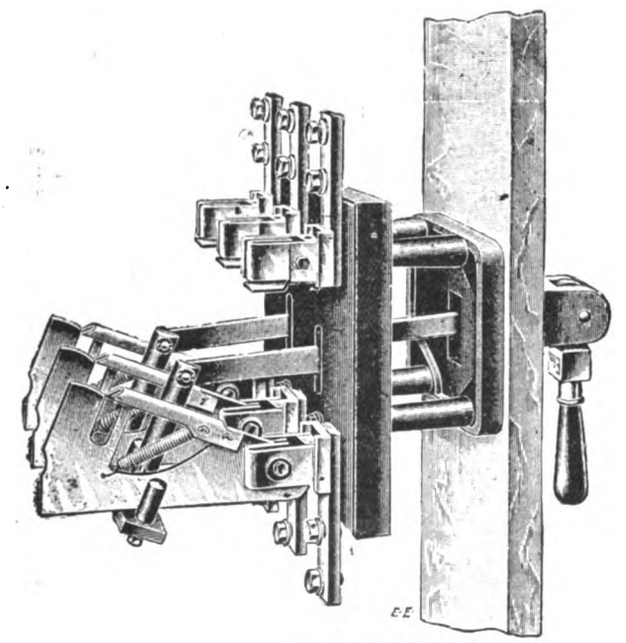


The Aston "Worm-Feed" Brush-holder.

By turning the insulated knob of a small screw, the pressure on the carbon can be regulated to the finest limit. One end of the spiral spring is connected to the worm-wheel, and the other end to the lever, and as the worm-wheel is turned by the thumb-screw, greater or less pressure is put on the carbon. The tube of the holder is split through half its length, and a split ring provided with a steel key is used for tightening the holder upon the brush pillar. The lever is extended beyond the pressure rollers to provide a ready means of raising to try the tension or remove the carbon. A small slot is provided in the front of the carbon-box, and as the carbon is fed forward, the lever finally comes to rest at the bottom of this slot. The possibility of the lever touching the commutator is thus avoided. The thumb-screw is fitted with an insulated knob, so that extra tension can be applied if required while running without fear of shock.

Low-Tension Switchgear.

The Union Electric Company, Limited, 151, Queen Victoria-street, E.C., are issuing a new list of their low-tension switchgear for capacities of from 20 to 6,000 amperes, and voltages up



Union B pattern L.T. Treble Pole Switch.

to 550. Two leading types of switches are dealt with in this list. Pattern B is of small ampere capacity, and made one, two, or three pole. Its leading features are as follows: A replaceable spark-carrying contact with exceedingly rapid break on each pole, which keeps the main contacts entirely free from all sparks; the replaceable finger is held in by split pins, the flat contact by an accessible bolt; arrangement for connections at back or front of switchboard; change-over arrangement with off position, both for front and back of board working; large contact surfaces, the 550-volt types having the same contact area although lesser ampere rating than the 250-volt types. Pattern C is made for larger currents up to 6,000 amperes. It is provided with magnetic blow-outs on all poles, replaceable spark-carrying rollers, and laminated brush contacts. Both types are arranged for mounting behind the switchboard with the operating handle in front. The accompanying illustration shows a treble-pole switch of the first-mentioned pattern. For use in connection with these switches, special open fusible cut-outs and enclosed handle plug carriers are also included in the list.

Catalogues, etc., Received.

WALL TELEPHONE.—The General Electric Company, Limited, Queen Victoria-street, E.C., are advertising their K 25 battery wall telephone by means of a little novelty card, which is an exact facsimile of the instrument. We understand this telephone has been remodelled in order to bring it up to the very highest possible state of efficiency and simplicity, the inside connections being particularly simple. It has the additional advantage of an extremely low price for such a well-finished and efficient article.

PORTABLE DRILLS AND ELECTRICAL ACCESSORIES.—From the Electrical Trades Supply, Limited, Great Charles-street, Birmingham, we have a well-illustrated catalogue of their portable electric drilling machines, also a list of E.T.S. damp and dust-proof electrical fittings for collieries, ironworks, factories, mills, ships, etc.; a list of electrical porcelain ware, including ceiling roses, cut-outs, wall plugs, lamp-holders, brackets, watertight fittings, etc.; and an abridged list of cord pendants, ceiling fittings, brackets, electroliers, and standards.

LEIGH ELECTRICITY ACCOUNTS

We give below an abstract of the revenue account for the year ended March 31, 1905, just issued by the Leigh Corporation Tramways and Electricity Committee.

Dr. *Expenditure.*	£	s.	d.
To generation of electricity	1,461	15	1
Repairs and maintenance of plant	598	11	3
Distribution of electricity	333	19	4
Rents, rates, and taxes	182	19	6
Management expenses, salaries, etc.	357	1	5
Special charges, insurance, etc.	284	4	7
	3,218	11	2
Balance, being gross profit for the year	1,588	4	11
	£4,806	16	1

Cr. *Income.*	£	s.	d.
By sale of current for lighting and power	4,410	17	6
Charging electric batteries	0	16	11
Rental of motors and other apparatus	250	15	2
Sale of lamps, fittings, etc.	142	19	0
Compensation claim paid by insurance company	1	7	6
	£4,806	16	1

BIRMINGHAM ELECTRICITY ACCOUNTS

The accounts of the city of Birmingham electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £665,424. Abstracts of the revenue account and balance-sheet are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	20,227	6	11
Distribution of electricity	1,246	10	3
Rents, rates, and taxes	3 527	18	3
Management expenses, salaries, etc.	5,314	4	5
Audit fees	40	0	0
Insurance, etc.	211	5	1
Bad debts	88	10	2
Total expenditure	30,655	15	1
Balance carried to profit and loss account	39,573	12	7
	£70,229	7	8

Cr. Income.	£	s.	d.
By sale of current, less discounts	67,831	13	8
Meter rents	1 808	2	10
Rents receivable	218	1	9
Contracting department surplus	232	2	10
Contributions for superannuation	139	6	7
	£70,229	7	8

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BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—loans outstanding and repaid	713,928	17	1
Balance at credit of reserve fund	49,393	19	2
Interest accrued and unpaid	4,919	2	7
Sundry creditors	7,371	4	4
Due to treasurer on revenue account	14,450	9	0
	£790,093	12	2

Cr. Assets.	£	s.	d.
Capital account—amount expended on works	665,423	19	0
Stores on hand	1,533	9	11
Sundry creditors for current, fittings, etc.	22,853	3	3
Invested on account of reserve fund	26,394	9	11
In hands of city treasurer	73,828	18	8
Cash in hand	59	11	5
	£790,093	12	2

GLASGOW ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., by the Glasgow Corporation electricity department for the year ending May 31, 1905.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	37,779	18	5
Distribution of electricity	9,426	18	5
Attending and repairs to public lamps	3,482	5	0
Rents, rates, and taxes	13,856	11	10
Management expenses, salaries, etc.	7,175	12	6
Special charges	2,875	10	11
Depreciation on works, machinery, mains, etc.	41,840	17	3
	116,437	14	4
Balance carried to profit and loss account	69,933	19	7
	£186,371	19	7

Cr. Income.	£	s.	d.
By sale of current per meter	173,890	15	11
Public lighting	12,480	18	0
	£186,371	13	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	1,290,000	0	0
Deposits in security of electricity rents	1,629	1	1
Accounts due to sundry tradesmen	7,504	15	8
Sinking fund	83,667	18	2
Reserve fund	12,723	12	8
	£1,395,524	7	7

Cr. Income.	£	s.	d.
Capital account—amount expended for works	1,244,162	12	10
Outstanding revenue assets	24,825	10	5
Stores on hand	41,989	16	11
Balance in bank	878	9	3
Sinking fund invested	83,667	18	2
	£1,395,524	7	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			21,584,088
Quantity sold	Private consumers	16,642,253	
	Public lamps	1,525,505	18,248,468
	By contract	80,710	
Quantity used on works			1,025 516
Total quantity accounted for			19 273,984
Quantity not accounted for			2,310,104
Number of consumers			11,643
Number of public lamps			825
Total maximum supply demanded (kilowatts)			31,399

APPOINTMENTS VACANT.

Chief Instructor in Mathematics, Northampton Institute, Clerkenwell. Salary, £150 per session. Applications by 30th inst. See advertisement in last issue.

Premium Pupil, Kilmalcolm Electric Lighting Co. See advertisement in last issue.

Assistant Engineer about 25 years of age, with good knowledge of mechanical engineering. Applications to G M 532, Messrs. Deacon's, Leadenhall-street, London, E.C.

Practical Engineer to supervise the equipment of a complete electrical tramway in India. Applications to Box No. K 10, *Electrical Engineer* Office. See advertisement in last issue.

Mechanical and Electrical Engineer. Salary, 30s. per week. Applications to R. N., *Electrical Engineer* Office. See advertisement in last issue.

Electrician, Monmouthshire Asylum, Abergavenny. Salary, £2 per week. Applications to the Medical Superintendent by 12th inst.

LEGAL INTELLIGENCE.

TRAM COLLISION.

Before Mr. Justice Grantham and a special jury at the West Riding Assizes, Leeds, last week, an action was heard in which Dr. Henry White, of Bradford, claimed £17,200 damages against the Bradford Corporation for personal injuries sustained on Easter Monday. One part of the doctor's claim was £16,000 for loss of practice, past and future. The plaintiff's case was that he was being driven in a phaeton from his residence in St. Jude's-place into Manningham-lane, and on reaching the corner he saw a tramcar coming along Manningham-lane 60 or 70 yards away. Believing there was sufficient time, he attempted to drive across the street to get to his right side. The phaeton had not cleared the car lines, however, when the car dashed into it, and both the plaintiff and his coachman were thrown out. The doctor had been told by his medical advisers that he was quite unfit to do his work. He had been in bed some weeks, and would be unable to follow his practice for a considerable time. The plaintiff contended that the car was being driven at a speed of over 20 miles an hour.

The defence was that when the phaeton drove out of St. Jude's-place at a smart trot the car was only 16 yards away. The driver rang his bell and applied the brakes, and but for the driver of the phaeton hesitating on the rails no accident would have occurred.

The jury awarded the plaintiff £1,500.

COMPANIES' MEETINGS AND REPORTS.

GASLIGHT AND COKE.

At the half-yearly ordinary general meeting of the Gaslight and Coke Co. last week, Mr. HOWARD C. WARD (deputy-governor), who presided, stated that there never was a time when competition was so keen and prices for electric current so low, especially those charged by borough councils who had their own electric undertakings, and who had the rates to fall back upon if they lost money. There had been a considerable saving in several directions. The Corporation of the city of London had decided to experimentally light Queen Victoria-street, Lower Thames-street, and Fleet-street with gas. That was extremely satisfactory, inasmuch as it would not only tend to increase the Company's gas sales, but it also showed that the most important corporation in the world realised that gas was a better and a cheaper light for the streets than electricity. Another matter for congratulation was the fact that they had secured the lighting of the new Victoria Station in competition with electric light at an extremely low figure.

As compared with the corresponding half-year of 1904 there was a considerable falling off. After paying a dividend of £4·8 per cent. there was a deficit of £30,000 in place of the surplus of £98,000 12 months ago.

LONDON ROAD-CAR.

At the forty-fifth half-yearly meeting of this Company, the CHAIRMAN stated that the number of passengers carried was 37,377,896, being an increase of 411,343 over the number carried in the corresponding period of 1904. The weekly average traffic receipts per car were £17. 3s. 7¼d., against £16. 18s. 2d., being an increase of 5s. 5d. per car per week. Of the total number of passengers, nearly one million were carried by motor omnibuses. Although the number of motors was relatively small, their greater earning power had had a considerable effect in increasing the average receipts of the cars, but it was only fair to say that the average receipts of the horse cars were slightly better than in the corresponding period. The experience gained enabled the Board to gauge the situation with tolerable accuracy. Their minds were made up regarding the type of motor which would not be adopted by them, as well as the type which would suit. Generally, the outlook was not unsatisfactory. The balance available for division was £21,903, of which it was proposed to transfer £2,000 to the general reserve, raising it to £60,000. It was also proposed to pay a dividend of 4s. per share on the fully-paid shares, carrying forward £6,613.

NERNST ELECTRIC LIGHT.

An extraordinary general meeting of this Company will be held on 14th inst, when the resolutions passed at the meeting on July 24 will be submitted for confirmation. These resolutions sanctioned the provisional agreement under which it is proposed that the Company shall sell to the Allgemeine Elektricitäts-Gesellschaft all the patent rights possessed by it for manufacturing and selling Nernst lamps elsewhere than in Europe and the United States of America and Canada, and including the Company's rights to the royalties payable by the Allgemeine Elektricitäts-Gesellschaft on deliveries of patented Nernst lamps for Great Britain, for £24,000, to be paid in cash.

ANGLO-AMERICAN TELEGRAPH.

The half-yearly meeting of this Company was held on Tuesday, Mr. F. A. Bevan presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN stated that the new half-year had commenced with increased traffic, and they looked forward to a good half-year, in spite of the fact that the Newfoundland authorities had taken it into their heads to impose a tax on them, which might cause a loss of £1,000 a year. They were also threatened with competition in Newfoundland.

The report was approved.

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SOUTH WALES ELECTRICAL POWER.

An extraordinary general meeting of this Company was held on Saturday at Cardiff, Mr. R. Forrest, J.P., presiding. It was resolved to create £100,000 additional debenture stock of the Company, bearing interest at the rate of 5 per cent. per annum, being the fourth and fifth instalments of £50,000 each, part of the £250,000 which the Company is empowered to borrow under its Act.

NORTH METROPOLITAN TRAMWAYS.

The report for the half-year ended June 30 last states that the gross receipts for the period have amounted to £307,419, and expenditure to £295,524. The number of cars running shows a decrease of 4·25; there was a decline of 44,093 in the miles run, and of £2,506 in traffic receipts. The sum of £11,794 has been charged against revenue for maintenance of the permanent way. For some time past negotiations have been pending with the London County Council for the surrender of the lease of their northern tramways, which was granted by the Council to the Company in October, 1897, and which would not have expired in the ordinary course until June, 1910, and also for the purchase of the properties, cars, horses, etc., which belong to and are employed by the Company in working these tramways. These negotiations have now resulted in an offer by the Council which the directors have decided to recommend the shareholders to accept, and the terms of which have been embodied in an agreement which will be submitted to the shareholders for confirmation at the general meeting to be held on the 16th inst. This agreement, which is to take effect as from April 1 next, will, if ratified, also put an end to various matters in dispute between the Council and the Company.

NEW COMPANIES REGISTERED.

City of Ely Electric Light and Power Co., Limited.—Capital, £5,000. Object: to adopt an agreement with H. Foote, L. Milne, and E. J. Owen, providing for the transfer to the company of the undertaking and powers granted to them by the Ely Electric Lighting Order, 1904, etc.

Newquay Electric Light and Power Co., Limited.—Capital, £15,000. Object: to carry on at Newquay, and elsewhere in Cornwall, the business of an electric light and power supply company in all its branches, and to adopt an agreement with H. Foote, L. Milne, and E. J. Owen for the acquisition of the undertaking and powers granted to them by the Newquay Electric Lighting Order, 1904, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Warrington.—Tenders are required for cables. Tenders by Aug. 11.

Sophia.—The District Finance Commission require tenders for telegraph material by Aug. 25.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Finchley.—The Urban District Council invite tenders for storage batteries and booster. Tenders by Aug. 15.

Turn-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct-coupled steam set.

Paris.—The Post and Telegraph Department require tenders for rubber-insulated copper wire. Tenders to above, 103, Rue de Grenelle, by Aug. 24.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Zaragoza. Tenders by Sept. 12.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Malago (Malaga). Tenders by Aug. 19.

Madrid.—The Public Works Department require tenders for the construction and working of two electric tramways in Barcelona. Tenders by Aug. 18.

Acton.—The Urban District Council invite tenders from manufacturers for the supply of arc lamp carbons and house fuse-boxes for a period of 12 months. Tenders by Aug. 21. See advertisement in last issue.

Larne (Ireland).—Tenders are invited for lighting the public streets and roads of the urban district of Larne by means of coal gas or electricity for three years from Aug. 1, 1906. Tenders by 10 a.m. on Sept. 2.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10,000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Swansea.—The Corporation invite tenders for supply, delivery, and erection of one intercommunication switchboard section for central exchange, and apparatus for sub-exchanges at Morriston and Mumbles. Tenders by Aug. 11.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Chelmsford.—The Town Council invite tenders for lighting the public streets and public clock within the borough with electricity, gas or other illuminating power for three or five years from March 25, 1906. Tenders by Sept. 8.

Dublin.—The Lighting Committee of the Corporation invite tenders for certain alterations and additions to the coal storing and conveying plant at their Pigeon House generating station. Tenders by Aug. 15. See advertisement in last issue.

Paris.—The Waterworks Department of the Municipality require tenders for supply and erection of motors, pumps, and generators for the proposed waterworks at Chantilly. For particulars apply to above authority. Tenders by Oct. 12.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Fulham.—The Council invite offers for a 300 kw. horizontal compound condensing slow-speed set with condenser complete, consisting of Musgrave engine fitted to a General Electric Co.'s alternator, speed 95 r.p.m. Offers to the Town Clerk by noon on Aug. 16.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23. See advertisement in previous issue.

RESULTS OF TENDERS.

Colchester.—The Town Council have accepted the tender of W. T. Henley's Telegraph Works Co. for cables at £490. 0s 2d.

Hammersmith.—The tender of Messrs. Foster, at £1,607, has been accepted for the erection of additions to the Borough Council's electric lighting works.

Scunthorpe.—The Urban District Council have awarded the order for storage battery of 122 standard lighting type cells to the Hart Accumulator Co.

Beckenham.—The Urban District Council have accepted the following tenders: Babcock and Wilcox, boilers, £1,171 without brickwork, and £1,946 with brickwork; General Electric Co., alternators, with a Belliss engine, £1,604.

Brighton.—The Town Council have accepted the tender of the Chloride Electrical Storage Co., Clifton Junction, near Manchester, at £3,600, for the supply, erection, and maintenance of a 260-cell storage battery having a capacity of 1,000 ampere-hours at the Southwick power station.

Hampstead.—Eight tenders for the supply of coal and coke to the various depots of the Council—including the electric lighting depot—for one year have been referred to the Works Committee with power to act. The tender of Mr. A. Mercer, of Boundary-road, for relaquering the electric light fittings in the town hall for £13 has been accepted.

Wishaw.—The Town Council have accepted the following offers for the carrying out of the electric lighting scheme, which is expected to be introduced in the beginning of October: Callender's Cable Co., London, underground mains, £5,437. 5s. 3d.; J. M'Ewan. Wishaw, £677. 18s. 4d., excavating and reinstating; Oliver and Co., Woolwich, £539. 10s. 6d., new flame lamps (45 in number).

Metropolitan Asylums Board.—The Board have accepted the following tenders: Messrs. James and Browne, 395, Oxford-street, W., to supply a chassis for £465, and the Electromobile Co., to supply an electrically-propelled ambulance on hire at three months for £10. Group III.—Cars driven by electricity: Electromobile Co., 7, Curzon-street, Mayfair, W., 8 h.p., £460, hire £10 per month; Carl Oppermann Electric Carriage Co., 7, Underhill-street, Camden Town, N.W., £425, hire £20 per month. The purchase price includes the amount to be paid for hire for three months unless otherwise stated.

Bath.—The Corporation have received the following tenders for storage battery for the electricity department:

Tudor Accumulator Co.	£2,483	5	0
Chloride Electric Storage Co.	2 190	17	10
Pritchetts and Gold	2,947	0	0
Premier Accumulator Co.	3 125	11	0
Accumulator Industries	2 378	0	0
Electrical Power Storage Co.	2,286	17	0
Ditto	2,534	0	0
Ditto	3,006	8	0
British Accumulator Co.	2,464	14	0
Hart Accumulator Co.	3,235	3	8
D. P. Battery Co. (accepted)	2,490	13	0
Ditto	2,790	0	0
A. B. P. Accumulator Co.	3,232	0	0

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Wimbledon.—The Urban District Council have received the following tenders for the supply and erection of a 15-ton overhead hand travelling crane at the electricity works:

J. Smith (Keighley), Limited, Keighley (accepted)	£155	0	0
Holt and Willetts	215	0	0
J. Hitchen and Sons	225	10	0
Rushworth Bros.	245	0	0
C. and A. Musker	255	0	0
Chatteris Engineering Works	261	0	0
Carrick and Ritchie	265	0	0
Broadbent and Sons	295	0	0
J. Booth and Bros.	297	10	0
J. Spencer and Co.	305	0	0
Chaplin and Co.	310	0	0

Beckenham.—The Urban District Council have received the following tenders for the extension of the boiler and engine house, etc., at their electric light works, Arthur-road, Beckenham:

Holliday and Greenwood, Brixton	£2,555
Wallis and Sons, Maidstone	2,189
Patman and Fotheringham, Islington	2,173
Cropley Bros., High-street Epsom	2,159
H. Lovatt Limited, West Kensington	2,028
Jones and Andrews, Beckenham	2,020
B. E. Nightingale, Albert Embankment	1,978
W. H. Hyde, Norwood Junction	1,970
H. Kent, 17, Albion-road, Lewisham	1,937
W. Wallis, Balham High-road	1,927
H. Heathfield, Beckenham	1,919
J. Smith and Sons, Junction Works, South Norwood	1,914
F. and G. Foster, Suffolk Works, Norwood Junction (accepted)	1,798

Wimbledon.—The Urban District Council have received the following tenders for the supply and erection of a turbo-alternator at the electricity works:

British Thomson-Houston Co. (Curtis-B.T.H.) (accepted)	£7,255	0	0
General Electric Co. (Brush-Parsons-G.E.C.)	7,445	0	0
Willans and Robinson (Willans-Bruce Peebles)	7,447	0	0
Do. (Willans-Dick Kerr)	7,684	0	0
Do. (Willans-Witting-Eborall)	8,474	0	0
Do. (Willans-Siemens)	9,559	0	0
General Electric Co. (Parsons-G.E.C.)	7,995	0	0
Bruce Peebles and Co. (Parsons-Bruce Peebles)	7,718	0	0
Do. (Rateau-Bruce Peebles)	8,490	0	0
Brush Electrical Engineering Co. (Brush)	7,723	10	0
British Westinghouse Co. (Westinghouse)	8,059	0	0
Richardsons, Westgarth, and Co. (Richardsons-Westgarth-Brown-Boveri)	8,290	0	0
C. A. Parsons and Co. (Parsons)	8,509	0	0
Witting, Eborall, and Co. (Zoelly-Witting Eborall)	9,523	0	0
Do. (Do.)	9,293	0	0
Do. (Richardsons-Westgarth-Witting-Eborall)	8,963	0	0
Do. (Do.)	8,733	0	0
Siemens Bros. and Co. (Parsons-Siemens)	9,374	0	0
Do. (Zoelly-Siemens)	10,605	0	0
Do. (Rateau-Siemens)	11,229	0	0
Mather and Platt (Zoelly-Mather and Platt)	12,418	0	0

Worthing.—The Corporation have received the following tenders for (1) supply and erection of one dry-back marine type steam boiler with fittings; (2) supply and erection of steam feed, drain, and other piping; (3) supply of vulcanised bitumen-sheathed feeder and pilot cables; (4) supply of stoneware conduits:

Boiler.

Fraser and Fraser	£658	0	0
E. Danks and Co.	650	0	0
H. and T. Danks	635	0	0
J. Fraser and Son	545	0	0
Ditto	575	0	0
Ditto	625	0	0
J. Musgrave and Son	1,007	0	0
Davey, Paxman, and Co.	579	10	0
Ditto*	622	0	0
Ruston, Proctor, and Co.	950	0	0
R. Taylor and Sons	590	0	0
J. Thompson	650	0	0
Tinker's Limited	730	0	0

Steam, drain, feed, and other pipes.

Babcock and Wilcox	135	0	0
Blackwell and Co.*	140	0	0
Defries and Sons	220	0	0
H. and T. Danks	150	0	0
E. Le Bas and Co.	142	0	0
J. Spencer Limited	160	0	0

Cables.

British Insulated Co.	850	15	0
Callender's Cable and Construction Co.*	828	16	5
Glover and Co.	849	0	0
W. T. Henley	861	0	0
St. Helen's Cable Co.	996	0	0
Johnson and Phillips	1,250	0	0

Stoneware conduit pipes.

Ames Crosta Engineering Co.	240	16	0
Albion Clay Co.	200	6	3
Ditto*	217	11	9
F. J. Cummings and Co.	184	14	0
E. Deane	336	0	0
H. R. Mansfield	231	17	6
Oates and Co.	227	10	0

*Accepted, subject to Local Government Board sanctioning loan for purpose on terms acceptable to the Corporation.

BUSINESS NOTES.

TRACTION.

Nottingham.—A fatality occurred on the Barford line owing to the failure of the lifeguard to act.

Birkenhead.—The experiment of 3d. return tickets to Liverpool is stated to have proved disappointing.

Rotherham.—At the meeting of the Town Council the chairman of the Tramways Committee stated that ½d. fares did not pay.

Kirkcaldy.—The District Committee have decided to take no action in regard to the proposal of the promoters of the Wemyss tramways to lay the rails of lines Nos. 2 and 6 on a raised track.

Rochdale.—The Corporation have rejected the Tramways Committee's proposal for 1½d. workmen's fares on the Littleborough section, holding that it would be politic to charge 1d. only.

Goods Traffic.—At a meeting of tramway managers held at Manchester, under the presidency of Mr. J. M. McElroy, the general opinion was that something should be done to develop goods traffic.

Removal.—The engineer's office of the Metropolitan District Railway has been transferred from Lillie Bridge Works, S.W., to the St. James's Park Station, to which address all future communications should be directed.

St. Petersburg.—It is reported that invitations for tenders for the construction of the St. Petersburg electric tramway system have only been sent to German, French, and Belgian firms, and not to British or American houses.

Charing Cross, Euston, and Hampstead Railway.—The half-yearly report states that the capital expenditure to date is £3,372,694, of which £741,158 was incurred in the past six months. During the current half-year the expenditure is estimated at £750,000.

Limerick.—It was expected that a scheme on the part of a private company for constructing a tramway would be considered by the Corporation last night. It is reported that the promoters intend the system to be for goods traffic only, in which case they are likely to meet with considerable opposition.

Derby.—At the meeting of the Town Council on the 2nd inst. great satisfaction was expressed with the way the contractors (Messrs. Wm. Griffiths and Co.) had progressed with their work. They had gained marks of approval and approbation on all hands, and the Tramways Committee did not think the town had ever had a better lot of men working in the place.

North-East London Railway Bill.—After hearing evidence on the lines of that given before the Commons Committee, the Select Committee of the House of Lords presided over by Lord Ludlow approved of this measure for a tube from the City to Waltham Abbey. Owing to the obstructive tactics of the Irish Nationalists the Bill has had to stand over this session.

Yarmouth.—At the meeting of the Town Council on Tuesday it was reported that the receipts for the past month had been £1,400. 12s. 9d. on the Yarmouth section, an increase of £18. 16s. 11d., and on the newly-electrified Gorleston section £1,070. 2s. 3d., a total of £2,470. 15s. The number of passengers carried during the month on the Gorleston section was 123,336.

Devonport.—The Tramways Committee's recommendation that the company's offer to pay the Corporation a fixed sum to be released from the obligation to erect shelters has been approved. The Corporation will erect several shelters themselves. Experiments are to be made on the Morrie-square route, and if the results justify such a course the company will permanently restore the service on this line.

London County Council.—A short extension of the County Council's tramways system from Blackfriars, Waterloo, and Westminster Bridges has been opened for traffic, and the cars, instead of stopping in Tooting High-street, proceed to Tooting Broadway. This line is shortly to be further extended in two directions, one branch going to the county boundary at Merton, and another to Tooting Junction railway station.

Bath.—Colonel von Donop, representing the Board of Trade, last week visited Bath for the purpose of inspecting the new extension of the electric tramways system. The new route commences from the existing line at the end of Newbridge-road, Lower Weston, and terminates at the Globe Inn, Newton St. Loe. The work, which was commenced on June 9, has been carried out expeditiously. The inspector expressed himself as satisfied with the work.

Aberdeen.—At Monday's meeting of the Corporation the annual tramway accounts were submitted. The gross revenue amounted to £70,430. and there was a net surplus of £12,288, which has been applied to renewals and depreciation. Details of the year's working have already appeared in our columns. The accounts were unanimously approved. It has been decided that the fares for the ensuing year shall remain practically as at present. A proposal to extend the system of ½d. fares was negatived.

Seaham and District Light Railway.—At the inquiry by the Light Railway Commissioners as to the expediency of granting an application for a provisional order to lay tramways from Ryhope to Seaham Harbour, Seaham Colliery, Murton Colliery, and South Hetton, to which we referred last week, Mr. D. Balfour, jun., M.I.C.E., of Messrs. D. Balfour and Son, consulting engineers, Newcastle-on-Tyne, gave detailed evidence as to the route, gradients, lengths, and cost of the line. The chairman intimated the Commissioners' assent to the proposal.

Bury.—The following resolution was adopted at last week's meeting of the Town Council: "To pass a resolution in pursuance of the recom-

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mendation of the General Purposes Committee approved by the Council, that the resolution passed at a meeting of the Council held on July 6, 1905, altering the resolution of the Tramways Committee on the 9th ult., with reference to obtaining further cars, be rescinded." It was intimated by the chairman of the Tramways Committee that the agreement with Heywood had virtually been concluded, subject to the approval of the respective Corporations.

Tipton.—As the result of negotiations which have been in progress for over 12 months, it is stated that there is now a prospect of an early solution of the tramway difficulty at Tipton, the British Electric Traction Co. having entered into an agreement with the District Council to commence within two months the electrification of the line from Dudley to Princes End, and from Ocker Hill to Wednesbury. Owing to the effect of mining subsidences, the question of the electrification of the intermediate section between Princes End and Ocker Hill is to remain in abeyance.

Ramsgate.—On the morning of the 3rd inst. a remarkable accident occurred on the loop line connecting Ramsgate and Broadstairs. As one of the cars was proceeding along Madeira-road, East Cliff, which is steep and winding, it left the rails, and, dashing into the iron fence and coping which skirted the footway, it was precipitated into space. It appears to have turned a somersault and alighted upon some vacant land 32ft. below. The four passengers and the conductor had remarkable escapes. The driver seems to have been shot out of the vehicle before it fell over, and sustained rather severe injuries. The Board of Trade have intimated that they will hold an inquiry.

Fareham.—The question as to the extension of the tramway line in West-street, over which there has been some discussion between the Gosport and Fareham Tramway Co. and the London and South-Western Railway, has been satisfactorily terminated. The line at present stops at a point about 200 yards from the railway station, and an effort was made by the company and the Urban District Council to obtain a concession from the railway company to run as far as the station. To this the latter demurred, but a letter has recently been received from the railway company granting permission to construct the line to a point within 30ft. of the company's pavement.

Plymouth.—The new section of the Corporation tramways, which extends from Pennycomequick to Old Town-street, *via* Cobourg-street has been inspected by Colonel Druitt, representing the Board of Trade. In the trial run, Mr. Raworth, jun., acted as driver, and in the car were Mr. R. R. Monk (chairman of the Tramcar Committee), Messrs. C. R. Everson, tramway manager, J. Paton, borough surveyor, and Okell, electrical engineer. The car travelled easily, and the inspector expressed satisfaction with the type of car and the trial, but stipulated that a Sprague brake should be fitted to each of the cars for service on this line as a precaution against running backwards down the hill at Pennycomequick. The cars are fitted with Raworth's regenerative control.

Morley.—The Town Council have adopted the following resolution: "That the town clerk write to the British Electric Traction Co. stating that the Corporation are very anxious to have the Morley tramways completed with as little delay as possible, and ask if they will give an undertaking that the railways will be completed within the period if the Council agree to the further extension, and that in the event of an unsatisfactory reply being received from the company, the town clerk be instructed to submit the facts to the Board of Trade." On the one hand, the Corporation is asked by the company to consent to this extension, and, on the other, it is being urged by the democratic section of the community to undertake the construction and extension of the tramways itself.

Tramway Extension in Yorks.—The Tramways Orders Confirmation (No. 1) Bill came on Monday before the Committee on Unopposed Measures at Westminster, the Deputy-Chairman of Committees (Mr. Laurence Hardy) presiding. The Bill confirms orders made provisionally by the Board of Trade empowering the Corporations of Bradford, Leeds, Keighley, and Pudsey to construct tramways. Mr. Bonnor Maurice explained that there was a contest in the House of Lords because the railway companies did not consider that they were sufficiently protected. The clauses objected to had been struck out of the Bill, and new ones inserted. These had been agreed to by all the parties interested, as well as by the Board of Trade. The Bill passed through committee, and was sent for third reading in the Commons.

Glasgow.—At a meeting of the inhabitants of Duntocher the following resolution was carried unanimously: "That this public meeting unanimously resolves to again approach Glasgow Corporation to request an extension of the tramways from Kilbowie to Duntocher, a distance of barely two miles. They submit that as there is a population of over 3,000 people in Duntocher and Hardgate, and a very considerable daily traffic between Duntocher and Clydebank (in which place nearly all the inhabitants of Duntocher are employed), that as the district around the two villages is peculiarly healthy and picturesque, and admirably suited to building purposes, and as a golf course with a large membership has recently been opened at Hardgate, the desired extension would be a great benefit to the locality, would develop the district, and could hardly fail to be remunerative to the Corporation."

Motor 'Buses.—The deputation appointed by Glasgow Corporation to visit the recent Electric Tramway and Railway Exhibition report that very distinct evidence has been given of the development of the motor 'bus in opposition to tramway traction, but they do not view with alarm any opposition from this source in Glasgow, as the expense of renewing the rubber tyres is admittedly very heavy, the cost being 2d. per mile run even on smooth pavement. They could not, therefore, be run on a paying basis on the square setts of the city streets, while the rough ride on the irregular streets would compare unfavourably with the smooth running of the cars. The deputation suggest, however, that in any further extensions it should be considered whether or not it would be wise to apply motor power to the cars in the outlying districts instead of equipping an overhead system. The heavy expense of renewing the tyres would be done away with, owing to the lines being laid.

Cardiff.—At the meeting of the Corporation Councillor Courtis moved that the borough treasurer pay monthly into the insurance fund 1¼ per cent. out of each day's gross traffic tramway receipts. Councillor Ramsdale pointed out that they had paid £3,000 for accidents. He was of opinion the amount should not be less than 2 per cent. Councillor Courtis replied that the present year had been quite exceptional, that they had accumulated a fund of £5,000, that during the past three years their expenditure on this account had been £2,382. 4s. 2d., or, roughly, an average of £800 a year, and that the committee felt under the circumstances 1¼ per cent. would be ample. In the first years of a tramways undertaking the expenses on account of accidents were always heavy, but as the years went on experience showed the number of accidents decreased. The motion was adopted.

Finchley.—At last week's meeting of the Urban District Council the surveyor reported that he had received an urgent request from the county surveyor that the plan of the light railway might be approved at once, and a plan was submitted showing the position of the track from the termination of the existing railway to the Barnet boundary. The Highways Committee reported that, with a view to expediting matters so that action might be taken by the County Council before their summer recess, they had instructed the surveyor to forward the plan to the county authorities approved on behalf of the Council to a point by Wallfield Cottage, subject to the paving of the margins of the track being carried out as the work of laying the railway proceeded. The committee also reported that it was not possible to deal with the proposed railways beyond Wallfield Cottage pending satisfactory settlement of the negotiations for widening as far as the Barnet boundary. The committee's action was approved.

Hull.—At the meeting last week of the Tramways Committee, the City Engineer submitted a letter from Messrs. Lackenby and Co., stating that they had delivered the last car cover of their contract to the depôt for fixing, and asked if the Corporation were prepared to proceed with a further number of coverings. The City Engineer said it was a question of whether they should adopt further coverings with opening roofs, or whether as an experiment they should try a cover with a fixed roof and opening side windows. It was decided to reply to Messrs. Lackenby and Co. that the Corporation do not propose at present to fix any further quantity of coverings of the description which they have been providing, and the city engineer was authorised to fix to one of the cars a sample cover with fixed roof and movable side windows. The tramway manager (Mr. W. McCombe) reported that the tramway receipts from April 1, the beginning of the Corporation financial year, to July 29, amounted to £37,387. 7s. 6d., which was an increase of £88. 0s. 10d. over the corresponding period of last year. The Mayor remarked that the great drawback to the system at the present time was the Hedon-road route, which, however, is showing signs of improvement.

Halifax.—The extension of the tramways to West Vale was formally opened last week by the mayor of Halifax, Alderman Enoch Robinson. On the previous day the new route was officially inspected by Lieut.-Colonel Druitt, on behalf of the Board of Trade, and passed by him. The extension measures 1 mile 3 furlongs 7 chains, and the 1d. stage has been altered to a point opposite the Prince of Wales Hotel. The doubling in Huddersfield-road amounts to 1 furlong 5 8 chains, from Stafford House to the top of Salterhebble-hill. The cost was £12,590 for the length from the top of Salterhebble-hill to the terminus at West-vale, and the doubling has entailed an expenditure of £1,082. These figures are less than the original estimate, which was £1 200 for the doubling and £13,543 for the new track. The line from the top of Salterhebble-hill is practically a double one, and included in the cost is the lowering of the road 2ft. 4in. under the railway arch so as to get headway. A private car left the town hall at 4 o'clock on Thursday week, and was joined by two others at Wards-end. The mayor was joined by the chairman of the Tramways Committee, Alderman T. Hey, Councillor Fawcett (vice-chairman), and the rest of the members, Mr. J. Lord (borough engineer), Mr. W. M. Rogerson (electrical engineer), Mr. F. Spencer (tramways manager), and others.

West Ham.—The report of the Corporation tramways for the year ending March 31 shows that the revenue derived from the electric tramways was approximately £55,000, and this amount was increased to nearly £62,000 by the receipts from the North Metropolitan Tramways Co. The working expenses of the electric trams amount to £37,851, and interest on capital absorbs £9.020, while sinking fund accounts for £4,325, leaving a net balance of £10,092. Of this last-mentioned amount £3,092 is allocated to reserve, while the substantial sum of £7,000 is contributed to the relief of rates. The following statistical information in regard to the electric lines is interesting: car miles, 1,237,165; passengers carried, 15,773,592; total number of units used, 1,311,865; units per car mile, 1·060; percentage of working expenses to receipts, 67; average traffic revenue per car mile, 10·68d.; average car miles per day per car, 105; average time-table speed per hour, 6¾ miles; average car hours per day, 16; average working expenses per car mile excluding power cost, 5 646d.; average working expenses per car mile including power cost, 7·343d.; average fare charged per mile, ·56d. Penny fares represented over 56 per cent. of the receipts. At the commencement of the financial year the system (reckoned as single line) represented 17 miles. During the year extensions aggregating no less than 41 route miles were opened. The population served is about 300,000. The tramways department and Mr. H. E. Blain, the manager, are to be congratulated upon these promising results.

Lancashire and Yorkshire Railway.—At the half-yearly meeting on Wednesday the chairman stated that the electric service upon

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the Liverpool, Southport, and Crossens line during the last six months had been quite satisfactory, and had been appreciated by the vast majority of the people who had used it, as the company had carried no less than 600,000 additional passengers with ordinary tickets. Their season tickets had also increased in number. The amount of building which was going on upon the line in consequence was also very gratifying, showing that it had done what was hoped it would do in attracting a large number of people to go and live out in this district. As to the cost of working, they had only had six months' experience as yet of the complete electric service, and the directors thought they would be better able to judge of the actual facts as to cost of working when they had had a complete 12 months' experience of operation. It was, however, clear that it would have been impossible to give the public the great advantages which they had in rapidity and frequency of service by any other method than by working electrically. There were, in addition, other indirect advantages to be considered; one, particularly, was the reduction of operations necessary at the terminal station, as the train could leave the platform it arrived at without any shunting, and this alone would postpone the necessity for enlarging the Liverpool station for some time to come. The short connecting line between Seaforth and the Liverpool Overhead Railway was brought into operation on July 2, and this additional convenience to the public would no doubt develop in time into an important feeder.

LIGHTING AND GENERAL.

Finchley.—The Urban District Council have agreed to expend £214 on laying cables.

Ashton.—The Guardians have agreed to borrow £5,000 for the purpose of electric lighting.

Islington.—Sanction has been received to the borrowing of £4 885 for electric lighting purposes.

Longton.—The output of electricity during July was 4,502 units, being an increase as compared with last year of 14 per cent.

Buralem.—Application is to be made for sanction to borrow the sum of £5 500 for the purpose of extending the electric lighting mains to Tunstall.

Huntingdon.—The preliminary report of Mr. F. W. Warden-Stevens upon the proposed electric lighting of the borough has been referred to the Public Health Committee for a report.

Brampton.—The Post Office authorities have obtained the Urban District Council's consent to the placing of an underground telegraph line along the road from Castlecarrock to Jockey Shields.

Gomersal.—An offer of the Electrical Distribution of Yorkshire, Limited, with regard to inclusion of the district in an application for a provisional order is before a committee of the Urban District Council.

West Auckland.—At a recent meeting of the ratepayers it was decided to accept the Cleveland and Durham Electric Power Co.'s offer to light the village with 55 16-c.p. electric lights for the sum of 37s. 6d. per lamp.

W. T. Henley's Telegraph Works Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 10 per cent. per annum, less income tax, for the half-year ending June 30 last, payable Sept. 1.

Outing.—The staff of F. A. Glover and Co. celebrated their annual outing on Saturday by an early excursion to Margate, and a cricket match (Mr. F. A. Glover's XIII. *v.* Mr. R. H. Hayne's XIII) at Thanet College ground commenced at 10 a.m.

Agency.—Messrs. Dorman and Smith, of Ordsal Electrical Works, Salford, have appointed Messrs. Andrews, Davidson, and Co., of 136, Bothwell street, Glasgow, to represent them in Scotland for the sale of their switches, fuses, switchboards, electrical accessories, and fittings.

London Gazette.—The first meeting in the estate of John Weston Martin and John Primmer Poor, jun., electricians, 186, New-road, Buckland, Hants, will be held at the Official Receiver's Offices, Cambridge Junction, High-street, Portsmouth, on Aug. 14, at 2 30 p.m.

Removal.—Messrs. Alfred Dickinson and Co., consulting engineers, have removed their London offices to 210, Gresham House, Old Broad-street, E.C., where Dr. John Mannheim is in daily attendance, and Mr. Alfred Dickinson on Tuesdays and Wednesdays, or by special appointment.

Tunbridge Wells.—Owing to the number of houses now requiring a supply of electric light in Camden Park all the house transformers will be moved, and a low-tension 05 distributing main will be laid, which will take its supply from a transformer pillar situated alongside the entrance gates to Camden Park.

Rochdale.—The discounts proposed to be allowed on electricity accounts will amount to £125 for the year, and the reductions in the charges for current for power purposes will represent a sum of £270. Both the discounts and the reduced charges are being made with the object of stimulating the demand for current.

Morley.—The total output from the electricity works during the month of June was 4,742 units, as compared with 5,895 units the corresponding month of last year, being a decrease of 1,153. The actual units sold to consumers by meter were 3,328 against 2,563 the same month last year, being an increase of 765. The number of lamps connected to date was 12,739.

Metropolitan Asylums Board.—The Local Government Board have sanctioned the proposal to enter into a contract with a selected firm or firms for the installation of electric lighting, telephone, and fire-alarm systems at the South-Eastern Hospital without first advertising for tenders, and promising to issue an order authorising the expenditure of a sum not exceeding £2,950 on the proposed alterations and additions to Millfield.

Carnarvon.—The Council in their contracts with the National Electric Construction Co. for the work and extension of mains have exceeded their borrowing powers by about £344, and application will be made for sanction to borow a further £1,000. Applications for 108 8-c.p. equivalents and promises of a further seven 8-c.p. equivalents have been received from persons in Palace-street, and an extension is to be made at a cost of £92.

Lifts.—In a small illustrated pamphlet the London Hydraulic Power Co., 9, Bridge-street, S.W., give a short summary with regard to the safety, convenience, and economy of their lifts, and they illustrate progress they have made since 1886 by a table which shows that in that year they delivered 1,271,000 gallons of water for 364 machines at work, and that these numbers had increased in 1905 to 17,708,000 gallons and 5,597 machines. Over 150 miles of mains are at present laid for the above purposes.

Perth.—The electricity accounts for the year ending May 15 show a revenue of £5,484 and expenditure £3,354, leaving £2,130 to be carried to the net revenue account. Interest on the sinking fund and reserve fund amount to £2,422. The assets are entered at £43,292. During the year 629,209 units were generated; there were 159,120 units used in public lamps, 358,100 units by private consumers, and 57,271 units in works giving a total of 574 491 units. There were 70 arc lamps and 59 incandescent pillars for public lighting, and the maximum supply demanded was 421 kw.

Bexley.—At a recent public meeting of the inhabitants of the district a resolution was passed protesting against the action of the Bexley Urban District Council "in agreeing secretly and without consulting their constituents to sell to the electric power monopolists the power station at Bexley at considerably less than cost price, and to buy from them power for the tramways and lighting at almost twice the price offered to private manufacturers, thus betraying the interests of the community and helping on the establishment of a trust in an industry of paramount importance."

Hull Municipal Telephones.—At the recent meeting of the Corporation Telephones Committee, which was held *in camera*, a letter from Mr. Bennett with reference to the construction of the overhead work was referred to a sub-committee, consisting of the chairman, deputy-chairman, and Messrs. Holder, Boyes, Bentham, and Hanger, with full power to deal with it. The telephone manager's recommendation that the committee should instal party lines for five subscribers at £3 per annum per subscriber for 720 messages, and after that number of messages at 1d. per call, was adopted.

Ramsey.—At the last Urban District Council meeting the clerk read a letter from Lord Stanley to the Right Hon. A. E. Fellowes, M.P., as to the provision of telephonic communication for the town. It was stated that to put Ramsey into telephonic communication with the trunk system would entail a somewhat costly circuit to Huntingdon, and in order to justify the expenditure it would be necessary to get 20 persons to rent exchange circuits at the rate of £6 a year for a connection to premises within half a mile of the exchange, with an additional 25s. for each quarter of a mile after the first half-mile.

Yarmouth.—The Stables Committee have resolved to purchase an oat and bean crusher to be worked by motor at a cost of £40. Nineteen applications have been received for electric light, estimated to bring in a revenue of £130, for which cables are to be laid at a cost of £530. The town clerk has been instructed by the Law Committee to serve notice on the National Telephone Co., under the several agreements between the Corporation and the company, requiring the removal at the expiration of six months' time of all posts now erected on the highways in the borough and on corporate property.

Redditch.—Compared with the previous 12 months the progress made by the electric supply undertaking in the past 15 months had been very satisfactory. On Jan. 1, 1904, the total number of consumers was 296. On March 31, 1905, the number was 383. On Jan. 1, 1904, the total lamp connection in 8-c.p. lamps was 15,844; on March 31, 1905, it was 23 345. The gross profit on the 15 months' working was £783, an increase of £323 over that obtained in 1903, and equal to a dividend of 2½ per cent. on the capital expended at the beginning of 1904. The analysis of the works costs shows that in the past 15 months the total cost per unit had been reduced from 2·07d. to 1·67d.

Stock Exchange.—The Stock Exchange Committee have appointed Aug. 16 special settling day in American Telephone and Telegraph Co.'s 3,980,000 dol. 4 per cent. collateral trust bonds of 1,000 dol. each, allotted in London, Nos. 55,732 and 55,733, 56,551 to 56,900, 57,401 to 57,486, 58,633 to 58,657, 61,848 to 61,880, 61,929 to 61,931, 62,369 to 62,383, 66,002 to 66,267, 66,526 to 67,000, 67,251 to 67,745, and 67,751 to 69 980; and Aug. 23 for Metropolitan Electric Tramways' 182,181 ordinary shares of £1 each, fully paid, Nos. 1 to 40,785 and 249,942 to 391,337. The committee have ordered Edmundson's Electricity Corporation's further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 70,001 to 80,000, to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to London United Tramways (1901) further issue of £300,000 4 per cent. first mortgage debenture stock; and to allow the following securities to be quoted in the official list: Marconi's Wireless Telegraph Co.'s shares of £1 each and Metropolitan District Railway Co.'s further issue of £100,000 4 per cent perpetual debenture stock.

Dalkeith.—The Electric Supply Corporation have concluded an arrangement with the Town Council to erect Nernst all-night lamps on the alternate arc lamp columns in a number of streets. These will be lighted when the arc lamps are put out for the night. The Corporation have fixed £2 each per annum as the cost for the light, and the fitting of the lamps and upkeep are undertaken by the contractors. A scheme of electric lighting for the less important streets is under the consideration of the Lighting Committee of the burgh, and they have recommended to the Town Council a scheme which works out,

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including the laying of the mains, at £2. 7s. 6d. per year for each light.

Blaydon.—The Urban District Council have concluded a draft temporary agreement with the County of Durham Electrical Power Distribution Co. to enable the company to start with the works at once, subject to certain reservations that the company and the Council should enter a contract under Section II. of the Electric Lighting Act, 1882, for the execution and maintenance of the works needed within the area of the provisional order, and that the period of such contract should expire at the end of 25 years from the date of the temporary agreement. Application is to be made to the Board of Trade "enabling them to carry their high-tension and distributing mains overhead, but that the Council still reserves the right to approve of the design and position of the poles for carrying the wires."

Felten und Guilleaume-Lahmeyerwerke.—We are informed that the agency for Great Britain and Ireland for insulated wires and cables for electric light and power purposes and for the Neptune copper rail bonds manufactured at the Mülheim works (Carlswerk) of Messrs. Felten und Guilleaume-Lahmeyerwerke, have as from Aug. 1 been transferred to the Lahmeyer Electrical Co., 109 and 111, New Oxford-street, London, W.C., and that their English chief electrical engineer (Mr. R. R. Todd) has joined the Lahmeyer Electrical Co from that date as manager of their cable department. The agency for telephone and telegraph wires and cables, as well as for all bare iron, steel, copper, and bronze wires for all purposes, and their numerous other wire manufactures—such as wire ropes, wire netting, barb wire, wire chains, wire mats, etc.—will remain with Messrs. W. F. Dennis and Co., 49, Queen Victoria-street, London, E.C., as before.

Dewsbury.—The accounts of the electricity department show a gross profit of £4,384. After allowing £356 for discount and leakages, the income from the sale of current amounted to £8,922, and sundry other receipts brought the total up to £9,243. The chief items of expenditure were £3,089 for the generation of electricity and repairs and maintenance; £602 for distribution; and £830 (including £285 transferred to joint expenditure account), management expenses. From the net revenue account it appears that £1,329 was paid in interest; £1,821 contributed to the sinking fund; £1,000 applied in aid of the rates; and £250 transferred to the reserve fund, still leaving a balance of £1,002 to carry forward. These figures total £5,403, which represents the income, made up as follows: balance from last abstract, £1,009; balance from this year's revenue account, £4,384; and bank interest, £9. The reserve fund now stands at £798.

Eastbourne.—Mr. J. Kempe Brydges in his annual report states that the units sold for private lighting were 753,562, as against 714,716 last year, and for power 34,423, against 18,686. The following figures are available: number of consumers connected, 1903-4 888, (1904 5 977); added during year, 84 (89); units sold, 897,193 (947,671); net balance, £3,858 (£2,726); allotted to depreciation fund £1,000 (£2,000); allocated to relief of rates, £750 (£725). The cost of working the undertaking has been reduced, the total cost per unit sold being 1·95d., as against 2·09d. last year, and 3·57d. when the Corporation first acquired the undertaking. Owing to the reduction in the price the revenue has fallen from 5·61d. to 5·1d. per unit, and the net profit has fallen from 1·03d. to ·69d. per unit. The coal bill has been slightly reduced, although the cost of coal per ton was 1s. 2d. more than last year. It is hoped that the introduction of the mechanical stoker, combined with the lower price of coal, will considerably reduce this item during the current year.

Kensington.—The Works Committee intimated at the last Borough Council meeting that they had had before them the further communication which had been received from the Kensington and Knightsbridge Electric Lighting Co. on the subject of the extension of the use of electricity for street-lighting purposes, stating that if the Council could see their way to light the side streets in the borough by this means, they would be prepared to supply the current for the purpose at 1d. per unit subject to the average lighting time per lamp being 3,600 hours per annum. The company also call attention to the suitability of Nernst lamps for lighting side streets by electricity, and stated that in the event of the Council being desirous of inspecting this kind of lamp they would be prepared to fix up three or four such lamps free of charge. A recommendation "that the company be informed that the Council are not prepared to adopt the proposal put forward at the present time," was agreed to. It was explained that the company's offer seemed to be made on the condition that the whole of the side streets were lighted by electricity.

Colchester.—The electrical engineer's last report states that the output of electricity (lighting) in units during June was 19,403 against 16,338 in 1904 and 15,113 in 1903; ditto (traction) ditto 38 931; number of consumers at end of June, 722 against 481 in 1904 and 362 in 1903; total number of 8 c.p. lamps connected 33,558, against 25 881 in 1904 and 22,819 in 1903. The Electric Light and Power and Tramways Committee having considered the report of the electrical engineer dealing generally with the question of cost incurred in generating electric current for tramway purposes, have made the following recommendations, which were adopted by the Council last week: to rescind its decision arrived at on May 3 last relative to the price of such current supplied during the said eight months, and in respect of the supply for the financial year ending March 31, 1906; (2) to fix the price of current so supplied during the said eight months at 1½d. per unit; (3) to direct that the question of price for the financial year ending March 31, 1905, be considered by the joint committees previously to the completion of the next annual accounts of the electric light and power department, the tramways department in the meantime to pay on account for current at the same rate—viz., 1½d. per unit—the payment to be subject to any needful adjustment after conference.

Willesden.—The accounts of the Urban District Council's electricity undertaking for the year ended March 31, 1905, show that the total number of consumers at the commencement of the year was 557, and at the end 1,002. The equivalent number of 8-c.p. lamps connected at the commencement of the year was 29,462, and at the end 49,300. The total increase in 8-c.p. lamps connected during the year amounts to 60 per cent. The revenue amounted to £13,301, and the expenditure on revenue account, including sinking fund charges, was £13 037, showing a profit on the second year's working of £204, as against a deficiency on the first nine months' working of £4. The expenditure included a sum of £334 legal charges incurred in the proceedings instituted against the Metropolitan Electric Supply Co. The report draws a comparison between the present mode of purchasing electricity in bulk and of generating the supply. The charges to consumers have been reduced both for lighting and supply for motive power, with the result that the average price received for private supply has been only 3·61d. per unit during the past year as against the first estimate of 4·61d., a reduction of nearly 20 per cent. As only 6 per cent. of the 874,914 units sold to private consumers was used for motors and heating, the average price for lighting is among the lowest received, not only in the Metropolis, but in the whole country. Notwithstanding the total average revenue per unit sold was only 3·64d., the year's working has resulted in a net profit, as before stated, of £204 after paying all charges. The low average price obtained has correspondingly affected the rate paid for bulk supply, which, instead of amounting to 2 231d. per unit sold, as originally estimated on a closely similar output, was only 1·5981d. per unit sold, or ·6331d. less. If the surplus in any year exceeds 5 per cent. upon the aggregate capital expenditure, a rateable reduction is to be made in the charge for the supply of energy. The Council already have a reserve in the profit of £3,300 received from the power company, and this may be applied in the purchase of sites for generating and sub-stations should the agreement with the company for bulk supply be terminated at any future date.

Bermondsey Inquiry.—The Bermondsey Municipal Association last week passed a resolution to the effect that the Board of Trade be asked to hold an inquiry into the electricity undertaking of the Council, and that a full copy of the committee's report be forwarded to that authority. The report referred to is one prepared by a committee of inquiry into the municipal electrical undertaking at Bermondsey which was appointed at a meeting of ratepayers last December. It deals principally with three points—namely, the loss on the dust destructor, the cost of electric street-lighting, and the system of accounts under which it is alleged that items are deliberately transferred to a purely administrative department, although they legitimately belong to the electric lighting undertaking—for instance, probably about £1 000 this year as parliamentary expenses. With regard to the actual cost incurred in erecting and working the destructor, the committee say: "From the borough treasurer's accounts for the year ending March 31, 1904, we find that the capital cost was £25,000; working and maintenance for 1904, £5,675. 8s 1¾d. The revenue was: supply of steam to baths, £300; supply to electric lighting, £500; sale of flue dust, £38. 1s. 1d.; destruction of trade refuse, £31. 15s. 1d.; insurance claims paid in respect of accidents to workmen, £16. 16s. 2d.—total, £886. 12s. 4d. Actual cost for the year, £4,788. 15s. 9¾d. The amount of refuse actually treated was 13,027 tons, and the cost of barging this at 2s. per ton would have been £1,302. 14s., so that the realised loss for the year was £3,486. 1s. 9¾d. It thus appears that the actual cost for destroying 13,027 tons of refuse was £4,788. 15s. 9¾d., or 7s. 4d. per ton, and the actual loss was £3,486. 1s 9¾d. In these figures no allowance is made for depreciation. If this is put at a very low estimate of 1½ per cent. on the cost price, £25,000, we shall have to add £375 to the net cost and to the actual loss for the year, thus bringing the net cost to £5,163. 15s. 9¾d., and the realised loss to £3,863. 1s. 9¾d." The committee compare the estimates and the actual result as follows: capital cost, estimate £10,000, actual result £25,855; maintenance, estimate £1,359. 4s 8d., actual result £5,675. 8s. 1¾d.; revenue, estimate £1,170, 1s. 8d., actual result £886. 12s. 4d.; cost for the year, estimate £189. 3s., actual result £4,788 15s. 9¾d.; cost of destroying refuse per ton, estimate 4d., actual result 7s. 4d.; net annual profit, estimate £786. 15s. 4d., actual result no profit, but instead a loss of £3,486. 1s. 9¾d. Concerning the electric light undertaking, the report points out that the ratepayers occupy a three-fold position: (1) that of sellers of means of production, (2) that of producers, and (3) that of consumers, and that it is, therefore, a palpable absurdity to contend that the whole undertaking is a financial benefit to the ratepayers, because one branch shows a balance, by allocating many of its own debits to one of the other two branches, and by exacting from the other an excessive charge. The report gives an analysis of the actual number of units produced during the year ended March 31, 1905: (1) to private consumers of electricity for lighting purposes; (2) to private consumers for power purposes; (3) to municipal institutions; (4) to the municipal authorities for street-lighting purposes; the expenditure occasioned thereby, and the amount realised by the sale. This analysis shows that the sale to private consumers results in a loss amounting to £203. 3s., but that the sale for public purposes—*i.e.*, by the ratepayers as producers to the ratepayers as consumers—realises by the fixing of an arbitrary figure a surplus of £1,000. The report shows how this £1,000 surplus, or net profit, as it is wrongly called in the accounts, is made. The report further complains that no reduction of price similar to that made to outside consumers is made in street-lighting, and the supply to municipal institutions, and that in consequence the revenue account is unduly inflated, also that whereas for the purposes of street-lighting £5,413. 9s. 6d. has been spent in the erection of arc lamps, the electric undertaking is not charged with one penny of the same. Similar remarks are made with regard to maintenance of arc lamps. With regard to the Council's estimates for the current year, which are based on reduced prices for current to outside consumers, the committee consider that Bermondsey possesses none of the characteristics

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which give a practical encouragement to an electric undertaking. They say: "(1) There are very few residences of any size in the borough, and no large retail establishments; (2) the large buildings are principally warehouses, which require, comparatively speaking, very little electricity for lighting purposes; (3) powers are refused to the undertaking by the Board of Trade in the part of Bermondsey in which customers would be most probably found, and are only conceded in that part which private companies apparently avoid as unprofitable." The committee thinks that the consumption of power may increase, but that three points must be noted: (1) the competition of the gas company, which supplies motor energy at a very low cost; (2) the fact that many large consumers generate their own electricity by means of energy supplied by the gas company; and (3) that the cost to such customers does not exceed 1d. per unit. Even if all the advantages were allowed—of not paying the complete instalments, of not taking into consideration the dust destructor deficit, of transferring accounts to other departments, and in the face of keen competition realising the large estimated increase—the profit as shown by the undertakers would only amount to 0·401 of 1d. per unit as far as motor power was concerned. To spend capital on generation of motor power, and to maintain the dust destructor for such generation, did, they consider, constitute a lamentable policy. A comparison is made with other districts, and the report concludes as follows: "It is generally agreed that the Camberwell area is one of the, if not the, best lighted in London. In the main thoroughfares burners of 80 c.p. are fixed, in the semi-main roads 60 c.p., and in all other 40-c.p. burners. The entire cost of public lighting for the year ended Lady Day, 1904, as shown in the Council's published report, was £11,752, an average of £90·8 per mile, the figure for the year to March last being lower. During the year ended Lady Day last Bermondsey for gas used in public lighting £3,753 and £4,738 for electricity, averaging £123. 1s. per mile. If the Camberwell system was in operation in Bermondsey a saving of about £2,200 per annum would be effected, with this additional advantage, that there would be a full efficiency of street-lighting throughout the night. One very great objection to the electric light for the streets is the obligation to turn them off at midnight, leaving the streets, by reason of the ineffective substitute provided, in comparative darkness. After 12 o'clock, in spite of the excessive cost of street-lighting, Bermondsey is the worse-lit district in the Metropolis."

PROVISIONAL PATENTS, 1905.

JULY 28.

15479. A contact hood for use in raising and lowering electric arc lamps and other apparatus. Claude Edward Gillett Gilbert, Chingford, Essex.

JULY 29.

15546. Improvements in apparatus for controlling and operating the points of electric railways and tramways. William Herbert Turner, Rowland Edward Dixon, and Thomas Bell Stewart, Swinegate, Leeds.

15561. Improvements in the production of metal articles or metal-covered articles by electro-deposition. Frank Iorns Gibbs, 128, Colmore-row, Birmingham.

15577. A new or improved cut-out for overhead tramway wires. Frederick Charles Morris and James Oliver Hart, 8, Quality-court, Chancery-lane, London.

15590. Improvements relating to points or switches for electric tramways working upon the slot-conduit system. Albert Newmann-Connett, 322, High Holborn, London. (Complete specification.)

15591. Improvements in devices for electromagnetically influencing the arcs of electric arc lamps working with alternating-current. Tito Livio Carbone, 322, High Holborn, London. (Complete specification.)

15594. Improvements in the conveying of currents to electrodes arranged in electrically-insulated tubes. Ganz und Co., Eisengiesserei und Maschinen-Fabriks Act.-Ges. m. b. H., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Aug. 26, 1904, being date of application in Germany.) (Complete specification.)

JULY 31.

15606. Improvements in the manufacture of metal articles by electro-deposition. Frank Iorns Gibbs, 128, Colmore-row, Birmingham.

15658. Improvements in and relating to telephone attachments. Nebo Earl Damico, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15673. Electric lamp bulb and method of and apparatus for finishing same. George Philip McDonnell, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 2, 1904, being date of application in United States.) (Complete specification.)

AUG. 1.

11301a. Improvements in mounting and heating cylindrical thermo-electric generators. Compagnie Thermo-Electrique (Système Hermite) Société Anonyme, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 3, 1905, being date of application in France. An invention comprised in Application No. 11,301, dated May 30, 1905.) (Complete specification.)

15681. Improvements in electric rotary switches or wipe contacts. Samuel Hindley, 78, Langdon-street, Sheffield.

15690. An improved system of electric road traction. Alfred Lyster Shepard, 32, Victoria-street, Westminster, London.

15714. Improvements in testing apparatus for traction insulators. Arthur Henry Pott and Kenelm Edgcumbe, Collindale Works, Hendon, London.

15739. Antiseptic mouthpiece or transmitter for telephone or speaking tubes. Joseph Vyvyan Wedgwood, The Wigwam, Aldwick, Bognor.

15752. Improvements in self-releasing brake handles for electric tramcars and other vehicles. Marius Belmondo, 6, Lord-street, Liverpool. (Complete specification.)

15769. Improvements in electric soldering irons. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15770. Improvements relating to the insulation of electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

AUG. 2.

15791. Improvements in the operation of points or signals for electric railways. George William Somerville and Oliver Hicks, 68, Owen-street, Accrington.

15819 Apparatus for electrically ringing church bells and the like. John Richardson Eyre and Edmond Meyer, Tudor Boddam, 28, Marlborough-hill, London.

15819. Improvements in and relating to automatic electric circuit breakers. Lionel Robinson and Co., Limited, and John Dingle Adams, 28, New Bridge-street, London.

15827. Improvements in electrical carbon brushes and in holders for same. Frederick James Hesmes Baker, 33, Cannon-street, London.

15836. Improvements in electric wiring. Reginald Frederick Yorke, 19, Holborn-viaduct, London. (Complete specification.)

15859. Improvements in prepayment meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States).

15860. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

15862. An improved electric press for bells. Frederick Fenwick Robinson, Royal Oak, Sawley-road, Long Eaton, Derbyshire.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 24.

1904.

15469. Use of vapour electric conducters in distributing systems for rectifying or other purposes. Kruh. (Date applied for under International Convention, July 13, 1903.)

16842. Electricity service systems and junction boxes therefor. Owen.

16932. Electromagnetic brakes for vehicles. Kramer. (Date applied for under International Convention, Aug. 7, 1903.)

16968. Arc lamps. Cook. (Post-dated Sept. 13, 1904.)

16978. Means for receiving or translating electric, wireless, or like impulses. Underhill.

17043. Electric bells, indicators, and domestic telephones. Bhisey.

17060. Magnetic compasses. Morrall.

17442. Electric controllers. Scott.

18203. Electric motor control systems. British Thomson-Houston Company, Limited. (General Electric Company.)

18204. Transformers especially adapted for use on electric vehicles. British Thomson-Houston Company, Limited. (General Electric Company.)

19160. Telephone cord. Sievert.

19506. Wall sockets and switches for electric circuits. Fletcher.

20715. Insulating edgewise-wound electric coils. British Thomson-Houston Company, Limited. (General Electric Company.)

20965. Leading-in conductors for electric incandescent lamps and the like. Carolan. (General Electric Company.)

20976. Electric traction. Clouston.

21028. Electrical measuring instruments. Elphinstone and Fast.

21043. Alternating-current electric motors. Carolan. (General Electric Company.)

21307. Electric energy meter. Javaux.

21672. Electric batteries. Lake. (Soc. Anon. Le Carbone.)

22372. Means for trolleys or vehicles to pick up and return electric current from and to conducters they traverse and obtain motion. Sayer.

1905.

1004. Dynamo-electric machines. Brown and Greenwood.

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369. Vapour electric apparatus for rectifying alternating electric currents and other purposes. Jackson. (Date applied for under International Convention, Jan. 9, 1904.)

3979. Supporting devices for electric conductors. Jones. (Date applied for under International Convention, March 14, 1904.)

4363. Apparatus for obtaining constant voltage from dynamos working at varying speeds. Ejquem. (Date applied for under International Convention, March 3, 1904.)

5409. Vapour electric apparatus. Hewitt. (Date applied for under International Convention, April 9, 1904.)

5553. Electric arc lamps. Riley and Rowing.

8659. Means for protecting electric telegraph lines against the influencing action of alternating-current lines situated in the neighbourhood thereof. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

8973. Vapour electric apparatus. Hewitt. (Date applied for under International Convention, May 13, 1904.)

9129. Thermal electric switches for incandescent electric lamps. Frey. (Date applied for under International Convention, Aug 3, 1904.)

10111. Insulation of electric conductors. Berger. (Date applied for under International Convention, May 14, 1904.)

10769. Receiver connections for wireless telegraphy. Thompson. (Ges. für drahtlose Telegraphie m. b. H.)

13084. Controllers for single-phase induction motors. Jackson. (Date applied for under International Convention, June 30, 1904.)

14214. Electric furnaces. Kjellin. (Date applied for under International Convention, July 11, 1904.)

14221. Means for producing current or radiations for a transportable wireless transmitter station. Thompson. (Ges. für drahtlose Telegraphie G. m. b. H.)

COMPANIES' STOCK AND SHARE LIST

Name.	Amount paid. £	Last price. £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6 xd
—— 4½ per cent. Mortgage Debentures	£0 ..	101-104
British Thomson Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red	100 ..	100-102
British Westinghouse Elec and Manuf. 6 per cent Pref., 275,001-375,000	5 ..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent 1st Debenture Stock	100 ..	94-95
—— 4½ per cent. 2nd Debenture Stock	100 ..	77-80
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10-11
—— 5 per cent Pref.	5 ..	5-5¼
Crompton and Co.	3 ..	1½-2 xd
—— 5 per cent. Debentures	100 ..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1¼-1⅜
—— "A" Shares, 01-017,139	5 ..	2-2½
—— 5 per cent. Debentures	100 ..	89-94
—— 4 per cent. Deb. Stock, Red.	100 ..	83-88
Electric Construction, Nos. 1 to 112,100	9 ..	⅜-½
—— 7 per cent. Cumulative Pref.	2 ..	1⅛-1¼ xd
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	93-96
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-96
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	11½-12½
—— 4½ per cent. Preference	5 ..	5⅜-5⅝
—— 4½ per cent. Debentures	100 ..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15-16
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Telegraph Construction and Maintenance	12 ..	51-53
—— 5 per cent. Bonds	100 ..	101-103
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11¼-12½
—— 4½ per cent. Debenture Stock, Red	100 ..	116-118
Bromley (Kent) Electric Light and Power Co.	5 ..	5½-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	10-10½
—— 7 per cent. Preference	5 ..	9¾-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9-9½
—— Nos. 60,001-80,000	5 ..	8¾-9½
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¾-13½
Central Electric Supply, 4 per cent. Guar. Deb Stock	100 ..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-8[illegible],000	5 ..	6¼-7¼
—— 4½ per cent Cum. Pref., 1-80,000	5 ..	5¾-5⅞
—— 4 per cent. Debenture Stock, Red.	[illegible] ..	[illegible]3 1-5
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5 ..	4 13/16-5 1/16
—— ditto (1903) 40,001-80,000	5 ..	4 13/16-5 1/16
Chelsea Electricity Supply	5 ..	6 6¼
—— 4½ per cent Debentures	100 ..	108 110
City of London, Ordinary	10 ..	10¾-11
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103 105
County of London Electric Supply, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref	10 ..	11¾-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent 2nd Debentures Prov. Certs	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅝
—— 4½ per cent First Mort. Deb.	100 .	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2½-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	99-102 xd
Havana Electricity, 1-15,000	10 ..	9½-10¼
Hove Electric Lighting, Ord., 1-13,000	5 ..	7¾-8¼
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	¾-⅞
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11½-12½ xd
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	97-100 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1½-2⅜
—— 6 per cent. Pref.	5 ..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 00,001-300,000	5 ..	9¾-10¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	00-103
—— 4½ per cent. Cum Pref.	5 ..	⅝-⅞
—— 3½ per cent. Mortgage Debenture, Red	100 ..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	99 101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5 ..	7¼-8¼ xd
—— do., 57,0 0-75,000	5 ..	7¾-⅞
—— 5 per cent. Pref., 1-57,000	5 ..	6 6½ xd
—— do., 57,0 0-75,0 0	5 ..	6-6½
Notting Hill Electric Lighting	10 ..	4-4⅛
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	100 102
Oxford Electric, Ordinary, 1-96 and 40-14,510	5 ..	6¼-7
4 per cent. Debenture Stock	100 ..	98 100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-104
Smithfield Markets Electric Supply, Ord 1-12,000	5 ..	2¾-2¾
—— 4 per cent. Debenture Stock	100 ..	76-80 xd
South London, Ordinary	5 ..	5-5¼
South Metropolitan Electric Light and Power, Ord.	1 ..	⅜-½
—— 7 per cent. Cum. Pref.	1 ..	1¼-1⅜
—— 4½ per cent. 1st Mort. Deb	100 ..	105-109
—— Ditto, June, 1904	— ..	—
St James's and Pall Mall, Ordinary, 101-20,080	5 ..	13-14 xd
—— 7 per cent. Pref	5 ..	4-4¼ xd
—— 3½ per cent. Deb.	100 ..	97 99
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5⅛-5⅜
Westminster, Ordinary	5 ..	12-12¼ xd
—— 5 per cent Cum. Pref., 110,1.1-138,251	5 ..	6¼-6⅜
Electric Tramways.—		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5 ..	5⅞-6
—— Ord.	5 ..	8¼-8½
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100 ..	101-106
Barcelona Tramways, Ord., 1-20,000	10 ..	13¾-13⅞
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9-10
—— 5 per cent Deb., Red., 1-600	100 ..	92-101 xd
—— 4½ per cent. Red Deb. Stock	100 ..	97-102 xd
Bath Elec. Tramways, Ltd., Pref. Ord. Shs., 75,001-150,606	1 ..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	95-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	105-108
—— Ord. Pref.	100 ..	99-102
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	102-105
—— 4, per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c.
—— 4 per cent Vancouver Power Deb.	100 ..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	8¼-8¾ xd
—— 6 per cent. Cm Pf., 30,001-60,000	10 ..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-124
—— 4½ per cent. 2nd Deb. Stock	100 ..	97-99
Buenos Ayres and Belgrano Trams.	5 ..	3-3½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 7/16-5 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	105-107
—— Prov. Cert., all paid	100 ..	101-104
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	96-98
Calcutta Tramways, 1-102,268	5 ..	9-9¼
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	106-108
Cape Electric Tramways, Nos. 1-480,000	1 ..	1⅜-1⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	¼-⅜
—— 4½ per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102-104
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14½ xd
—— 6 per cent. Cum Pref.	10 ..	15-16 xd
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼ xd
—— 6 per cent. Pref., Nos. within 1-60,0 0	10 ..	15-16 xd
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4, per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5 ..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	98 101
Madras Elec. Trams (1904), 5 per cent. Deb. Stk., Rd.	100 ..	102-104
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	¼-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	104-106
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	104-108
Montreal Street Rail., Sterling 5 per cent (Mort.) Deb., 1908, 1-600	100 ..	102-105
— — Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104 xd
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent Cum Pref	10 ..	9¾-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅝
—— 4½ per cent Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,152 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 —	90-92
—— 4 per cent. Pref	100 ..	101-103
—— " " deferred	100 ..	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	110-112

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Name.	Amount paid. £	Last price. £
City and South London, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	120-123
—— ,, ,, ,, '95	100	119-122
—— ,, ,, ,, '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3½-4½
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	98½-93½
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid. £	Last price. £
Telephones.—		
National Telephone, Preferred	100	107½-108½ xd
—— Deferred Stock	100	104-106 xd
—— 6 per cent. Cum. First Pref	10	1½-13½ xd
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾ xd
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock. Red.	100	103-105
Oriental Telephone and Electric Company	1	1 3/16-1 5/ 6
—— 6 per cent. Cum. Pref.	1	1½-1¼

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week. Ending	1905. £	1904. £	Increase or decrease. Week. £	Current year. £	Miles of single track open. 1905.	1904.	Accounts for past year. Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	Aug. 5	1,560	1,687	- 127	- 751h	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 5	414	449	- 35	—	8	8	,, 15	14,328	3,316 380	353,945	1	9·71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 6	1,050	1,227	- 177	- 657	23·53	23½	March 31	55,025	11,145,531	1,309,803	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 5	343	765	- 22	+ 923	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 2	986	1,012	- 15	+ 611	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 3	1,5'6	2,871	-1,335	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 5	1,146	2,351	-1,204	- 1,903	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 6	2,010	1,981	+ 29	+ 1,205	40	38	March 31	95,766	20,205,196	2 161,130	1·13	10·63	2,394	6·13
Bournemouth Corporation	,, 2	1,611	1,713	- 102	—	16 83	16 83	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	July 29	4,531	4,899	- 368	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	Aug. 7	1,345	2,211	- 866	— h	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 4	5,408	7,008	-1,600	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 5	1,085	1,044	+ 41	—	10 60	10·60	March 3	—	—	—	—	—	—	
Burton Corporation	,, 6	551	505	- 154	- 698	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	July 29	2,207	2,255	- 47	+ 649	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	Aug. 5	220	259	- 39	- 415	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 5	5,5c6	5,'66	- 103	- 695h	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·60
City and South London Railway.	,, 6	2,263	2,243	+ 20	- 232h	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 2	241	557	- 316	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 3	553	555	- 2	+ 722	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 4	227	230	- 3	+ 199	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	July 29	275	297	- 22	—	4½	4½	,, 31	11,250	2,853,800	284,'43	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Aug. 4	139	177	- 38	- 634	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 4	4,211	4,790	- 579	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 4	1,206	1,561	- 355											
Dundee City Tramways	,, 2	849	876	- 27	—	22	23	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 5	884	995	- 111	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 5	14,514	14,901	- 387	+ 6,908h	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 2	1,691	2,055	- 371	+ 940	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 5	1,445	2,517	-1,072	—	35	35	,, 31	69,938	12,838,150	1,666 262	1 24	9·71	1,923	—
Hull Corporation	,, 5	2,255	2,583	- 328	- 240	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 2	113	207	- 94	- 461	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 2	212	240	- 28	—	7½	7½	May 15	12,201	3,632,855	432,316	·775	6·519	—	7·649
Leeds Corporation	,, 5	5,982	7,909	-1,929	—	89	89	March 25	288,233	64,223,646	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	July 29	11,299	10,953	+ 346	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	Aug. 6	1,672	1,768	- 96	- 591h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	July 29	15,716	13,708	+2,008	+47,281	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	Aug. 3	165	236	- 91	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 5	12,869	13,820	- 951	—	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,293	6·99
Nelson Corporation	,, 5	121	123	- 2	+ 261	—	2¾	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 5	3,942	3,971	- 29	+ 2,530	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 6	1 716	1,278	+ 438	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 5	2,571	3,341	- 770	- 1,000	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	396,517	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 3	440	645	- 205	—	9½	7½	,, 31	23,569	5,251,472	593,054	1 07	9 55	2,612	7·49
Salford Corporation	,, 7	4,422	4,242	+ 180	—	70½	—	,, 31	214,111	39,213,560	4,884,560	1·28	10·29	—	—
Scarborough Tramways Co.	July 22	343	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 6	4,890	5,288	- 398	+ 3,958	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 2	1,095	1,443	- 348	- 526	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	July 5	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	Aug. 4	924	806	+ 118	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	July 30	1,609	1,372	+ 237	+ 567	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	Aug. 2	212	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 5	914	1,099	- 185	—	11·86	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	July 13	342	332	+ 10	+ 175	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 27	1,723	—	—	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	Aug. 2	803	1,003	- 200	—	—	7½	,, 31	—	—	—	—	—	—	—

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Electro-Peat.—It is reported that a plant for the manufacture of electro-peat fuel has been erected at Kiberry Bog, near Athy, County Kildare, upon the estate of the Duke of Leinster, and that it will be in operation before the end of the present month.

New Publication.—The latest of the "Model Engineer Series," issued at 6d., by Messrs. Percival Marshall and Co., is, "Screw Threads and Twist Drills (Small Sizes)," by George Gentry. The handbook contains definitions and tables of a number of types, including the Whitworth, British Association, and the International Metric Standard, but we must confess to a feeling of surprise that no allusion whatever is made to the work of the Engineering Standards Committee on the subject.

Submarine Signalling.—At the instance of Trinity House the first experiments to be made in England with the apparatus for the transmission of submarine signals which has been perfected by Mr. Millet, of the Submarine Signal Co., were last week conducted in the Straits of Dover. The system has been successful in its trials at the lightships outside New York. By means of the signals, steamers approaching New York have been enabled accurately to ascertain their position as much as four and five miles away in thick fog. The vibrations travel under water over four times faster than in air. The experiments in the Channel last week are stated to have been successful.

American Apprentices.—The General Electric Co. announce that assistants are required at its factory in West Lynn, Mass., and the following rates of pay are offered. Drawing office apprentices, who must have graduated at a high school, commence at 22s. per week, and advance by half-yearly increments to double that amount in three years, at the expiration of which they receive a bonus of £15 if their services have been satisfactory. Shop apprentices who are graduates of high schools begin at 18s. 6d. and advance to £2, with a bonus of £22 at the end of four years. Grammar school graduates or high school students receive for the latter class work 14s. per week, advancing to 35s., with a bonus of £22 at the end of four years. It will be noticed that no premium is required from those entering the works.

The Production of Iron Mirrors.—A method of producing light iron mirrors for galvanometers is described by Mr. V. Bierwicke in *Annalen der Physik*. An iron strip capable of being electrically heated to redness is arranged in an air-tight glass vessel. Immediately over the strip is suspended the material (glass, mica, or celluloid) on which the mirror is to be deposited. The containing vessel is then highly exhausted by means of a mercury pump, and when a pressure of only a few thousandths of a millimetre is reached the iron strip is raised to a bright red heat, and the deposition of iron commences. The deposit maintains its good reflecting qualities for a long period; it appears perfectly coherent under the microscope, and is capable of retaining a high degree of residual magnetism. In this way the mirror can be employed as its own magnet in place of heavy cut-steel mirrors. The reflecting power of these mirrors for white light is about 62 per cent. of that of a silver mirror.

Electricity in Mining.—At the Mining Congress recently held at the Liége Exhibition, Mr. L. Creplet, engineer of the Société International d'Electricité, Liége, advocated the use of continuous-current motors for driving roll trains. There are already several applications in Belgium. The Grievegnée Company uses a merchant mill driven by a compound-wound motor that can develop from 450 h.p. to 900 h.p., and the Providence Company has another capable of from 500 h.p. to 1,000 h.p. The Ougrée-Marihaye Company (which has already applied this improvement) will in a few months have in use a roll-train motor of 1,000 h.p. to 1,500 h.p., capable of direct driving at 75 r.p.m. to 135 r.p.m. M. Greiner, general manager of the Cockerill Works, Belgium, stated that the problem of driving roll trains electrically is already solved from an economical point of view, and he expressed the opinion that the best solution is central electric generators driven by gas-engines, and each roll train driven by its own motor.

Production of Tickets.—From time to time railway and tramway companies find their right to call for the production of passengers' tickets questioned before various tribunals by travellers of more or less acrimonious temperament. In general the courts have upheld the validity of the companies' by-law in reference to this matter, and had this not been the case one might well wonder what practical means the companies would have of placing an obstacle in the way of constant fraud by unscrupulous passengers. Seeing, then, that the regulation harmonises with both law and equity it is a matter for some surprise that it should meet with disregard at the hands of a member of the legal profession. This happened the other day when Mr. Herbert Clifford Gosnell, solicitor, refused to produce his ticket, stating that he "could not be bothered." Apparently he made no effort to find it, but considered it less troublesome to hand the inspector his card, with the remark that the company could take out 40 summonses if they liked. For technical reasons the magistrate dismissed the charge as there was a lack of corroborative evidence, but acts like these on the part of a lawyer do not seem precisely the kind of thing to encourage harmonious relations between tramway owners and the community in general.

Patents.—Messrs. Jordan and Sons have just published a treatise on "The Law and Practice Relating to Patents, Trade Marks, and Designs," by Mr. David Fulton, of the Middle Temple. This is the third edition, and has been revised to include the changes introduced in the regulations which came into force on the first day of January. The precedents quoted comprise more than 300 additional cases, some of them of considerable importance. The publication of this edition has been deferred in order that all available information upon the new system of patents examination might be included. A good deal of apprehension was expressed on this score, so it is gratifying to have the author's assurance that the careful and discriminating use of their powers by the Patent Office promises to make the new system a really beneficial one. The present volume is of a comprehensive character, and deals with patent law and practice from every point of view that one can think of. Trade marks and designs are similarly treated, and the appendices contain the text of the International Convention and several useful forms. The treatise (which is priced at 12s. 6d.) is written in eminently lucid terms, and is relatively free from legal verbiage, so that it furnishes a serviceable guide to layman as well as lawyer, and should certainly be of use to the engineer.

The American Institute.—The issue dated July of the *Proceedings* of the American Institute of Electrical Engineers contains the following papers: "High-Power Surges in Electric Distribution Systems of Great Magnitude," by Charles Proteus Steinmetz; "Comments on remarks made by Colonel R. E. B. Crompton before the International Electric Congress at St. Louis," by J. W. Howell; "Water Powers of the South-Eastern Appalachian

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some justification for such a course. It is a heavily-rated borough, and the tramway system has been constructed upon sound lines, so that in the early years there is not such pressing necessity for making an ample allowance for depreciation, and it must be confessed that, apart from the relief afforded to the rates, it is not every municipal tramway undertaking that can place over £3,000 to reserve in the first year, in addition to carrying passengers at low fares. The population of 300,000 was carried some 52 times during the year, and the average fare worked out at ·84d. The 1d. fares were responsible for over half of the receipts, and the ½d. fares contributed 25 per cent. to them. The 1½d. and 2d. stages were little patronised, and it is rather surprising to find that "workmen" with cheap tickets were only 1·2 per cent. of the travellers. Taken altogether the West Ham tramways department have good cause to feel satisfied with the results attained, and Messrs. Bullock and Blain, the electrical engineer and tramways manager respectively, are to be congratulated upon the outcome of their efforts.

Patent Practice. — Attention is directed in a paragraph appearing in the Patent Office *Journal* to a recent decision of the Law Officers in connection with Rule 4 of the Patents Rules, 1905. This rule provides that: "The statement of the invention claimed with which a complete specification must and shall be clear and succinct as well as separate and distinct from the body of the specification." The Law Officers intimated that they had no desire to lay down that the number of claims amounts to any infringement, as a specification may justifiably contain a number of separate claims. At the same time, the Law Officers deprecate the American system of attempting to deal with every possible contingency, as this is apt to result in unnecessary copiousness to the detriment of lucidity. A remark made by the Solicitor-General in expressing his concurrence with the views of the Attorney-General, is worthy of reproduction. "I agree that the mere number of claims will not necessarily constitute an infringement of this rule, supposing the claims to be real and substantial; but, on the other hand, although each claim may, in itself, be clear and succinct, if the claims are not really and substantially separate, I think in that case it would come within this rule, and that the claims, taken as a whole, would not be clear and succinct." There is no doubt that in the past the claims appended to the specification have often suffered from excessive verbiage, and this admonition from the Law Officers is a timely one. The *Journal* also calls attention to Rule 14 of the Patents Rules, 1905, which prescribes that "every Convention application, in addition to the specification left therewith, must be accompanied by a copy or copies of the specification, and drawings or documents filed or deposited by the applicant in the Patent Office of the foreign state or British possession in respect of the first foreign application, duly certified by the official chief or head of the Patent Office of such foreign state or British possession as aforesaid, or otherwise verified to the satisfaction of the comptroller." The comptroller has been advised that it is obligatory that the necessary verified documents should be left at the same time as the Convention application, and in future this requirement, is to be rigidly enforced.

The Big Power Scheme.—The metropolitan borough councils owning electrical undertakings, apprehensive of another attempt to formulate a huge private scheme for supplying electricity in bulk, propose to hold another conference with a view to protecting themselves against what they term the monopolists, and a conference under the auspices of the London County Council is also in contemplation. In an interview with a *Daily News* representative Mr. Mills, chairman of the Islington Electric Lighting Committee, stated that the experience gained during the proceedings before the Select Committee would not be wasted, as it had taught the borough councils the importance of combination. He thought the boroughs now realised that they would have to unite to provide power cheaply in bulk. If electricity could be supplied cheaply by a company, it could be supplied cheaply by municipalities. By a new scheme for extending their plant, they in Islington would be able to generate electricity more cheaply than they could have bought it from the Administrative County of London Company. The boroughs were disappointed at the attitude of the Board of Trade, which had quite gone over to the side of the monopolists. Mr. Mills did not think the last had been heard of the promoters, though he doubted whether they would essay such a sweeping scheme again. If the London local authorities can show that they are in just as good a position as the promoters of the Administrative County of London scheme to give a cheap supply of power, they would pretty well dispose of the latter's case, but it can hardly be said that they have shown this to be the case up to the present. From some statements to a representative of the same journal by Dr. T. B. Napier, chairman of the London County Council Parliamentary Committee, it appears not improbable that the County Council may revive its bill for a bulk supply to the metropolis if there is a "tolerably unanimous" request on the part of the borough councils, who would be expected to give a definite assurance that they would take sufficient current to prevent a loss. This scheme would raise again the vexed question of competition between the present supply companies and a municipal authority, which up to the present has not been sanctioned by Parliament. We also doubt if the County Council would be granted powers to go outside their area, as is now proposed.

The Bradford Burn-out.—We regret to note that the electricity supply at Bradford was interrupted last week, due to a fault on some main feeders. On Wednesday, 9th inst., the first indication of the fault was noticed at 5.25 p.m., when arcing occurred between the armour of two of the cables in the basement of the Valley-road works at the point of entry from the roadway. The arcing developed into a short-circuit, which was extinguished with sand. About half an hour after a heavy short-circuit occurred at some point outside the works premises, which caused the automatics of all the machines running on the general supply service, together having a capacity equalling 1,800 kw., to open, thus discontinuing the supply, and attempts which were made to again switch in the machines proved abortive. Smoke issuing from the cable culvert leading into the basement led to the conclusion that the trouble was not far removed from the works, and immediate steps were taken to open up the ground above the culvert, and to remove the cover of the same, which consisted of heavy York flags, some of which weighed as much as three tons. In the meantime the feeders were disconnected from the 'bus bars and from the network and tested, and a sufficient number of healthy feeders coupled up to maintain the load, and the supply was restarted at 9.50 p.m. The remaining feeders found unaffected were coupled up during the night, and the damaged cables repaired and again put into use during the succeeding day. Six cables, having a combined sectional area of 7½ square inches, were affected, several being burned clean through. The most badly damaged portion was found at a point about 60 yards from the works. The cause of the first cable breaking down has not yet been ascertained, but the effect of the breakdown raised

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the potential of the lead sheathing and armour, and caused arcing from the same to other cables in the same culvert, which eventually burned through the protective sheathing of these, and at last developed into a short-circuit between the various cables affected. A somewhat similar breakdown occurred last December, and under the advice of Mr. Alfred S. Blackman, the city electrical engineer, the Bradford Council recently sanctioned the expenditure of £40,000 for providing new mains and for sectionalising and fusing the network. The work of laying these mains and providing the switchgear is at the present time proceeding with all possible speed. When the scheme is completed a feeder on which a fault develops will be automatically disconnected from the main supply by its fuses, and a similar occurrence to that of last week prevented.

Transformers.—We notice from the *Official* (*Patents*) *Journal* that a patent has been obtained in this country by Mr. J. S. Peck, of Pittsburg, U.S.A., in connection with a type of transformer designed to prevent or lessen the variation in the compounding effect. In a distributing

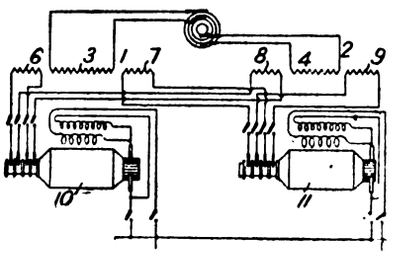

FIG. 1.

system in which transformers and rotary converters supply current to direct-current mains, the transformers are arranged with sectional secondary windings, so wound as to provide for the production, by changes in the number of converters, of either no effect or predetermined effects on the voltage variation of the direct-current circuit. When compounded converters are employed in such a system, the compounding effect—*i e*, the variation in the direct-current voltage due to variation in the direct-current load—varies with the inductive effect of the transformers on the alternating current, and therefore is, with ordinary arrangements of transformers, variable with changes in the number of converters in use. To prevent or lessen this variation, the transformers 1, 2, and the converters 10, 11, may be arranged as shown in Fig. 1, in which the transformer secondaries consist of sections 6, 7, and 8, 9

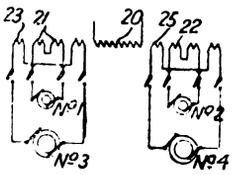

FIG. 2.

on opposite sides of the primaries 3, 4, and the converters are fed from the similar sections 6, 8, and 7, 9. The inductive effect in this case is almost exactly the same when one or both converters are in operation. When three converters are provided the secondary sections for two of them are on opposite sides of the transformer primaries, while those for the third each consist of two parts in series, and located outside of the others. A transformer for each phase is provided. The exact equivalent of the inductive effects with one, two, or three converters in operation is not obtained in this case, but is approximated to. In Fig. 2 will be seen the arrangement of the secondaries, 21, 22, 23, and 25, of each transformer used when four converters, No. 1, No. 2, No. 3, and No. 4, are provided. The compounding effect with one converter, or with one on each side of primaries, 20 in operation in this case, is about half that obtained with all in operation; but with two on the one side of the primaries in operation it is about the same as with all. An effect intermediate between these values is obtained by using any three.

The Past Session.—Compared with last year, there was a falling off in the number of electrical measures before Parliament, the figure for the past session being for traction, lighting, and power, 41, against 58, and of these half a dozen, for one reason or another, failed to become law Traction accounted for 28 Bills, and lighting and power for 13. A portion of the Bills were, as usual, merely for alterations, amendments, or extension of time. In addition, certain corporations promoted omnibus Bills which included electrical matters. On the whole, companies were in a considerable majority over municipalities. The session was somewhat remarkable for the absence of rejected measures, failure to gain the Royal assent being due to abandonment or withdrawal. The promoters of the East London and Lower Thames Power Company did not go beyond depositing their Bill, and the Central London Railway Company withdrew theirs pending the decision of the London Traffic Commission. Few public Acts were before Parliament, and the Supply of Electricity Bill was withdrawn, while a measure entitled "The Tramways and Public Companies (Ireland) Act (1883) Amendment Bill" was abandoned. This withdrawal of the Supply o Electricity Bill for the second time emphasises the laxity which often creeps into our legislative procedure. A mas of evidence was waded through again, and all for nothing the measure being sacrificed through lack of time. The Government really ought to make up its mind to deal with this Bill in a business-like manner. The number of provisional orders granted was little different from last year the figures being 59 for lighting and 12 for tramways against 61 and 13. Under the Scottish Private Legislature Act three orders were granted in reference to tramways. The outstanding feature of the session was the long struggle over the Administrative County of London Power Bill, which, despite the energy of the promoters, failed to gain a place in the Statute-book this session, although ordered for third reading after an extensive inquiry. The London County Council's General Powers Bill excited a lot of discussion in reference to the free-wiring clause, which caused electrical contractors a good deal of alarm. Ultimately, it was decided that the Borough Council should be empowered to borrow money for the purpose of providing free wiring, but that they should not execute the work themselves. The London United Tramways were granted further time for their extensions, which are being proceeded with at a fair pace, and will enable passengers to travel as far as Esher by car. The Metropolitan Electric Supply Company obtained an extension of their area for power supply. A public Bill with an electrical element in it was that of the Pneumatic Tube Despatch Syndicate. The evidence of numerous experts as to its utility failed to convince the committee, who found the preamble non proven. In the latter part of the Session a Select Committee inquired into the agreement entered into by the Postmaster-General with the National Telephone Company for the transfer of the latter's undertaking in 1911. In their report, the Select Committee made recommendations as to the encouragement of municipal systems, but Lord Stanley contended that these were supererogatory, and Parliament upheld that view, so that, in accordance with its terms, the agreement becomes operative automatically at the end of this month.

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FROME ELECTRICITY WORKS.

Frome, or to designate it by its more correct name Frome-Selwood—so called because of its ancient proximity to the forest of Selwood—is a prosperous and up-to-date town of about 12,000 inhabitants, situated in the east extremity of Somerset amid picturesque country and

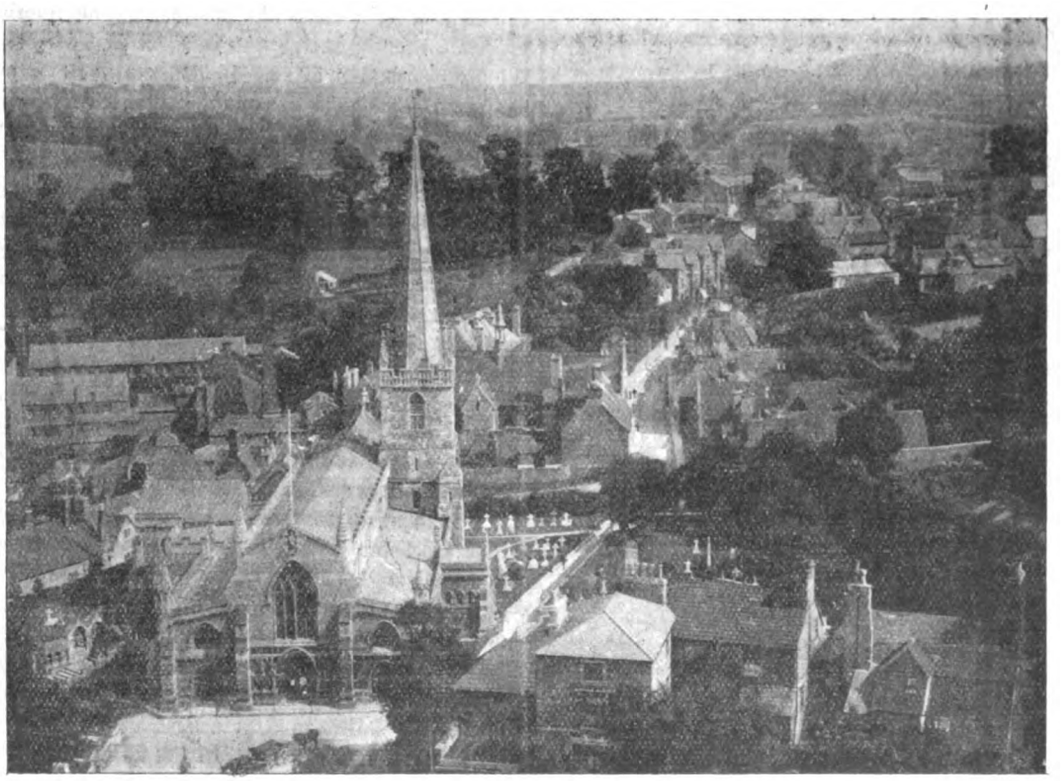
MR. F. HASTINGS MEDHURST, M.I.E.E., CONSULTING ENGINEER.

beautiful and historic surroundings. The annals of the town go far back into the vista of bygone ages; it was known, undoubtedly, to the Romans, and King Alfred's final victory over the Danes was won only a short distance away. The town itself is mentioned in history in the reign of Ina, King of Wessex, when in 689 his near kinsman Aldhelm—a monk of Malmesbury—founded a mission for the purpose of converting the lawless robbers that then infested the surrounding country. Nearly 300 years later, King Edred, "the then most potent King of Britain," was, when at Frome, taken with a grevious sickness in the tenth year of his reign, and died there "ere the blessed Dunstan could reach him to receive his confession." From Doomsday Book we learn that the town then belonged to the King, and occupied the fortunate position of never having been assessed. Thus from century to century the history of Frome could, if space permitted, be traced in considerable detail. The district was loyal to the Stuarts throughout that disastrous period, and the surrounding villages still bear many traces of the stirring events of those times.

Frome ceased to be a borough after the passing of the

MR. F. MICHELL NICHOLL, RESIDENT ENGINEER.

Redistribution of Seats Act, 1884, and the Local Board was, upon the passing of the Local Government Act in 1894, succeeded by the Urban District Council as the local authority for the town. Geography books of early date state Frome to be a town celebrated for cloths and strong beer, but some 20 or 30 years ago the depression in the woollen trade resulted in the closing of several of its largest mills, and for a time it was frequently referred to as "the decaying town of the West." Other industries, however, quickly sprang up, and to-day Frome, for its size, is one of the most flourishing towns in the county. In 1900 the boundaries of the urban district were extended, and immediately after the completion of that undertaking the question of an electrical installation was taken up by



View from the Top of Chimney Shaft of the Frome Electricity Works. From a copyright photograph by Wheeler, Frome.

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the Council. The subject had been discussed on several occasions during the previous autumn, but no definite steps were taken until the spring of 1900. The Council then determined to investigate the matter, and obtained expert advice. Mr. F. H. Medhurst was selected to report on the whole question, and he has continued to act as the Council's consulting engineer to the present time. In his report Mr.

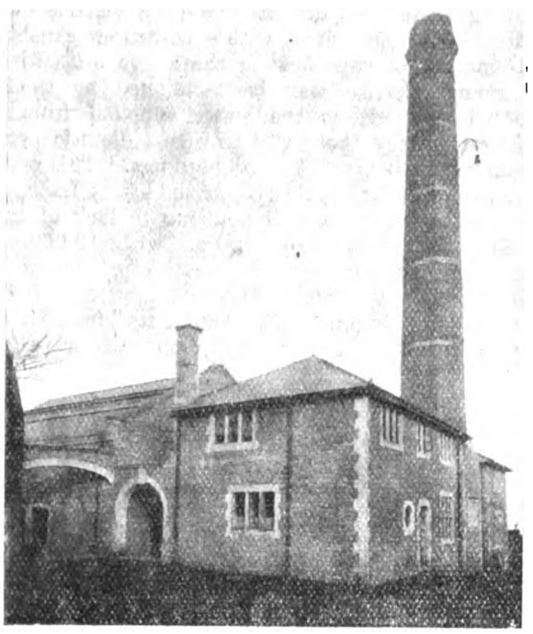


FIG. 1.—Exterior of the Frome Electricity Works.

Medhurst recommended the Council to erect electricity works for continuous-current distribution. An electric lighting order was applied for, and almost immediately it was confirmed a sub-committee was formed to inspect various electricity works. The committee on receipt of their report unanimously recommended the Council to proceed with a scheme of electricity supply, and succeeded

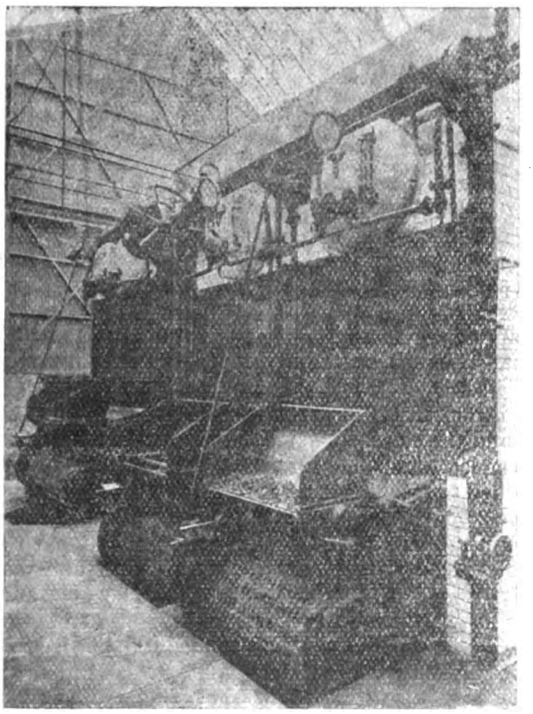


FIG. 2.—The Boiler House, showing Chain Grate Stokers.

in carrying their report. It is interesting to notice that electric lighting matters had been discussed at no less than thirty meetings before the final step was taken. Some months elapsed before further progress was made owing to the opposition of several influential ratepayers, who anticipated that the undertaking would be a burden on the rates, and that a cheaper supply would soon be available from the works which a power company proposed to erect some eight miles away. This company, by the way, has not yet commenced operations. To meet the above objections, Mr. Medhurst suggested that tenders for the complete equipment and maintenance of electricity works should be

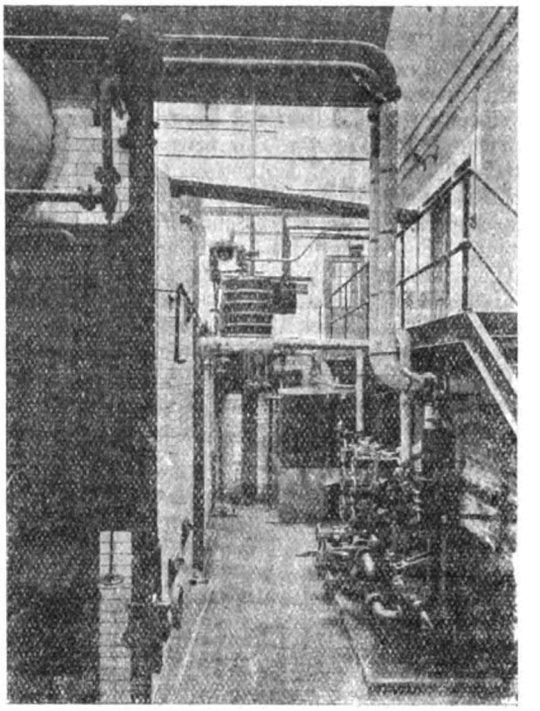
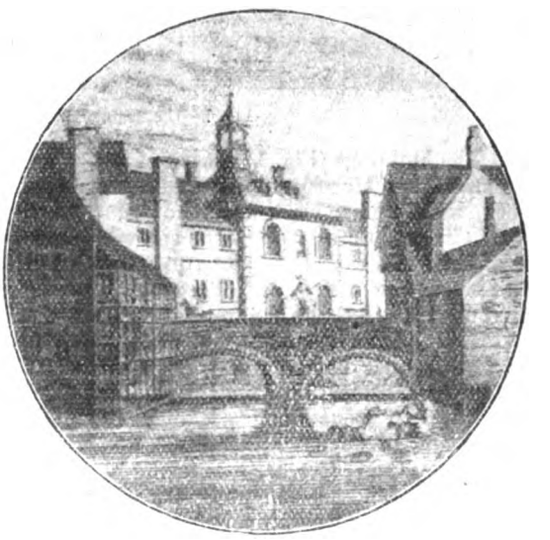


FIG. 3.—Boiler House, showing Pumps and Feed Heater.

obtained from several firms of undoubted stability, on the basis of the Council raising the necessary capital and paying for the undertaking, the contractors taking, on completion of the scheme, a lease of the undertaking at an annual rental equivalent to the interest and sinking fund on the loan raised by the Council for the equipment of the works; the Council having the right to determine the agreement at the end of 7, 10, or 14 years; the contractors holding their lease for 25 years if so desired, carrying out the works under the supervision of the Council's engineer and maintaining the same to his satisfaction.

Several leading members of the Council, including the chairman, Mr. H. T. Rawlings, and Councillors Seward, Woodland, Penny, and R. T. Rawlings, were strongly in



Frome Town Bridge in 1780.

favour of the scheme being carried out in the ordinary way at the risk of the Council, holding that any initial loss would soon be more than balanced by the success of the undertaking. In deference to the wishes of a number of ratepayers, it was, however, decided in August, 1902, to proceed with a guaranteed scheme as detailed above. Plans and specifications were then prepared by Mr. Medhurst,

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and the tender of Messrs. Edmundson's Electricity Corporation, Limited, was accepted in January, 1903, the total being £20,156. 5s. Messrs. Edmundson's principal sub-contractors were as follows: buildings and chimney shaft, Messrs. Hodder and Sons, Frome; boilers, mechanical stokers, and steam-pipes, Messrs. Babcock and Wilcox; condensing plant, Messrs. Cole, Marchent, and Morley; water softener, Mr. William Boby; crane, Messrs. Isles; steam-turbine dynamos, Messrs. C. A. Parsons and Co.; balancer booster, Messrs. Thomas Parker; switchboard, Messrs. Edmundson's Electricity Corporation; battery, Messrs. the D.P. Battery Company; mains, Messrs. Callender's Cable and Construction Company; cooling tower, Messrs. the Klein Engineering Company; lamp brackets, Messrs. Singer and Sons, Frome. The Local Government Board inquiry was held in the same month, the sanction of that department obtained in due course, and building operations started in the autumn of 1903.

The works have been erected on a central site acquired by the Council some years previously, formerly occupied by Messrs. E. Cockey and Sons, Limited, the well-known firm of gas engineers, who have long since moved to larger premises. The buildings (Fig. 1) consist of a boiler-house, engine-room, accumulator-room, and chimney shaft, also an office block, with stores, workshop, showroom, engineer's and general offices. Local stone has been used in the construction of the work, with Bath stone quoins and dressings, the whole presenting a neat and pleasing appearance, on which the builders are to be congratulated. The chimney shaft, 110ft. in height from the flue level, and approximately of 6ft. internal diameter, rests upon a bed of concrete on solid rock, some 15ft. from the surface. The base, of stone, with bath stone quoins, is 30ft. in height, the shaft itself being of octagonal section. Red Cattybrook bricks have been used here, with relieving bands of white brick. The cornice and cap of blue Staffordshire brick give a satisfactory finish to a well-proportioned shaft. Entrance to the offices is obtained on the east side of the building, a staircase leading from the hall to the engineer's office, general office, and showroom on the first floor. The stores and lavatory are situated on either side of a passage leading from the hall to the workshop. Access is given here to a small yard, and this forms an additional entrance to the works. A second door in the workshop opens on to a gallery in the boiler-house. This section of the works is 48ft. in length, 42ft. in width, and 26ft. in height to the springing of the roof. The coal bunkers in communication with it have been built below the ground level for convenience in handling the coal. The storage capacity of the bunkers is about 80 tons.

The steam raising plant (Fig. 2) consists of three water-tube boilers of Babcock and Wilcox's manufacture, two to evaporate 5,000lb. of water per hour and one 7,000lb. per hour at a working pressure of 160lb. per square inch. These boilers are fitted with chain-grate mechanical stokers. The moving grates are driven by a 4-h.p. electric motor. The boilers have been fitted with superheaters capable of giving 150deg. F. of superheat to the above quantities of steam. Some surprise may be occasioned by the use of water-tube boilers, as the water supplied from the Council's waterworks, though of excellent dietetic properties, contains some 25deg. of total hardness. This matter, however, was carefully considered, as the use of Lancashire boilers was out of the question owing to lack of space. Condensing plant capable of dealing with 10,000lb. of steam per hour has been provided for the turbines, so that condensed steam is available for feeding the boilers. A 28in. vacuum is usually obtained. The "make up" feed water is softened by a Boby-Chevalet heater detartariser (Fig. 3). In this apparatus unsoftened water is admitted at the top and exhaust steam at the bottom, the steam passing up through a series of trays boils the water. The carbonate of lime is deposited in the trays and settling tank at the bottom, and the softened water is then ready for use.

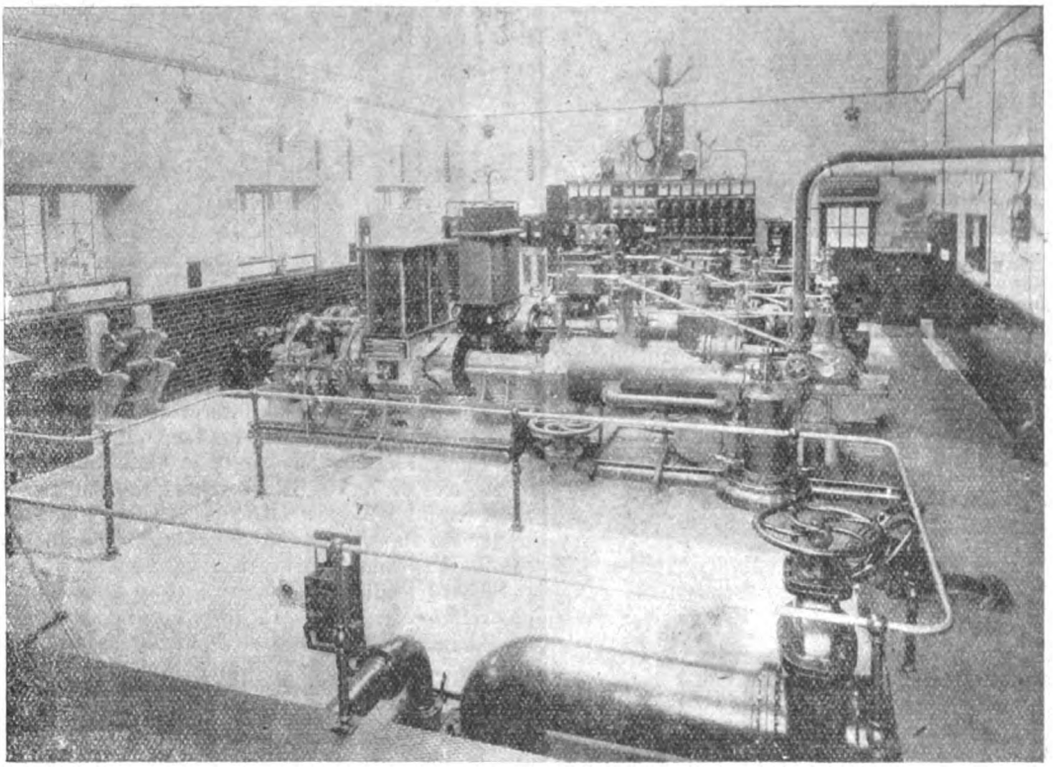

FIG. 4.—The Engine Room at Frome, showing the Parsons Turbo-Generator.

Two vertical compound direct-acting Hall steam pumps are provided for feeding the boilers. Each pump is designed to deliver 2,000 gallons of water per hour against a pressure of 160lb. per square inch. Each boiler can be supplied with either hot or cold water. The steam pipes are of wrought steel, with valves of Dewrance's make. The whole system of piping has been carefully arranged, all water from drains is collected and utilised, and the steam and hot-feed pipes and valves lagged with mica coverings.

A door at the north end of the gallery in the boiler-house gives access to the engine-room. This is 48ft. in length, 30ft. in width, and 18ft. in height to the springing of the roof. A five-ton overhead travelling crane spans the building, which, with its terazzo floor, glazed tile dado, polished metal work, and general neatness reflects credit on its designers. It is, without doubt, one of the daintiest, and at the same time one of the most business-like engine-rooms to be found in or out of the West Country.

The electrical equipment (Fig. 4) comprises three Parsons

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steam-turbine dynamos, running at 3,650 r.p.m., and the usual accessories. Two of these turbines are 150-kw. machines, or 250 h.p. each, and one is a 75-kw. machine. This type of plant runs practically without vibration, and was adopted in consequence of the bad foundations.

FROME TURBO-GENERATORS.—TEST AT MAKERS' WORKS.

Load.	Kilo-watts	R.P.M.	Steam pressure at stop valve of turbine. Lbs per square inch.	Super-heat Deg. F.	Vacuum. Inches of mercury.	Llbs. steam per kilowatt-hour.
Full...	150	3,650	143	134	24 9	24·3
Half...	150	3,650	156	123	24·7	31·3
Full...	75	4,300	147	145	24	27·6
Half...	75	4,300	147	151	24	37·7

Details of the tests made on these sets are given in the table. They govern within 2 per cent. from full load to no-load, and can give 10 per cent. overload when running non-condensing. The exhaust steam from the turbines is led to a surface condenser sunk in a pit in the engine-room. The condenser is supplied with water from a Klein's cooling-tower erected at the west end of the site. The tower, of creosoted timber, is built over a concrete tank 10ft. in depth, and is 40ft. in length, 32ft. wide, and 65ft. high. The circulating water (40,000 gallons per hour at full load) flows from the tank under the tower, passes through the condenser, and is forced to a point in the tower some 30ft. from the ground. It is thence distributed in small quantities over a number of laths down which it trickles to the tank below and again flows to the condenser. The temperature of the water is, of course, lowered by its partial evaporation in contact with the draught of air created in the tower, which is open to the atmosphere at its base and acts in the same way as a ventilating shaft. The condenser is provided with an Edwards three-throw air-pump and with a centrifugal circulating pump driven by a 20-b.h.p. electric motor.

The current generated by the steam-turbine dynamos at from 480 to 530 volts is taken to the main switchboard, and from thence it flows through the various measuring and regulating instruments to the feeding and distributing mains. Separate mains are run to various parts of the town, so that in the event of a cable breaking down only a small part of the town would be affected. The cables are of the well-known Callender type, lead covered and further protected by steel tapes wound on spirally. They are laid direct in the ground and covered with hard bricks. All the connections between feeders and distributing cables are made in feeder pillars of the Callender-Ward type. The feeders are triple-concentric cables, and for the distributors three and four core cables are used. The latter four-core cables are used where street-lighting has to be supplied from the private-lighting mains.

On the north side of the engine-room is the "balancer booster" for balancing the three-wire system, and for charging the batteries. The balancer can deal with 60 amperes out-of-balance current on the 240-480 volt system. The boosters can each add 85 volts when passing a current of 54 amperes to the batteries. The accumulators consist of 260 D.P. cells, with a capacity of 400 ampere-hours. They have been placed in a spacious room at the back of the switchboard.

The growth of the undertaking has been very rapid and points to a successful working from a commercial point of view. The number of applications for light and power early necessitated the substitution of a 150-kw. turbo-generator, in the place of the second 75 kw. originally specified, and a third generator set and boiler have already been added.

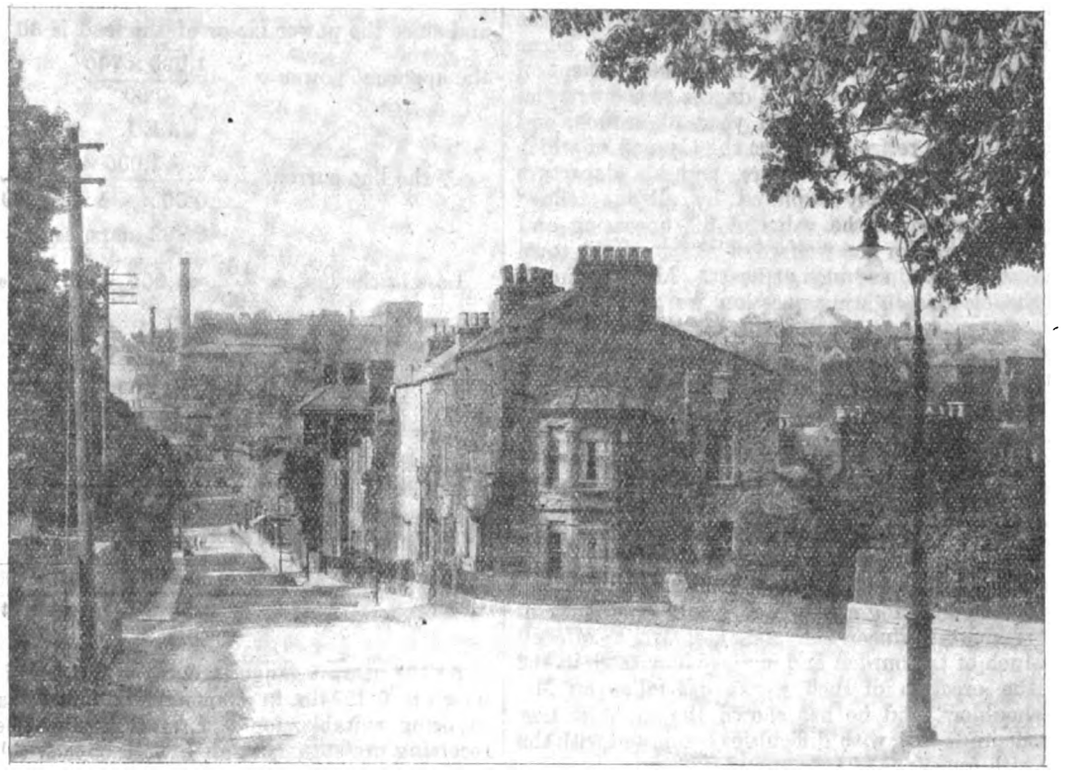

FIG. 5.—View from North-parade, Frome, showing Electric Lamp for Street Lighting.

A supply of current was first given to private consumers on July 1, 1904, and the streets were lit by electricity for the first time on Aug. 1, 1904. The original intention of the Council was to erect 10 arc lamps and about 41 incandescent lamps in the streets. The contractors, however, submitted a tender for the whole of the street-lighting on favourable terms, and the streets are now lighted by 10 three-ampere twin-carbon arc lamps of the Reason type, and 261 incandescent Nernst lamps of 80 c.p. The lamps are switched off at 11.30 p.m., with the exception of two 40-c.p. lamps on the arc lamp posts, which are switched on automatically when the arcs are switched off, and 46 of the Nernst lamps at street corners. New posts have been ordered for additional lamps, but the majority of the gas lamp posts have been utilised, fitted with graceful brackets, manufactured at Messrs. Singer's Art Metal Works. The lamps are controlled in groups from switch pillars, and the general effect of the lighting is considered highly satisfactory.

The contractors have adopted a spirited policy in the matter of charges for electrical energy. The price per unit on the maximum demand system is 7d. and 4d. per unit for lighting and power respectively for any quantity up to the amount which would have been used if the maximum

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demand had continued for approximately one hour each day per quarter, and for any further units 3d. for lighting and 1d. for power, or a flat rate of 6d. for lighting and 2½d. for power. The price of gas in the town, it may be noted, was 3s. 4d. per 1,000 cubic feet until the works were under construction, since when it has been 3s. per 1,000 cubic feet. The contractors wire houses complete, if so desired, and charge a rental for the use of the installation of 4½d. per lamp per quarter. Alternatively, the installation can be paid for by instalments, spread over a number of years. In special cases current is supplied by 1d. or 1s. in the slot meters, at 7d. per unit. This charge covers both the rent of the meter and the rent of the installation. Motors and other apparatus can also be hired, and several of the leading manufacturers of the town have given a considerable impetus to the undertaking by substituting electric motors for their existing steam or gas engines. The number of motors on the mains is now 102, the range being from 35 h.p. to ¼ h.p. The equivalent number of 8-c.p. lamps, including all current-consuming apparatus, at the commencement of supply was 3,050 and at the present time is 19,579, while a further number of over 1,500 8-c.p. lamps await connection.

No description of the Frome Electricity Works would be complete without some acknowledgment of the valuable services of Mr. H. T. Rawlings, the chairman of the Council from 1898 to 1904, and others who have borne "the burden and heat of the day." The establishment of the undertaking was due in no small degree to the energies of Mr. Rawlings, spread over several years of arduous and incessant work. His retirement from the Council, of which he had been a member for 12 years, and his departure from Frome, are genuinely deplored by all his fellow-townsmen, who appreciate the value of his unceasing and unostentatious efforts for the welfare of the good old town whose interests he had so much at heart. Mr. Rawlings's views on the electric lighting question were shared, and vigorously advanced, by a number of his colleagues, who have every reason to look back upon their labours with feelings of satisfaction. The services of the popular clerk to the Council, Mr. Ames, in the cause of electricity have proved of the highest value. His keen interest in the scheme has been a leading factor in its success. Mr. George T. Pardoe has acted as clerk of works, and has ably supported the Council's interests.

Messrs. Edmundson's Electricity Corporation have carried out the contract in their usual thorough and workmanlike manner, and no little credit for the success of the installation is due to the untiring energy and wide experience of their able resident engineer and manager, Mr. F. Michell Nicholl. Much of the burden and anxiety inevitable in the course of the erection of such works has fallen on Mr. Nicholls's shoulders, and he has shown the greatest tact and judgment in dealing with difficulties connected with the works and with questions of supply and demand.

In a word, no effort has been spared to provide up-to-date and efficient electricity works, and an inspection shows that the consulting engineers, Messrs. F. H. Medhurst and Lloyd, are to be congratulated on the result. Most of the photographs from which the above illustrations were made were taken by Mr. W. F. Wheeler, of Frome.

NOTES ON AERIAL POWER LINES.

(Continued from page 192.)

BY CHE.

Before applying the particulars already given respecting the mechanics of the problem it will be well to point out that the existence of tension implies elastic stretching, and that elastic extension is a factor which has not received sufficient attention in the past. If we suppose, for instance, that the tension of the wire becomes F_1, instead of F, the length of the wire becomes

$$L_1 = l\left(1+\frac{l^2 w_1^2}{24 F_1^2}\right) \quad . \quad . \quad . \quad (4a)$$

and if the temperature falls at the same time to the temperature θ_1 C, the length of the wire will be given by the formula

$$L_1 = L\{1+\alpha(\theta_1-\theta)+\epsilon(F_1-F)\} \quad . \quad . \quad (11)$$

in which ϵ = coefficient of elasticity of the material of the wire. From equations (4) and (4a) and by substitution we have

$$l\left(1+\frac{l^2 w_1^2}{24 F_1^2}\right) = l\left(1+\frac{l^2 w^2}{24 F^2}\right)\{1+\alpha(\theta_1-\theta)+\epsilon(F_1-F)\}$$

which gives (by neglecting products containing terms above the first degree) the approximate relation

$$\frac{l^2 w_1^2}{24 F_1^2} - \left[\alpha(\theta_1-\theta)+\epsilon F_1\right] = \frac{l^2 w^2}{24 F^2} - \epsilon F \quad . \quad (12)$$

A knowledge of the most unfavourable conditions—i.e., a knowledge of α, θ_1, θ, w, w_1 and F_1—enables the best length to be determined to give to the span and to the tension, F, for normal working conditions.

Let us now consider the following problem: *It is required to transmit 1,000 h.p. a distance of 50 miles by means of three-phase currents at a frequency of 50 periods, the pressure between the line wires at the receiving end being 20,000 volts. The power factor of the load may be taken as 80 per cent., and the power lost in the line should not exceed 15 per cent. of that received.*

Let E = pressure between the line wires, and I = line current.

then power received $= \sqrt{3}\,E\,I\cos\theta$;

and since the power factor of the load is 80 per cent.,

$$\text{the apparent power} = \frac{1{,}000\times 746}{0{\cdot}80}$$

$$= \sqrt{3}\,E\,I.$$

$$\therefore \text{ the line current } I = \frac{1{,}000\times 746}{0{\cdot}80\times\sqrt{3}\times 20{,}000}$$

$$= 26{\cdot}92 \text{ amperes.}$$

$$\text{Loss in the line} = \frac{15}{100}\times 1{,}000\times 746 \text{ watts}$$

$$= 3\,I^2\,R,$$

if R = resistance of each line wire.

$$\therefore \quad R = \frac{150\times 746}{3\times(26{\cdot}92)^2} \text{ ohms.}$$

but $$R = \frac{{\cdot}66}{10^6}\times\frac{50\times 5{,}280\times 12}{{\cdot}7854 d^2};$$

where d = diameter of the wire in inches.

$$\therefore\ d = \sqrt{\frac{{\cdot}66\times 50\times 5{,}280\times 12\times(26{\cdot}92)^2}{10^6\times{\cdot}7854\times 50\times 746}}$$

$$= 0.232\text{in.}$$

As the nearest gauge (B.& S.) to this size of wire is No. 3, which is 0·2294in. in diameter, this wire may be selected as being suitable for the transmission line. Since the receiving pressure is high it will be advisable to dispose the three-line wires at the corners of an equilateral triangle of 5ft. 2in. (62in.) side; and electrically it is important to determine the drop in volts in the line and the voltage at the beginning of the line. The resistance of a wire 0·2294in. in diameter and 50 miles in length is

$$R = \frac{{\cdot}66}{10^6}\times\frac{50\times 5{,}280\times 12}{{\cdot}7854\times({\cdot}2294)^2}$$

$$= 50{\cdot}6 \text{ ohms.}$$

Therefore, the drop in volts in each line is $e_p = R\,I$, or

$$e_p = 50{\cdot}6\times 26{\cdot}92 \text{ volts}$$

$$= 1{,}362{\cdot}15 \text{ volts.}$$

The next important factor is the reactance drop in the line, and this is

$$e_s = 2\pi \sim L\,I,$$

in which L is the inductance of two wires 62in. apart and 50 miles long, and which may be obtained by Maxwell's formula,

$$L = 2\,l\left[0{\cdot}5+2\log_\epsilon\frac{d_1}{r}\right]\times\frac{1}{10^9} \text{ henrys,}$$

in which L = the coefficient of self-induction of two long, straight, and parallel copper wires, l the transmission length in centimetres, d_1 the distance between the centres of the wires, and r is the radius of the wire. For practical pur-

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poses it is more convenient to work with the distance in feet, and if l' denotes the transmission length in feet, the above formula becomes

$$L = 2\,l'\,(2{\cdot}54 \times 12)\left[{\cdot}5 + 2 \times 2{\cdot}3026 \log \frac{d_1}{r}\right] \times \frac{1}{10^9} \text{ henrys.}$$

$$= 2\,l'\left[15{\cdot}24 + 140{\cdot}366 \log \frac{d_1}{r}\right] 10^{-9} \text{ henrys.}$$

$$\therefore L = 2 \times 50 \times 5{,}280\left[15{\cdot}24 + 140{\cdot}366 \log \frac{62}{{\cdot}1147}\right] 10^{-9} \text{ henrys}$$

and $$\log \frac{62}{{\cdot}1147} = \log 540 = 2{\cdot}732.$$

$$\therefore L = 528\,[15{\cdot}24 + 140{\cdot}366 \times 2{\cdot}732]\,10^{-6} \text{ henrys}$$

$$= 0{\cdot}2105416 \text{ henry,}$$

and the reactance $= 2\,\pi \sim L$

$$= 2 \times 3{\cdot}1416 \times 50 \times 0{\cdot}2105416$$

$$= 66{\cdot}13 \text{ ohms.}$$

$$\therefore \text{reactance drop} = e_s = 66{\cdot}13 \times 26{\cdot}92$$

$$= 1{,}780 \text{ volts.}$$

The vector diagram showing the phase-relationships existing between the generator E.M.F., O E, the receiver pressure, O E_1, the resistance drop, $E_1 E_2$ (e_p), and reactance drop, (e_s) E_2 E, are shown in Fig. 3. The

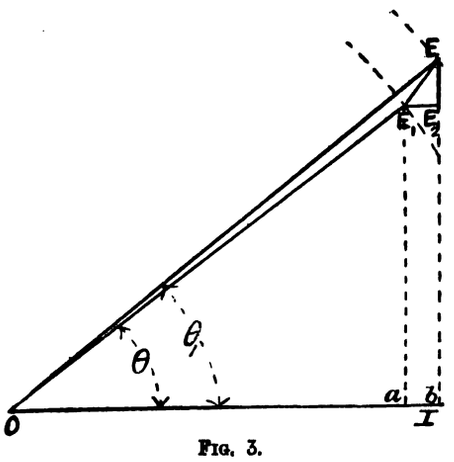

FIG. 3.

actual line drop is given by the arithmetical difference between O E and O E_1 (and not by the vector E_1 E) as indicated by the dotted arcs of the circles. The phase of the current is given by the vector O I, and since the power factor of the load is cos $\theta = 0{\cdot}8$

$$O\,a = O\,E_1 \times \cos\theta$$

$$= 20{,}000 \times 0{\cdot}8 = 16{,}000$$

and $$a\,E_1 = 12{,}000 = E_2\,b$$

$$\therefore O\,E = \sqrt{(O\,b)^2 + (b\,E)^2}$$

$$= \sqrt{(16{,}000 + 1{,}362)^2 + (12{,}000 + 1{,}780)^2}$$

$$= 22{,}166 \text{ volts,}$$

and the drop in the line is O E − O E_1, or 22,166 − 20,000 = 2,166 volts, and this is 10·83 per cent of the receiver pressure.

It may be noted that $E_1\,E = \sqrt{e_p^2 + e_s^2}$

$$= \sqrt{(1{,}362)^2 + (1{,}780)^2}$$

$$= 2{,}241 \text{ volts.}$$

From Fig. 3 it is obvious that in this case the inductance of the line has but a slight effect upon the phase relation between the current and the pressure—*i.e.*, $(\theta_1 - \theta)$ is a small angle. As regards the efficiency of the line we have

$$\eta = \frac{P}{P + 3\,I^2R};$$

in which P = power delivered, and I^2R = watts lost in the line, therefore

$$\eta = \frac{1{,}000}{1{,}000 + \dfrac{3\,(26{\cdot}92)^2 \times 50{\cdot}6}{746}};$$

$$= \frac{1{,}000}{1{,}147{\cdot}45} = 87{\cdot}1 \text{ per cent.}$$

(To be continued.)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The South African tour of this association was inaugurated at Cape Town on Tuesday last when the President, Prof G. H. Darwin, M.A., LL.D., Ph.D., F.R.S., delivered the first portion of his address. The second portion is being reserved till the members meet in Johannesburg.

Professor Darwin in the commencement of his address said: Bartholomeu Diaz, the discoverer of the Cape of Storms, spent sixteen months on his voyage, and the little fiotilla of Vasco da Gama, sailing from Lisbon on July 8, 1497, only reached the Cape in the middle of November. These bold men, sailing in their puny fishing smacks to unknown lands, met the perils of the sea and the attacks of savages with equal courage. How great was the danger of such a voyage may be gathered from the fact that less than half the men who sailed with da Gama lived to return to Lisbon. Four hundred and eight years have passed since that voyage, and a ship of 13,000 tons has just brought us here, in safety and luxury, in but little more than a fortnight.

How striking are the contrasts presented by these events! On the one hand compare the courage, the endurance, and the persistence of the early navigators with the little that has been demanded of us; on the other hand consider how much man's power over the forces of Nature has been augmented during the past four centuries. The capacity for heroism is probably undiminished, but certainly the occasions are now rarer when it is demanded of us. If we are heroes, at least but few of us ever find it out, and, when we read stories of ancient feats of courage, it is hard to prevent an uneasy thought that, notwithstanding our boasted mechanical inventions, we are perhaps degenerate descendants of our great predecessors.

Yet the thought that to-day is less romantic and less heroic than yesterday has its consolation, for it means that the lot of man is easier than it was. Mankind, indeed, may be justly proud that this improvement has been due to the successive efforts of each generation to add to the heritage of knowledge handed down to it by its predecessors, whereby we have been born to the accumulated endowment of centuries of genius and labour.

I am told that in the United States the phrase "I want to know" has lost the simple meaning implied by the words, and has become a mere exclamation of surprise. Such a conventional expression could hardly have gained currency except amongst a people who aspire to knowledge. The dominance of the European race in America, Australasia, and South Africa has no doubt arisen from many causes, but amongst these perhaps the chief one is that not only do "we want to know," but also that we are determined to find out. And now, within the last quarter of a century, we have welcomed into the ranks of those who "want to know" an Oriental race, which has already proved itself strong in the peaceful arts of knowledge.

I take it, then, that you have invited us because you want to know what is worth knowing; and we are here because we want to know you, to learn what you have to tell us, and to see that South Africa of which we have heard so much.

The hospitality which you are offering us is so lavish, and the journeys which you have organised are so extensive, that the cynical observer might be tempted to describe our meeting as the largest picnic on record. Although we intend to enjoy our picnic with all our hearts, yet I should like to tell the cynic, if he is here, that perhaps the most important object of these conferences is the opportunity they afford for personal intercourse between men of like minds who live at the remotest corners of the earth.

We do not know whether the last hundred years will be regarded for ever as the *sæculum mirabile* of discovery, or whether it is but the prelude to yet more marvellous centuries. To us living men, who scarcely pass a year of our lives without witnessing some new marvel of discovery or invention, the rate at which the development of knowledge proceeds is truly astonishing; but from a wider point of view the scale of time is relatively unimportant, for the universe is leisurely in its procedure. Whether the changes

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which we witness be fast or slow, they form a part of a long sequence of events which begin in some past of immeasurable remoteness, and tend to some end which we cannot foresee. It must always be profoundly interesting to the mind of man to trace successive cause and effect in the chain of events which make up the history of the earth and all that lives on it, and to speculate on the origin and future fate of animals, and of planets, suns, and stars. I shall try, then, to set forth in my address some of the attempts which have been made to formulate evolutionary speculation. This choice of a subject has, moreover, been almost forced on me by the scope of my own scientific work, and it is, I think, justified by the name which I bear. It will be my fault and your misfortune if I fail to convey to you some part of the interest which is naturally inherent in such researches.

Prof. Darwin then dealt with several branches of his subject, which are outside the scope of our paper. He afterwards said: Evolutionary doctrines concerning inanimate Nature, although of much older date than those which concern life, have been profoundly affected by the great impulse of which I have spoken. It has thus come about that the origin and history of the chemical elements and of stellar systems now occupy a far larger space in the scientific mind than was formerly the case. The subject which I shall discuss to-night is the extent to which ideas, parallel to those which have done so much towards elucidating the problems of life, hold good also in the world of matter; and I believe that it will be possible to show that in this respect there exists a resemblance between the two realms of Nature, which is not merely fanciful. It is proper to add that as long ago as 1873 Baron Karl du Prel discussed the same subject from a similar point of view, in a book entitled "The Struggle for Life in the Heavens."

Although inanimate matter moves under the action of forces which are incomparably simpler than those governing living beings, yet the problems of the physicist and the astronomer are scarcely less complex than those which present themselves to the biologist. The mystery of life remains as impenetrable as ever, and in his evolutionary speculations the biologist does not attempt to explain life itself, but, adopting as his unit the animal as a whole, discusses its relationships to other animals and to the surrounding conditions. The physicist, on the other hand, is irresistibly impelled to form theories as to the intimate constitution of the ultimate parts of matter, and he desires further to piece together the past histories and the future fates of planets, stars, and nebulæ. If then the speculations of the physicist seem in some respects less advanced than those of the biologist, it is chiefly because he is more ambitious in his aims. Physicists and astronomers have not yet found their Johannesburg or Kimberley; but, although we are still mere prospectors, I am proposing to show you some of the dust and diamonds which we have already extracted from our surface mines.

The fascinating idea that matter of all kinds has a common substratum is of remote antiquity. In the Middle Ages the alchemists, inspired by this idea, conceived the possibility of transforming the baser metals into gold. The sole difficulty seemed to them the discovery of an appropriate series of chemical operations. We now know that they were always indefinitely far from the goal of their search, yet we must accord to them the honour of having been the pioneers of modern chemistry.

The object of alchemy, as stated in modern language, was to break up or dissociate the atoms of one chemical element into its component parts, and afterwards to reunite them into atoms of gold. Although even the dissociative stage of the alchemist problem still lies far beyond the power of the chemist, yet modern researches seem to furnish a sufficiently clear idea of the structure of atoms to enable us to see what would have to be done to effect a transformation of elements. Indeed, in the complex changes which are found to occur spontaneously in uranium, radium, and the allied metals we are probably watching a spontaneous dissociation and transmutation of elements.

Natural selection may seem, at first sight, as remote as the poles asunder from the ideas of the alchemist, yet dissociation and transmutation depend on the instability and regained stability of the atom, and the survival of the stable atom depends on the principle of natural selection.

Until some 10 years ago the essential diversity of the chemical element was accepted by the chemist as an ultimate fact, and, indeed, the very name of atom, or that which cannot be cut, was given to what was supposed to be the final indivisible portion of matter. The chemist thus proceeded in much the same way as the biologist, who, in discussing evolution, accepts the species as his working unit. Accordingly, until recently the chemist discussed working models of matter of atomic structure, and the vast edifice of modern chemistry has been built with atomic bricks.

But within the last few years the electrical researches of Lenard, Röntgen, Becquerel, the Curies, of my colleagues Larmor and Thomson, and of a host of others, have shown that the atom is not indivisible, and a flood of light has been thrown thereby on the ultimate constitution of matter. Amongst all these fertile investigators it seems to me that Thomson stands pre-eminent, because it is principally through him that we are to-day in a better position for picturing the structure of an atom than was ever the case before.

Even if I had the knowledge requisite for a complete exposition of these investigations, the limits of time would compel me to confine myself to those parts of the subject which bear on the constitution and origin of the elements.

It has been shown, then, that the atom, previously supposed to be indivisible, really consists of a large number of component parts. By various convergent lines of experiment it has been proved that the simplest of all atoms—namely, that of hydrogen—consists of about 800 separate parts, while the number of parts in the atom of the denser metals must be counted by tens of thousands. These separate parts of the atom have been called corpuscles or electrons, and may be described as particles of negative electricity. It is paradoxical, yet true, that the physicist knows more about these ultra-atomic corpuscles, and can more easily count them than is the case with the atoms of which they form the parts.

The corpuscles, being negatively electrified, repel one another just as the hairs on a person's head mutually repel one another when combed with a vulcanite comb. The mechanism is as yet obscure whereby the mutual repulsion of the negative corpuscles is restrained from breaking up the atom, but a positive electrical charge, or something equivalent thereto, must exist in the atom so as to prevent disruption. The existence in the atom of this community of negative corpuscles is certain, and we know further that they are moving with speeds which may in some cases be comparable to the velocity of light—namely, 200,000 miles a second. But the mechanism whereby they are held together in a group is hypothetical.

It is only just a year ago that Thomson suggested, as representing the atom, a mechanical or electrical model whose properties could be accurately examined by mathematical methods. He would be the first to admit that his model is at most merely a crude representation of actuality, yet he has been able to show that such an atom must possess mechanical and electrical properties which simulate, with what Whetham describes as "almost Satanic exactness," some of the most obscure and yet most fundamental properities of the chemical elements. "Se non è vero, è ben trovato," and we are surely justified in believing that we have the clue which the alchemists sought in vain.

Thomson's atom consists of a globe charged with positive electricity, inside which there are some thousand or thousands of corpuscles of negative electricity, revolving in regular orbits with great velocities. Since two electrical charges repel one another if they are of the same kind, and attract one another if they are of opposite kinds, the corpuscles mutually repel one another, but all are attracted by the globe containing them. The forces called into play by these electrical interactions are clearly very complicated, and you will not be surprised to learn that Thomson found himself compelled to limit his detailed examination of the model atom to one containing about 70 corpuscles. It is indeed a triumph of mathematical power to have determined the mechanical conditions of such a miniature planetary system as I have described.

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It appears that there are definite arrangements of the orbits in which the corpuscles must revolve, if they are to be persistent or stable in their motions. For the purpose of general discussion, which is all that I shall attempt, you may take it that the number of corpuscles in such a community is fixed; and we may state that definite numbers of corpuscles are capable of association in stable communities of definite types.

An infinite number of communities are possible, possessing greater or lesser degress of stability. Thus the corpuscles in one such community might make thousands of revolutions in their orbits before instability declared itself; such an atom might perhaps last for a long time as estimated in millionths of seconds, but it must finally break up and the corpuscles must disperse or rearrange themselves after the ejection of some of their number. We are thus led to conjecture that the several chemical elements represent those different kinds of communities of corpuscles which have proved by their stability to be successful in the struggle for life. If this is so, it is almost impossible to believe that the successful species have existed for all time, and we must hold that they originated under conditions about which I must forbear to follow Sir Norman Lockyer in speculating.

But if the elements were not eternal in the past, we must ask whether there is reason to believe that they will be eternal in the future. Now, although the conception of the decay of an element and its spontaneous transmutation into another element would have seemed absolutely repugnant to the chemist until recently, yet analogy with other moving systems seems to suggest that the elements are not eternal.

At any rate it is of interest to pursue to its end the history of the model atom which has proved to be so successful in imitating the properties of matter. The laws which govern electricity in motion indicate that such an atom must be radiating or losing energy, and, therefore, a time must come when it will run down, as a clock does. When this time comes it will spontaneously transmute itself into an element which needs less energy than was required in the former state. Thomson conceives that an atom might be constructed after his model so that its decay should be very slow. It might, he thinks, be made to run for a million years, but it would not be eternal.

Such a conclusion is an absolute contradiction to all that was known of the elements until recently, for no symptoms of decay are perceived, and the elements existing in the solar system must already have lasted for millions of years. Nevertheless, there is good reason to believe that in radium, and in other elements possessing very complex atoms, we do actually observe that break-up and spontaneous rearrangement which constitute a transmutation of elements.

It is impossible as yet to say how science will solve this difficulty, but future discovery in this field must surely prove deeply interesting. It may well be that the train of thought which I have sketched will ultimately profoundly affect the material side of human life, however remote it may now seem from our experience of daily life.

I have not as yet made any attempt to represent the excessive minuteness of the corpuscles, of whose existence we are now so confident; but, as an introduction to what I have to speak of next, it is necessary to do so. To obtain any adequate conception of their size we must betake ourselves to a scheme of threefold magnification. Lord Kelvin has shown that, if a drop of water were magnified to the size of the earth the molecules of water would be of a size intermediate between that of a cricket ball and of a marble. Now each molecule contains three atoms, two being of hydrogen and one of oxygen. The molecular system probably presents some sort of analogy with that of a triple star; the three atoms, replacing the stars, revolving about one another in some sort of dance which cannot be exactly described. I doubt whether it is possible to say how large a part of the space occupied by the whole molecule is occupied by the atoms; but perhaps the atoms bear to the molecule some such relationship as the molecule to the drop of water referred to. Finally, the corpuscles may stand to the atom in a similar scale of magnitude. Accordingly a threefold magnification would be needed to bring these ultimate parts of the atom within the range of our ordinary scales of measurement.

I have already considered what would be observed under the triply powerful microscope, and must now return to the intermediate stage of magnification, in which we consider those communities of atoms which form molecules. This is the field of research of the chemist. Although prudence would tell me that it would be wiser not to speak of a subject of which I know so little, yet I cannot refrain from saying a few words.

The community of atoms in water has been compared with a triple star, but there are others known to the chemist in which the atoms are to be counted by fifties and hundreds, so that they resemble constellations.

I conceive that here again we meet with conditions similar to those which we have supposed to exist in the atom. Communities of atoms are called chemical combinations, and we know that they possess every degree of stability. The existence of some is so precarious that the chemist in his laboratory can barely retain them for a moment; others are so stubborn that he can barely break them up. In this case, dissociation and reunion into new forms of communities are in incessant and spontaneous progress throughout the world. The more persistent or more stable combinations succeed in their struggle for life, and are found in vast quantities, as in the cases of common salt and of the combinations of silicon. But no one has ever found a mine of gun-cotton, because it has so slight a power of resistance. If, through some accidental collocation of elements, a single molecule of gun-cotton were formed, it would have but a short life.

Stability is, further, a property of relationship to surrounding conditions; it denotes adaptation to environment. Thus salt is adapted to the struggle for existence on the earth, but it cannot withstand the severer conditions which exist in the sun.

[The President here announced that he proposed to consider various theories of evolution in the heavens in the second portion of his address, to be delivered at Johannesburg on Wednesday, Aug. 30.]

HOTEL WIRING.

It is the fashion on the Continent much more than here to arrange electric incandescent lamps so that they may be controlled from more than one position. In this country we have hitherto limited the application of the principle mainly to corridor and hall lighting. To be able to switch

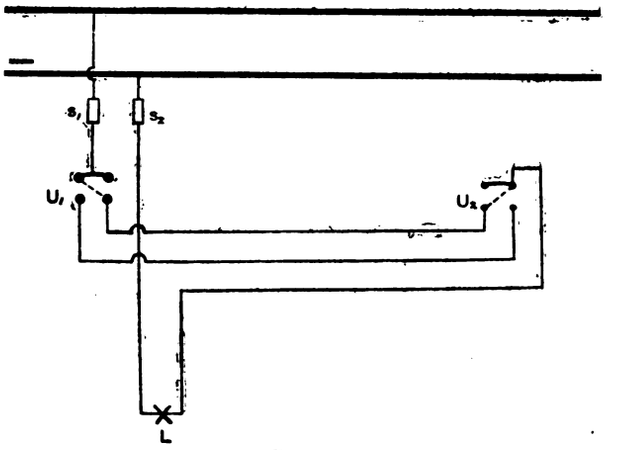

FIG. 1.

on a light from either end of a corridor has been recognised as a convenience and adopted, while the same applies in the case of a hall or landing light, which can be controlled from both the foot and head of the staircase. Continental engineers have, however, given the system wider application. In a German hotel, for instance, it is not unusual to find that one's bedroom lamp or lamps can be controlled from two different points. Complications are necessarily involved, but convenience is held to be of primary importance in these matters. In a contribution to the *Elektrotechnischer Anzeiger* "A. H." describes some current

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practice. The diagram (Fig. 1) represents a common arrangement of connections. In this example the lamp, L, is supposed to be fixed in a central position for general illumination, while one single-pole two-way switch, U_1, is placed near the door and another, U_2, within convenient reach of the bed. The lamp, it will be seen, may be controlled from either switch at will. The switches themselves are preferably of the quick make-and-break two-way type. The only complication, and possible extravagance where the local conditions are unfavourable, is the necessity for three connections to each switch. When surface wiring on porcelain insulators with treble flexible is used it looks ugly, and with conduit wiring it is frequently found

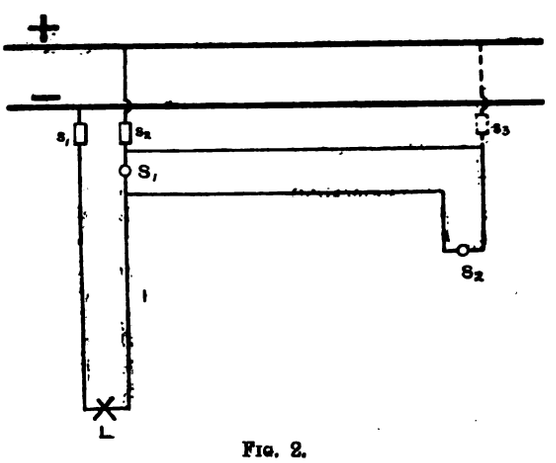

Fig. 2.

necessary to lay two tubes, apart from any preference which may be given to separate wires on account of greater safety. Reverting to the diagram, it should be mentioned that s_1 and s_2 represent fuses. Should it suffice to control the lamp from different points by means of two switches, S_1 and S_2, arranged in parallel as shown in Fig. 2, the connections are considerably modified, two wires only, frequently, indeed, but one, being then required between the switches, while the substitution of simple for two-way switches represents a further advantage. The use of but one switch wire is possible when a convenient and short connection can be made to the main conductors as indicated by the dotted

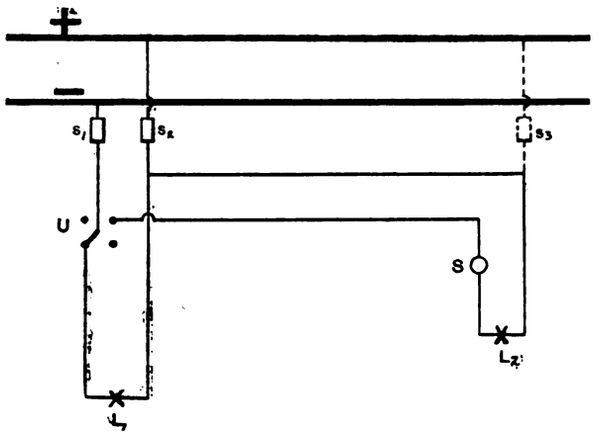

Fig. 3.

line in Fig. 2. But this involves the introduction of a third fuse, s_3, whose maximum capacity, together with that of the parallel fuse, s_2, must not exceed that of the lamp lead, l. This arrangement enables the lamp, L, to be switched on from either of the two positions, but both switches must be set in the off position before it can be extinguished. In order to obtain maximum convenience from the arrangement it must, therefore, be remembered to set the door switch to the off and the bed-side switch to the on positions respectively before retiring. Another arrangement frequently met with includes two lamps so connected that only one can be used at a time. A suitable, and at the same time simple, means of accomplishing this end is illustrated by the diagram (Fig. 3). It is assumed here that one of the lamps, L_1, serves for the general lighting of the room, while the other, L_2, is fixed near the bed or writing desk, but in any case may be extinguished through a switch, S, placed within convenient reach of the bed. Referring to the diagram, it will be seen that a two-way switch, U, and an ordinary single-pole switch are requisite in this case, while between the two, as in the previous example, two wires are required at the most and frequently under favourable conditions only one. A dotted line is again employed to represent the alternative connection whereby it would be possible in favourable circumstances to effect the saving in question. But in that event it would be necessary to add

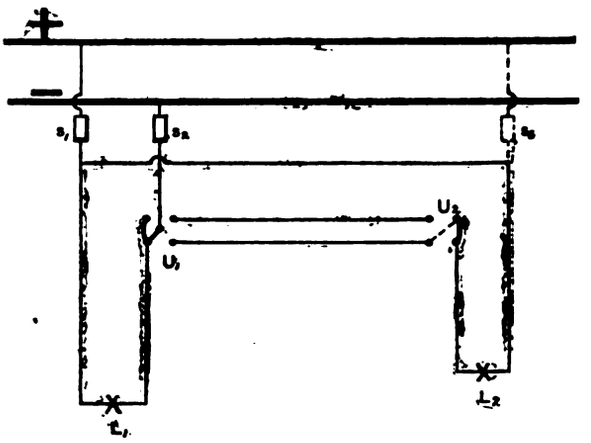

Fig. 4.

a third fuse, s_3, of equal capacity to the other two. When complexity and cost are secondary to convenience the arrangement just described may be modified as shown by the diagram Fig. 4. This modification enables the second lamp L_2 to be controlled—say, from the door switch, when the other switch is in any position. In the case of the arrangement, Fig. 3, on the other hand, with the simple switch s open, it would be impossible to switch on the second lamp L_2 from the door. But, in addition to a greater number of wires the arrangement, Fig. 4, involves the use of a two-way and a three-way switch, U_2 and U_1, respectively. In conclusion, reference may be made to an arrangement for controlling three lamps so that one

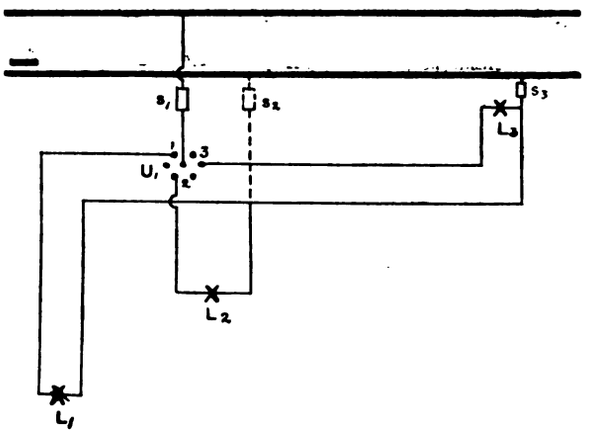

Fig. 5.

only can be used at a time. This condition necessitates the employment of a three-way switch, U_1 (Fig. 5), provided with intermediate dummy contacts, so that in the positions 1, 2, and 3 the corresponding lamps, L_1, L_2, or L_3, are switched on, while no circuits are closed through the dummy contacts. It is assumed that the lamp, group of lamps, or electrolier, L_2, serves for the general illumination of the room, while L_1 and L_3 are desk and bedside lamps respectively. It would be well, adds "A. H.," to provide the last-mentioned, especially the bedside lamp, with separate single-pole switches or switch-holders for local control. The dotted line indicates how a possible saving in wire might be effected. But here, again, this saving would entail the use of a third fuse.

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"FLYWHEEL EFFECT" AND "STORED ENERGY" IN ROTATING PARTS OF ELECTRICAL MACHINERY, AND THE PARALLEL RUNNING OF ALTERNATORS.

BY ZODIAC.

The successful operation of electrical machinery, notably alternators and rotary converters, is largely dependent on the steady running of the engines driving the generators, and is, therefore, closely connected with the question of the stored energy in the moving parts. In English practice it is usual to state the kinetic energy of a given wheel in foot-pounds or foot-tons; on the other hand, Continental engineers use the value $G D^2$ as expressing the flywheel effect. The conversion from the one system to the other is a simple matter, but, nevertheless, apt to cause difficulty to the student. The energy in foot-pounds stored in a given flywheel is given by the expression

$$\text{Kinetic energy (in ft.-lbs.)} = \tfrac{1}{2} M v^2,$$

where M = the mass of the wheels in poundals and v the velocity in feet per second.

If D = the effective diameter of the wheel (gyration) and n = the speed in revolutions per minute,

$$V \text{ (in feet per second)} = \frac{D \pi n}{60}$$

D being in feet. If W = the weight of the rim in pounds,

$$M \text{ (in poundals)} = \frac{W}{32\,2}. \quad \text{In C.G.S. units } M = \frac{G}{9\,81},$$

G being the weight in kilogrammes.

The Continental method is to express the "flywheel effect" (not the kinetic energy) in terms of $G \times D^2$, G being the weight in kilogrammes and D the effective diameter in metres, $G D^2$ being given in kilogramme-metres^2. If we express the weight in pounds (as W) and D in feet, we get the expression $W D^2$ in pound-feet^2. The comparison of the two systems will be rendered easy if the expressions are written thus:

$$\tfrac{1}{2} M v^2 \text{ (in ft.-lbs.)} = \frac{1}{2 \times 32{\cdot}3} \times \left(\frac{\pi n}{60}\right)^2 W D^2 \quad (1)$$

or in kilogramme-metres

$$\tfrac{1}{2} M v^2 = \frac{1}{2 \times 9{\cdot}81} \times \left(\frac{\pi n}{60}\right)^2 G D^2 \quad . \quad (2)$$

The conversion from kilogramme-metres to foot-pounds is, of course, a simple matter: kilogramme-metres $\times$ 7·2178 = foot-pounds. Working out (1) for a wheel running at 600 revolutions, we get

$$\frac{M v^2}{2} \text{ (in ft.-lbs.)} = 15{\cdot}3 \times W D^2.$$

A useful rule for converting $G D^2$ (in kilogramme-metres^2) into $\frac{1}{2} M v^2$ in foot-tons is:

$$\tfrac{1}{2} M v^2 \text{ (in ft.-tons)} = G D^2 \times \text{revolutions}^2 \times 45 \times 10^{-8} \quad . \quad (3)$$

Example.—$G D^2$ = 61,000 kg.-m.^{2}; G = 12,500 kg., or 27,550lb.; D = 2·21 m. = 7·24ft.; speed, 166.

$$M = \frac{27{,}550}{32{\cdot}2} = 855{\cdot}6 \text{ poundals}$$

$$v = \frac{D \pi n}{60} = \frac{7{\cdot}24 \times \pi \times 166}{60} = 62{\cdot}89\text{ft. per second}$$

$$v^2 = 62{\cdot}89^2 = 3{,}955.$$

$$\tfrac{1}{2} M v^2 \text{ (in foot-tons)} = \frac{855{\cdot}6 \times 3{,}955}{2 \times 2{,}240} = 756 \text{ approximately.}$$

Using formula (3) we get

$$\tfrac{1}{2} M v^2 = 61{,}000 \times 166^2 \times 45 \times 10^{-8} = 756{\cdot}4 \text{ foot-tons.}$$

With formula (1)

$$\tfrac{1}{2} M v^2 = \frac{1}{64{\cdot}4} \left(\frac{\pi \times 166}{60}\right)^2 \times 27{,}550 \times 7{\cdot}24^2$$

$$= \frac{75{\cdot}34 \times 27\,550 \times 52{\cdot}4}{64{\cdot}4}$$

$$= 1{,}694{,}126 \text{ foot-pounds} = 756{\cdot}4 \text{ foot-tons.}$$

$G D^2$ is the German expression; the French generally use the letters $P D^2$ (kilog-metres^2). I have adopted the equivalent $W D^2$ for the English units, to avoid confusion.

Two useful rules for finding approximately the energy stored ($\frac{1}{2} M v^2$) in the rotating armature or field magnet of a machine are:

Stored energy in ft.-lbs. =

$$\frac{\text{Weight of armature in lbs.} \times \left(\text{Revs. per min.}\right)^2 \times \left(\text{Mean diameter in feet}\right)^2}{23{,}000}.$$

The above is approximately true for armatures whose diameter is large as compared with their radial depth. For armatures of large radial depth and for field magnets with heavy rims,

$$\text{Stored energy in ft.-lbs.} = \frac{A \times L \times (d^2 - d_1^2)}{60{,}000},$$

A being the average weight per cubic foot of material, L the length of armature or magnet parallel to shaft, and d the external diameter in feet; d_1 is the effective internal diameter in feet as determined from the drawings. One cubic foot of cast iron weighs 450lb., one cubic foot of wrought iron weighs 485lb., one cubic foot of cast steel weighs 500lb.

The average value for the stored energy in flywheels used for electric lighting purposes is three foot-tons per electrical horse-power, and four foot-tons for traction work. In the case of the three-cylinder compound Allis engine at the Glasgow tramways (4,000 i.h.p.), four foot-tons per electrical horse-power at normal speed (75 revolutions) has been allowed. The Borsig four-cylinder tandem of 2,500 i.h.p. shown at Paris, 1900, has 3·6 foot-tons per electrical horse-power, the speed being 90 revolutions.

If F = the permissible fluctuation of energy above and below the normal (in foot-pounds), R the radius of gyration, and f = the fluctuation of speed above and below the normal, expressed as a percentage of the normal speed, then

$$F = \frac{W R^2 n^2 f}{587{,}500}, \text{ and } W = \frac{293{,}750\ F}{R^2 n^2 f},$$

W being the weight of the rim in pounds.

The permissible *speed variation in one revolution*, or the "*cyclic irregularity*," is dependent on the frequency employed; for a given speed, the higher the frequency the better must the engine be as regards uniform turning moment. Electrical considerations demand that at any load the phase displacement shall not exceed a given value; for instance, with rotary converters two electrical degrees—*i.e.*, the maximum angular displacement of a given point on the rotating part of the alternator either ahead (+) or behind (−) that position which it would occupy if running at a uniform speed, shall not exceed

$$\frac{2\text{deg.}}{\text{Number of pairs of poles}},$$

in other words, two electrical degrees.

Take, for example, a 50-cycle alternator running at 250 r.p.m., the number of pole pairs would be 12, and the maximum "cyclic irregularity"

$$= \frac{2\text{deg.}}{\text{Number of pairs of poles}} = \frac{2}{12} = \tfrac{1}{6}\text{deg.}$$

In other words, in order to ensure that the electrical displacement shall not exceed + or − 2deg., a point on the rotating magnet system of this generator must not vary + or − more than 0·16 of a degree from the point corresponding to absolute uniform rotation. The total "cyclic irregularity" or angular variation would be from minus 0·16 to plus 0·16—*i.e.*, 0·32deg. Suppose, now, the frequency be reduced to 25 cycles—*i.e.*, a 12-pole machine (six pairs of poles)—the cyclic irregularity would now be $\frac{2}{6} = \frac{1}{3}$deg., and the total angular variations from −0·33 to +·33 = 0·66deg. Hence the 50-cycle machine would obviously require a much larger flywheel effect as compared with the 25-cycle machine if coupled to the same class of engine.

From this it will be evident that with a given engine speed, the lower the frequency the better the parallel running, because a low frequency means a smaller number of poles, so that any speed variation per revolution causes a smaller phase displacement between the E.M.F. waves of the various alternators in parallel. Similar considerations

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point to the advisability of using high-speed engines for alternator driving. Steam-engine builders usually state the speed variation in one revolution—*i.e.*, the total variation above and below the mean speed—1 in 250 to 300 being a usual figure for two-crank slow-speed engines, this being equal to a total (– to +) angular variation of $\frac{360 \times 1}{250} = 1{\cdot}44$deg. For gas-engines the coefficient of cyclic irregularities should not exceed 1 in 300.

When two alternators are running in parallel, one may be ahead and the other behind by the maximum "cyclic irregularity" so that the two E.M.F. waves will differ by twice this amount, as regards being out of phase. The synchronising current flowing between the two machines will be proportional to the sine of this total angle of phase displacement; assuming each machine leads and lags 2deg. respectively, the synchronising current will be proportional to the sine of 4deg. With well-designed engines and alternators the synchronising current flowing alternately from one alternator to the other should not exceed 5 per cent. of the full-load current of one generator.

Theoretically, the alternator armature impedance should be small and the ohmic resistance equal to the reactance, in order that the synchronising tendency shall be as large as possible. Practical considerations, however, do not allow of this condition being complied with; modern alternators have an armature reactance from 16 to 20 times their armature resistance, the synchronising effort under these conditions being found to be sufficient in practice. While Continental practice allows a pressure drop for the alternators of from 16 to 20 per cent., it is unfortunately too common for English engineers to demand pressure drops as small as 10 per cent. Alternators having such small pressure drops are almost certain to give trouble as regards parallel running, and, as a matter of fact, serious trouble has been experienced in certain tramway generating stations using alternators with low-pressure drops owing to paralleling difficulties.

When two or more alternators are running in parallel, there is always a tendency for oscillations in the relative motions of the generators to take place, to the detriment of the good parallel running of the machines. This oscillation or swinging phenomenon is very likely to take place if there is a considerable cyclic irregularity in the engine turning moment, and especially if this has a time period nearly equal to the natural period of the alternator swing. The time taken for one of the alternators to make a complete swing is given by the equation

$$P\,t = 2\sqrt{\frac{I}{T}}$$

where $P\,t$ = the time of one complete swing in seconds; I = the moment of inertia of the alternator's moving parts (one machine); and T = the restoring torque in pound-feet per radian of displacement. The synchronising power is proportional to the sine of the angle of displacement.

In order that the parallel running of the plant may be satisfactory, $P\,t$ must be greater than the time of one revolution. In the case of an existing defective plant weight must be added to the flywheels so as to increase the value of I, thus, of course, increasing $P\,t$. Two alternators running in parallel can be compared to two pendulums (friction being neglected) whose bobs are coupled together by a spiral spring. If these pendulums are displaced from the vertical, the one to the left and the other to the right, the stretched spring will tend to pull the two bobs together (thus acting as a synchronising current) again. When, however, they do get to their original position, they will have acquired so much kinetic energy that they will overstep the mid position—*i.e.*, vertical—and rush on until they are again inclined to the vertical, only in the opposite sense. This swinging to and fro will continue until the energy has been spent in stretching the spring and overcoming friction. Such oscillations (assuming well-designed engines) are generally due almost entirely to the governors. The governors should be separately adjusted, so that not only is the no-load speed of all the sets the same, but the percentage drop in speed for small changes of load must be identical for the various engines. The drop in speed from no load to full load should be about 5 per cent.—*i.e.*, the governing should not be too close or the load will not be properly distributed. If the drop in speed is very small, say 1 per cent., the governors will be so sensitive that they will respond to small unavoidable momentary speed variations, tending to cut off steam as the speed rises, and to make the cut-off later as the speed falls. Hence there will be an oscillation of the governor system. If the periodic time of the governor oscillation is less than or equal to that of the generators, the governors will successfully follow the oscillations of the plant, and the steam distribution will be such as to damp out the swinging and keep the generators in parallel. If, however, the periodic time of the plant is smaller than that of the governor, it will be unable to follow the generator oscillations, and will lag behind by as much as half a period. Under these conditions steam will be admitted when it should be cut off and *vice versâ*; hence the oscillations are not only kept going, but are actually increased by the lag of the governors so that the generators become unstable and any rotaries on the circuit are liable to "hunt" badly. The remedy is to fit oil dash-pots to the governors, so that, while they will take care of any permanent speed variation, they are prevented from responding to slight quick changes in speed. Air dash-pots are very little use in this respect. The desired "cyclic irregularity" should be obtained by careful engine design and suitable dashpot governors rather than by the use of excessive flywheel effects. In future there is no doubt that the use of damping coils, amortisseurs, and equalising transformers will be much more general than at present; on the other hand, to scotch up good (but too sensitive) governors, as is done in more than one English alternating-current station, is simply to throw away one of the most useful aids to good parallel running of the plant.

DETERMINATION OF THE SPECIFIC ELECTRICAL RESISTANCE OF COAL, ORE, ETC.

BY G. C. WOOD, B.SC.

The following is an abstract of the above interesting paper, which was read recently before the Institution of Mining Engineers at Newcastle-on-Tyne. The paper was introduced by a preface by Prof. H. Stroud, M.A., D.Sc., which reads as follows:

Last summer it appeared to the council of the institute that it was very desirable to have an accurate knowledge of the electrical resistance of coal as well as of the rocks above and below any given seam of coal. No data being available, Mr. G. C. Wood, Durham County Council Scholar of the Armstrong College, was asked to undertake an investigation of the specific electrical resistance of coal, ores, etc., and suitable examples were obtained for experiment. The experiments have been carefully carried out by Mr. Wood, and the results obtained are of considerable practical interest. The specific electrical resistance of coal for the cases examined is, in comparison with the layers above and below the coal, exceedingly high; in fact, so high that coal may be regarded as a very fair insulator. This fact, among others, is one worthy of note in connection with electrical work underground. When the coal is damp the conductivity is practically wholly due to the water present. Mr. Wood has recently been determining the specific resistance of a carboniferous limestone from the Barton quarries, near Darlington. This limestone has been found very suitable for use as ballast on electric railways employing a live rail. The substitution of this limestone for the coke-breeze at first used on the electric lines of the North Eastern Railway Company, has, the writer understands, practically prevented any danger to persons coming into accidental contact with the live rail, provided that there is not a simultaneous contact with the earthed running rail. There is also included a test of the specific resistance of a block of cement-concrete, composed of 2½ parts of crushed brick to one of Portland cement: the crushed brick comprising equal parts of fire-brick (waste from coke ovens) and common brick (waste).

Introduction.—The samples of coal, ore, etc., used in this investigation may be grouped as follows: (1) Coal, and the rocks lying immediately above and below; (2) ironstone, and the rocks lying immediately above and below; and

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(3) lead-ore and the adjacent rocks. In order to obtain the electrical resistance of the coal, ores, etc, the specimens were worked into shapes with parallel faces. A paste of black-lead and water was spread evenly on the faces and dried. A copper plate was cleaned, on this was laid a sheet of tin foil, and on this again was placed the sample with one of its blackened faces on the foil. On the top of the specimen was placed another sheet of tin foil, and then another copper plate. Thus contact could be established at the two copper plates, and such a weight was laid on the top as experiment showed would make good contact. The method employed in the measurement of the samples was one or other of the following: (*a*) Wheatstone bridge; (*b*) high-resistance substitution; and (*c*) the high-resistance leakage. The specimens of coal examined were supplied from the Cowpen, Harton, and Murton collieries. The iron-stone was supplied from Skelton Park mines. The lead-ore examined was supplied from the Greenside mines, near Penrith.

The author describes in detail the experiments made on six kinds of coal as obtained from the three collieries mentioned in the Newcastle district. The actual figures will be found in the table which appears below. In order to show the method of procedure we give the following details of the experiments made on the Cowpen Colliery coal. The specific resistance (1) of the black shale roof was determined by the (*b*) method with a piece with an area of 130·4 square centimetres and a thickness of 1·2 cm., and was 4,090 ohms, and the specific resistance was 444,800 ohms per cubic centimetre. The resistance of another piece with an area of 29·8 square centimetres and a thickness of 1·12 cm., was 16,800 ohms, and the specific resistance was 446,400 ohms per cubic centimetre. The mean specific resistance was 445,600 ohms per cubic centimetre.

2. *Coal*.—The sample of gas coal supplied from this colliery was of such a shape and so easily worked that one piece was obtained of fairly large cross-section. The resistance (method *c*) of a piece with an area of 96·3 square centimetres and a thickness of 3 cm., was 1,120 megohms, and the specific resistance was 36,000 megohms per cubic centimetre.

3. *Grey Sandstone Thill*.—The resistance (method *b*) of a piece with an area of 30·2 square centimetres and a thickness of 2·8 cm. was 1,900 ohms, and the specific resistance was 20,500 ohms per cubic centimetre. The resistance of another piece with an area of 18·4 square centimetres and a thickness of 1·2 cm. was 1,310 ohms, and the specific resistance was 20,100 ohms per cubic centimetre. The mean specific resistance was 20,300 ohms per cubic centimetre.

The experiments on the ironstone and its surrounding strata were carried out in the same way, and the experiments on the lead ore were likewise similar. In this case, however, smaller samples were used. The results obtained with direct current and small voltages were confirmed by other experiments, using variable current in a Wheatstone bridge method. In this case a telephone took the place of the galvanometer, and a microphone was inserted in the battery circuit. Other experiments with voltages of 100, 200, and 220 volts were used for determination of the resistance of the samples which were connected in series with the voltage and with a tangent galvanometer. For all the specimens that could be measured this way it was found that there was practically no difference from their resistances as abtained above. The samples of coal had too high a resistance to be determined by this method. From an examination of the results of the tests, as given in Table I., it will be seen that lead ore is the only ore which, by practical tests based on differences in electrical resistance of large masses, could, with certainty, be distinguished from its surrounding rocks. It may also be noticed that coal, and especially hard steam coal, has a comparatively high electrical resistance. This important result should be borne in mind in connection with practical work. The following values in megohms per cubic centimetre indicate the magnitude of the specific resistance of coal and other well-known bodies: Gutta-percha, 400,000,000; arc-light carbon, 0·000,000,004; and coal, say, 40,000. Coal has, consequently, 10 million million times greater resistance than arc-light carbon, and 10 thousand times less resistance than guttapercha of the same dimensions.

The author had previously experimented with the carboniferous limestone used as ballast on the North-Eastern Railway, and found a specific resistance of 1,014,000 ohms per cubic centimetre. A piece of cement concrete flooring was found to have a specific resistance of 754,000 ohms per cubic centimetre.

TABLE I.—Specific resistances of Minerals found in Mines.

Name of mine.	Description of mineral.	Specific resistances per cubic centimetre (ohms).
Cowpen	Roof: black shale	445,600
Ditto	Gas coal	36,000,000,000
Ditto	Thill: grey sandstone	20,300
Harton	Roof: black shale	357,500
Ditto	Steam coal: top panel	80,100,000,000
Ditto	Ditto bottom panel	*
Ditto	Gas coal	33,000,000,000
Ditto	Coarse coal	3,395,000,000
Ditto	Thill: bluish-grey posty shale	105 900
Murton	Roof: soft blue shale	432,900
Ditto	Coal	33,900,000,600
Ditto	Thill: blue shale	13 000
Skelton Park	Roof: dogger rock	52,100
Ditto	Ironstone	157 000
Ditto	Thill: bottom rock	52,050
Greenside	Lead ore	7½
Ditto	Old red sandstone	8,375 000
Ditto	Mountain limestone	2,900,000

* This value is omitted from the table, as the specimen contained iron pyrites.

OBITUARY.

We regret to announce the death at Westcliffe-on-Sea of Mr. E. W. Langdon, who was for many years chief of the Midland Railway electrical department at Derby. Mr. Langdon, who was 73 years of age, was educated at the Royal Naval School, New Cross, and afterwards joined the staff of the Electrical and International Telegraph Company, and served at Winchester, Portsmouth, and Southampton. When the telegraphs were transferred to the State, Mr. Langdon became head of the electrical department of the London and South-Western Railway, but in 1878 he became head of the Midland Railway department at Derby, which office he held until about a year ago. Although his chief work in connection with the Midland Railway had to do with telegraphy and signalling, Mr. Langdon took from the first a very great interest in electric lighting. The plants laid down by him for lighting the principal stations on the railway were remarkable for their completeness. The results obtained from working these stations were placed at the disposal of the whole profession, and formed an interesting guide as to what could be done with isolated plant in the way of cheap production. Mr. Langdon also took a great interest in the electric lighting of trains, and was responsible for the introduction of one or two systems for the Midland Railway Company. In connection with the Institution of Electrical Engineers, Mr. Langdon displayed his versatility and interests. He held at various times nearly every office possible, and was in the early days the secretary of the Institution for some years. He occupied the presidential chair in 1901-2. It was, however, in his contributions to the *Transactions* of the Institution that he showed the wide range of his engineering knowledge. Papers will be found from him on practically every subject connected with electrical engineering. His views on the electrification of main line railways, as set forth in the papers read a few years back, led to most interesting and valuable discussions. His death will be much regretted by all who had the privilege of knowing him.

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SOMETHING OF A SCANDAL.

Statisticians love figures, but the figures they present to us are often of little use. Could not some of these dry-as-dust gentlemen obtain information of a definite character as to the cost of parliamentary operations? It has been estimated by men who have the best opportunity for knowing the ins and outs of the whole question that the abortive proceedings in regard to the Power Bill brought before Parliament this session has cost supporters and opponents together something approaching one hundred and fifty thousand pounds. One hundred and fifty thousand pounds is a tidy sum, and would be enough to equip a fair-sized installation. Indeed, the possession of such a sum would make many a reader give up work and take to pleasure, thinking himself one of the favoured men of the earth. When we come to inquire what really is the outcome of this huge expenditure, it is hard to say with any degree of accuracy. A good deal of advertisement, a good deal of preliminary work will not have to be done again, but otherwise the money is lost, and the result is nil. There is no question as to agreement with the promoters of this particular Bill. That is not the question, which is of far wider import, and may be stated—as to whether, under all circumstances, the existing costly methods of procedure to get an opposed—nay, even an unopposed—measure through Parliament are not something of a scandal. This is no new topic for discussion. In the abstract everybody admits that reformation is needed, but concretely everybody who has any power in the matter is against reform. It can hardly be expected that agents, lawyers, or experts, who largely divide the money among them, should be eager to change a system which brings so much grist to the mill. These men naturally have no great incentive to press a change, and, therefore, it is difficult to see how any reform can be brought about. One of the causes leading to the existing state of things is in the number of authorities that have a voice in the question. Each authority, of course, has its say in opposition, and here is where so much money goes. Again, the number of authorities bring about difficulties of reform. A tramway scheme interferes with quite a number of authorities, and it is but reasonable that those who are to be interfered with should be heard on the matter. On this point if reform is to come about it will be by superseding a number of authorities by a central authority, as suggested by the late Commission on London Traffic. The London County Council is the central authority for the sewerage of the metropolitan area; if similarly a central authority was answerable for the construction and the maintenance of roads and streets, that would be the one authority to be heard about a scheme—tramway or otherwise — likely to interfere with the streets, and by a simplification of this kind a large part of the parliamentary costs would be avoided. It is, perhaps, not generally understood that the costs of the opposing authorities, as in the case of the Power Bill, have to be borne by the rates of the districts; and the summation of the various amounts paid by authorities over the London area alone in opposition to a variety of schemes is a huge total, so that the question must not be looked at solely from the side of the promoters. In the case of a scheme ultimately decided to be a suitable one, and one forming a link in the chain of modern progress, these preliminary expenses form an item in future balance-sheets that may seriously handicap the undertaking. Scores of good schemes are wrecked by inflated capital, and anything that can be suggested by way of reform to minimise these expenses should be welcomed. Is it possible to suggest a practical solution

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for the abolition of such a costly scandal? At least one point of reform can be urged—that any Bill passing and not getting further than the Committee stage should be automatically continued from that stage during the next Session, and the whole process not have to be commenced anew.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONE PURCHASE.

SIR,—The late vote in the House of Commons possibly settles the telephone policy of the country definitely, but in view of the active part I have taken in the telephone question in the past a few remarks from me may be permissible. Although the municipalities are to be excluded in the future from participation in telephone enterprise, yet it will not, I think, be seriously contested by any unbiassed person who has given attention to the subject that such progress as has been made, either in the direction of efficiency of service or reductions of rentals, must be credited to the municipalities. When they entered the field the telephone service of the country, whether conducted by the Post Office or the National Telephone Company, was in a deplorable state of inefficiency, and the rates all round were high, such competing companies as had endeavoured to improve matters in this respect having been nobbled by the overpowering monopoly. Even the existing Post Office exchange in London is the outcome of municipal action, for it was established by the Post Office only as a last resort to prevent the London County Council and the City Corporation from undertaking the task themselves. As soon as the establishment of a municipal exchange in Glasgow became an assured fact the National Telephone Company introduced toll rates and party-line rates all over the kingdom, hoping thereby to soothe the prevailing discontent, and, by yielding a good part of what the voice popular demanded, to diminish the tendency towards competition. By this move they qualified to some extent their former prohibitive flat-rate charges, which excluded small users from participating in the benefits of the telephone. These lower charges and the consequent spread of telephones are boons which the whole country owes to the few courageous municipalities which decided to defy the Jabberwock. At the same time the company made gigantic efforts to improve its service, most markedly in Glasgow and in other towns where competition was either assured or threatened, and for the first time in its history began to condescend to take some note of the wishes of its subscribers. Had it not been for the municipal action the prohibitive flat rate, without toll rates and without party line rates, would certainly have been insisted upon for years yet to come. Much has been made of the fact that but few of the municipalities took advantage of the Act of 1899. But it must not be forgotten that several of the provisions of that Act bore heavily against the corporations, for by it they, as competitors, were saddled with terminal fees, compelled to continue wayleaves in perpetuity, and forced to consent to an extension of the company's existence for a period equal to their own license. These disabilities were serious enough to render municipalities cautious, and on the top of them came the campaign inaugurated by the company at the very birth of the very first municipal exchange, in which was employed every means, fair and unfair, to ridicule, disparage, and misrepresent the municipal undertakings. The people of Tunbridge Wells were engineered into a panic and foolishly sold their infant exchange when success had been already assured. This extraordinary event naturally had the effect of keeping other municipalities back, but it could not succeed perpetually. When the various Corporation undertakings were quite new and could only publish accounts covering a broken year, or a first complete year, these tactics were successful, but when several years had elapsed, and the municipal undertakings, instead of collapsing as predicted, continued to progress and to show favourable financial results, it became necessary for the company to adopt some other means, for if the municipalities were given further rope, it was known that they would demonstrate, without any question whatever, that low telephone rates were compatible, not only with efficiency, but with every financial requirement; and that the result which was staved off in the first instance by misrepresentations, was bound, sooner or later, to emerge—that is, that the Corporations generally would take up the telephone just as they did the electric light after several years' inaction, owing to dubiety as to whether electric light undertakings could be made to pay. In such an event the company could not have survived, as everything has shown that it is not able to compete successfully with the municipalities. To maintain its position or increase the number of its subscribers in the competing areas the company has had to give preferences and to charge only a few shillings a year, and frequently nothing at all for its telephones, with the result that it is working at a loss wherever it has to compete with a municipality. Under these circumstances the policy was changed and the company threw up the sponge. Knowing it could not compete, it decided to sell its undertaking to the Post Office, and has, unfortunately for the country, succeeded. Rightly read, the sale is an admission of defeat and a resort to a forlorn hope, for by no other means could the dreaded municipal competition be averted. The company has run away and sheltered behind the Post Office. Some day, probably, these facts will be recognised, and then the debt which the country owes to the few courageous Corporations will be estimated at its proper value. By the sale which has been approved by Parliament monopoly has been re-established, and with it the country will have to suffer all the usual consequences, including inefficiency and high rates. Already, in order to make the company's plant admissible for purchase, a much lower standard of efficiency than has prevailed with the Corporations has been set up by means of a specification permitting of cheap and nasty work. The inefficient system which the Post Office have set up in London will probably be extended all over the country; invention will be discouraged and progress disowned. Once the Post Office has spent its money in putting in apparatus, whether it is good or bad, nothing will be put out of use, because the Post Office will never scrap old apparatus if it can help it. One of its most cherished prejudices against the telephone in the early days was that its extension would cause the scrapping of the many thousands of A.B.C. telegraph instruments of which the Post Office was then possessed.

The municipalities before the Select Committee made a gallant effort to prevent the country from falling into these various errors, and succeeded so far that the committee, appointed by the Government itself and consisting chiefly of Conservative members, were convinced, and recommended that the beneficent municipal control should continue and be extended. It is remarkable that two separate committees, investigating at an interval of seven years, agreed practically on the course they considered the best to adopt. But the Government set aside its own Select Committee when it found that it did not report in accordance with its wishes, and by a party vote following on a feeble discussion in a half empty House, before the evidence presented to the Select Committee had been circulated, committed the country to an expenditure unknown in amount and to a perpetual monopoly.

The inconsequence of the debate may be exemplified by the fact that when the Postmaster-General said that the company had definitely decided not to accept the agreement if new municipal licences were granted, no member reminded him that by Clause 14 of the agreement the Post Office had specially reserved the right to grant such licences, and that consequently the refusal of the company really meant a demand for the suppression of a part of the agreement—viz, Clause 14—which it had already signed.

There are grounds for thinking that the six local authorities owning telephones have reason to fear that it is not the intention of the Government to treat them fairly, but that, in return for the loyal assistance they rendered in aid of the Government's declared telephone policy of 1898, they are to be treated shabbily, and, if possible, caused to lose at least a portion of the capital they have invested on

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the faith of Government pledges and guarantees.—Yours, etc.,
A. R BENNETT.

Westminster, S.W., Aug. 15, 1905.

THE FIFE ELECTRIC POWER COMPANY, LIMITED.

On Tuesday last the first generating station for the general supply of electricity under the Fife Power Company's Act of Parliament, 1903, was opened. This pioneering station is situated near Dunfermline, in the centre of a large weaving industry. It is also in the coal-producing area, which extends over a large portion of the power company's district. Hence cheap coal is available, and this is delivered by rail to the present station.

A somewhat unusual course was adopted by holding the annual general meeting of the company in the generating station, immediately preceding the opening ceremony—several visitors from neighbouring factories, collieries, and works of all kinds being present. As soon as the formal business was disposed of, the chairman, Mr. R. E Walker (of the firm of R. E. Walker, Reid, and Co., Dunfermline), made a speech explaining the present position of the company and its prospects for the future. He then started the two main engines and the two exciter engines, thus practically putting the whole of the machinery of the generating station into operation, and proving to the complete satisfaction of the company present that the plant was really completed and in perfect order, and ready for commencing the supply of power to the district.

The CHAIRMAN in his speech referred to the fact that the coal industry was, at present, somewhat depressed, but expressed the opinion that it would, no doubt, soon revive, and that cheap power would greatly assist this desirable end. He pointed out that the development of a power company was bound to be a slow process, as even after orders from consumers were booked, the delay which occurred in the consumers themselves settling their contracts for the necessary motors for their own premises, and in the work of erection, frequently extended over many months. He alluded to the prospect of supplying power to tramways, which another company will probably be shortly constructing in and around Dunfermline. He also mentioned that negotiations for supply in bulk to the Dunfermline Corporation were proceeding. While he could not say more at present, he would venture the opinion that the extremely generous offer which his company had made to the town was such that it would be difficult for the town to go past the company and erect their own works.

The chairman afterwards called upon Mr. W. A. CHAMEN (previously electrical engineer to Glasgow Corporation, and now representing Messrs. Bramwell and Harris, the consulting engineers) to explain some of the points regarding the machinery, which he did, pointing out at the same time some further possibilities which lay before the power companies, by means of which the whole face of the country might be transformed, both from a residential and industrial point of view. He referred to the fact that the contract for the equipment of the generating station had been carried out by Messrs. Bruce, Peebles, and Co., Limited, of Edinburgh.

Mr. T. O. CALLENDER, at the request of the chairman, next spoke in the capacity of contractor for the mains, which have already been laid from the generating station into Dunfermline. He spoke of the extremely promising prospects which lay before the Fife Company, and in the course of his remarks referred to the fact that Mr. Miller, the convener of the Wishaw Electricity Committee, and Mr. Cox, the engineer, were present, and that they represented the first town in Scotland to make an agreement with a power company—viz., the Clyde Valley Electrical Power Company—for supply in bulk.

These two gentlemen afterwards spoke, giving information respecting the arrangements referred to by Mr. Callender, and expressing their satisfaction therewith. They both considered that for small towns to put down their own generating stations was an extremely unwise and expensive plan to adopt, when supply at cheap prices from a large power company could be had for the asking.

The generating station, which is only a pioneer one containing 1,000 h.p. of generating plant, we hope to describe fully in a later issue. Meantime, we may say that it is very neat and compact, and is equipped in a way which will enable a supply of power to be given on economical and business lines.

MACHINES AND SWITCHBOARD FOR A LABORATORY.

BY E. SMITH, B.SC., A.R.C.SC.

The experiences met with in providing apparatus for a course designed to extend beyond the ordinary grade of the City and Guilds are responsible for the following notes on suitable machines, switchboard, and apparatus. The set given will be found to be very complete for elucidating all the necessary technical points. It is really suitable for a class of about 12 students where the lecturer is without assistance. Six students would work on the machines one evening and take ordinary laboratory work the following week. This set would also be useful as a demonstration group to bigger classes in a larger laboratory. Objections might be made against the continued use of the same machines, but there is a great advantage in learning the principles of the subject, step by step, on well-known machines. The point at issue is not forgotten amongst the difficulties of connecting up to strange apparatus. The ordinary student meets with many different types in his daily work, and very probably deceives himself by his superficial knowledge. It is almost unnecessary to state that the student should be given all possible data about the machines at the start, and that working drawings should be provided with every machine. There should be an ammeter and voltmeter available for every circuit. Ammeters are now both good and cheap, and there should be no economy practised on them.

Machines.—The machines suitable for a direct-current supply are three in number. One 2-b.h.p. four-pole converter, shunt-wound, 1,500 r.p.m.—therefore, ~ 50. The field winding should be provided with a rheostat whose resistance is half that of the field coils. Six slip-rings, giving single, three, or four phase. One 1-b.h.p four-pole converter, shunt-wound; field rheostat to have a resistance four times that of the shunt coils; 1,500 r p.m., with all resistance cut out, ~ 50. Six slip-rings like the larger machine. Series windings also should be provided; the ampere-turns at full load approximately equal to those of the shunt coils. It would be an advantage to have the series coils arranged in pairs, which could be placed either in series or in parallel. The axle should carry a contact disc at its commutator end. Each machine is to have a broad pulley, the two pulleys to be facing so as to be coupled together by a semi-flexible connection. If the voltage on the direct side be between 100 and 200, the supervision of the switchboard with young students can be less strict. One ·25-b.h.p. three-phase induction motor, with wound rotor and slip rings and a generously designed three-way rheostat for the rotor. The flexibility of a three-phase motor for teaching purposes is quite remarkable. This motor should also be provided with a pulley, and so placed that it can be driven from one of the other machines by a belt. The above machines form a complete and compact set, and can be obtained at a reasonable price, as they have no peculiarity of design. A combined and convertible series-repulsion motor, 1 b.h.p., at a reasonable price, would be a boon for teaching purposes. With the other direct-current and alternate current type of motors at present available this, however, is not to be expected.

The Switchboard.—The switchboard, of which a somewhat detailed diagram is given, practically explains itself. All the connections can be traced to the machines, and those for the experiments are all to be made on the front of the board. The motor connections, which are quasi-permanent, can be taken through holes and along the back of the board. The machine terminals to be used are either marked in large letters or figures. The six alternating-current terminals bear figures; 1, 2, and 3, being the three-phase terminals, and 3, 4 and 5, 6, being the single-phase terminals, 90deg. phase apart. S S represent the series

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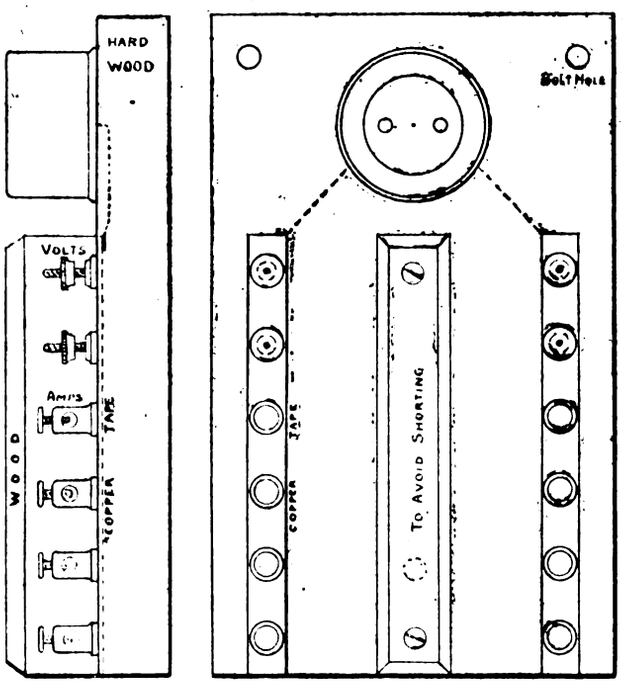
turns which can be reversed by the plug and socket arrangement whilst the turns are short-circuited. It has been found extremely useful with beginners to place between any pair of live terminals an upright length of wood, a little higher than the terminals, to prevent accidental short-circuiting. The machine terminals should be on slate or marble, and of the ordinary screw and hole type. The field rheostats should be designed to carry currents continuously. Above the machine panels come two long slabs of slate or marble bearing special connection boards. These do entirely away with careless connections, and allow for any number of connections to one point. The boards may be of any hard wood, and could be soaked in paraffin wax if necessary. They are bolted through on to the slate. One board has been drawn large to show the details. At the top of each is a socket to receive any voltmeter plug. On each piece of copper tape are two-volt connections, which ought to be soldered or fastened to it by a set screw. The current terminals are of the screw and hole type, and furnished with wood screws. A lead washer can be introduced between the base of the terminal and the copper tape to make complete contact.



Connection Board.

The machines should be placed about 3ft. in front of the switchboard, and the latter should stand free from any wall. The cables (all labelled) from the machines should be led into a groove along the floor and taken up in a single-layer group to the middle of the lower part of the board, and then distributed. The resistances for the loads on the transformers could then stand at the sides below and behind the switchboard. The supports to the board have not been indicated. The middle panel bears one of the main supply terminal pairs and also the terminals of the wires which supply the laboratory. This enables alternating or direct currents to be supplied to any bench in the room. A series circuit round a room is invaluable for class work. For example, when a potentiometer experiment is taken with elementary students, if each switch be shunted by one or two secondary cells in series, a fairly constant voltage can be obtained by each worker. Besides, galvanometer and electrolytical experiments can be done with a certainty that is refreshing to a beginner who has just gone through a course in frictional electricity. The voltmeters and ammeters can be mounted on a wooden panel. Each voltmeter is provided with a twin flexible and plug. The low-reading ammeters are provided with cut-out switches, so that they may be placed in series with higher range instruments and cut out when overloaded. The fuses at the side of the connection boards may be used for subsidiary circuits.

The top of the switchboard forms a shelf, on which extra instruments may be placed if necessary. The hinged shelf at the bottom of the board will be found useful for portable wattmeters, etc. If the board be connected to a town supply it is well to have a small red incandescent lamp to indicate when the top main switch is on.

Instruments.—These should all be numbered and the types should be representative. It would be a great advantage if teaching instruments were provided with transparent fronts. Ammeters with more than one range are to be avoided. One ammeter can only be in one circuit for any one experiment. Voltmeters with more than one range are rather useful, as they can be placed in any circuit at any time. Electrostatic voltmeters to cover the whole likely range are a necessity. The writer fixed a pointer to an ordinary quadrant electrometer for direct voltages up to 40, the reading at which an ordinary electrostatic voltmeter begins, the needle being electrified from the supply voltage. The small alternating voltages had to be read from the mirror indications.

Secondary cells in a small laboratory which is closed for several weeks per year are very troublesome; for larger currents at low voltages, a motor generator yielding about 150 watts at 4 to 8 volts is far more preferable.

Cut Outs, etc.—The laboratory should be provided with a number of connection boards similar to those on the switchboard. The cut-outs, plugs, etc., should be of commercial type, and of a generous size; certainly not home-made. A number of separate fuse blocks should be available.

Cables.—The wires should be of two kinds—twin flexibles of high grade insulation for volt connections, the free ends being provided with contact plates, and one size of cable for current wire, say $^{7}/_{20}$ Temporary connections which are fully visible may have a fairly large current density. The ends of the insulation must be carefully bound in all cases. The ends of the $^{7}/_{20}$ should either be soldered solid or sweated into thimbles. When two cables are joined together they should not be twisted, but connected by proper screw connectors and the junctions wrapped round with tape.

Transformers and Choking Coils.—These are amongst the few things that can be advantageously made in the laboratory workshop. The different coils on the cores should be brought to terminals on the covering board so that various voltages may be obtained. Ordinary hoop iron twisted round into a hollow square does very well for a core. Paper or paraffined paper can be used between the layers. Suitable numbers for the coils are pairs of 50, 100, 100, 500. Thick copper wire and plenty of iron should be used. The coils may be put in parallel for heavy currents.

Resistances.—Lamp resistances fitted with ordinary single-pole switches should be used. They are reliable and constant. Liquid resistances are exceedingly useful where the current must be altered gradually. Coiled iron resistances are cheap, but they give too much trouble with their large variations due to temperature. It is much better to use wire with a negligible coefficient. All resistance frames should be fitted with single-pole switches for cutting out the coils step by step.

WIRELESS TELEGRAPHY MEASUREMENTS.*

BY W. DUDDELL, MEMBER, AND J. E. TAYLOR, ASSOCIATE MEMBER.

(*Continued from page 197.*)

Height of Receiving Air Wire Varied.—The transmitting conditions were kept constant and the height of the receiving air wire was varied by using vertical wires of different lengths. The receiving circuit was retuned to suit each height of vertical wire by altering the self-induction in series with it. Observations of the received current were made both with the air wire tuned as above and untuned—that is, with no self-induction in series with it. The results are given in Curve I. Taking the tuned results first and the receiver near the fishponds, where the screening of the receiver was comparatively small, the law connecting the height of the receiver air wire and the current in it is practically linear between 30ft. and 56ft.; below 30ft. the current increases less rapidly than the height. With the receiver in the paddock and the air wire suspended from a

* Paper read before the Institution of Electrical Engineers.

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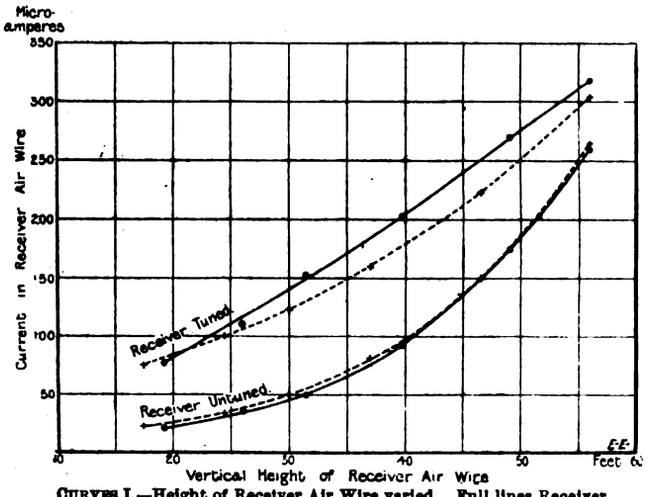
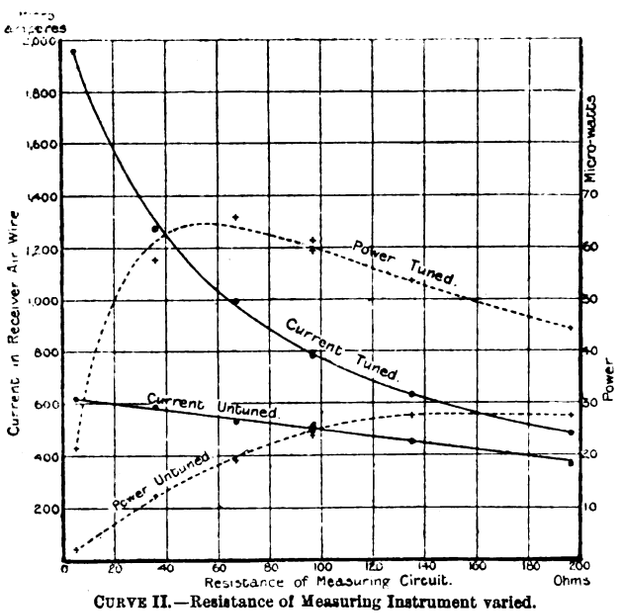
spar fixed to the top of a terminal pole so that the lower part of the air wire was screened by the stays and other conductors, the curve between height and current does not become linear even at the top. That there was considerable loss of energy when the receiver was in the paddock is shown by the fact that rather more current was observed when the receiver was near the fishponds and the transmitter at a distance of 2,110ft. than when the receiver was in the paddock and the transmitter 1,588ft. away; or, in other words, equally strong signals were received at one-third greater distance when the receiver was not in



CURVES I.—Height of Receiver Air Wire varied. Full lines Receiver near Fish Ponds. Dotted lines Receiver in Paddock.

the paddock. It will be observed that the curve of tuned received current in the more screened situation (the paddock) more nearly approaches the shape of the untuned current curves, owing, probably, to the damping losses in the wires, stays, etc., on the pole. This point is not without practical significance, inasmuch as it would indicate that to obtain the sharpest tuning the stay wire of wireless telegraphy masts should be well divided up into short insulated sections to avoid the production of oscillations in them which would cause damping in the receiver. Without the self-induction in the air wire,



CURVE II.—Resistance of Measuring Instrument varied.

increasing the height naturally increases the received current very rapidly, under the conditions of the experiment, as it not only increases the E.M.F. induced in the wire, but also improves the tuning, so that a larger current is obtained even for the same induced E.M.F. The tests were commenced in rainy weather, but nearly the whole of the results given were obtained in dry weather. No considerable effect on the strength of the received signals was noticed when it changed from wet to fine.

Resistance of Measuring Instrument Varied.—In order to investigate the effect that the resistance of the measuring instrument in series with the receiver air wire had on the

TABLE IV.—Resistance of Measuring Instrument Varied. Receiver near fishponds, distance 1,245ft. Height of receiver air wire, 56ft. Height of transmitter air wire, 42ft. Current in transmitter air wire, 0·486 ampere. Spark-gap, 7·08mm. Mercury interrupter. Wave No. 2 (400ft.).

Total resistance Ohms.	Tuned. Current. Micro-amps.	Tuned. C^2 R. Micro-watts.	Tuned. Calculated current. Micro-amps	Air wire only. Current. Micro-amps.	Air wire only. C^2 R. Micro-watts.	Air wire only. Calculated current. Micro-amps
5·55	1,958	21·3	1,950	616	2·11	616
35·9	1,269	57·9	1,306	583	12·2	581·5
66·6	995	65·9	979	537	19·2	541
97·0	795	61·3	784	507	24·9	500
97·0	784	59·6	784	498	24·1	500
135·1	628	53·3	628	454	27·8	451·5
196·2	475	44·3	476	372	27·2	383·5

value of the received current, a low resistance (5·55 ohms) heater was placed in the thermo-galvanometer and additional resistances were used in series with it so as to increase the resistance as required. Each of these resistances consisted of a single Λ-loop of (0·001in.) Kruppin wire, the total length of wire in the longest one, which had 99 ohms resistance, being only 7cm. Not more than three of these resistances were ever used in series with the instrument at one time, so that the self-induction and capacity effect of these resistances was probably small. The total resistance—that is, the resistance to steady currents—of the thermo-galvanometer and above series resistance is given in column 1 of Table IV., and the observed current in column 2. From the observed current and resistance the available power in the measuring circuit has been calculated as $C^2 R$. These values, both for the receiving circuit, tuned and untuned, are plotted in Curve II In the tuned condition, the available power reached a maximum when the receiving circuit had a resistance of about 60 ohms, so that it is evident that this would be the correct resistance to give to any receiver of the thermal type used directly in series with this air wire. The current decreases very rapidly with increase of resistance, and almost exactly according to the relation: Current (tuned) $= \frac{0{\cdot}12}{(56+r)}$, where r is the total resistance of the measuring circuit. With the receiver air wire only, the results may be expressed: Current (untuned) $= \frac{0\,12}{\sqrt{(185)^2+(56+r)^2}}$. The values of the current calculated from the above formulæ are given in Table IV. for comparison with the observed values. The agreement between them is very close. Taking the formula $\frac{0{\cdot}12}{\sqrt{(185)^2+(56+r)^2}}$ the first point to be noted is that it is of the same form as the equation giving the current in an ordinary alternating-current circuit, containing resistance, self-induction, and capacity in series. If in such a circuit the self-induction be adjusted so as to give a resonance $(L\,p - \frac{1}{F\,p} = 0)$ — *i.e.*, the circuit be tuned to the same period as the impressed E.M.F.—then the first term $(185)^2$ will vanish, and we get our "tuned" equation as we find by experiment. To get a good resonance or sharp tuning in such a circuit, it is also necessary that the term $(56+r)$ should be as small as possible. Therefore, to get the best tuning, r should be small, but to obtain the most energy to work the receiving instrument r should be about 56 ohms. If, however, the constant 56 can be reduced, both the sharpness of the tuning and the available power may be proportionately increased. It is, therefore, of great importance to inquire what causes the vertical receiving air wire to dissipate energy as if it had a resistance of 56 ohms. Part, at least, of this effect is no doubt due to radiation, but some part may be due to losses at the earth connection and to eddy-current losses in the oscillating system. It should be observed that when a dissipation factor of this magnitude is associated with the air-wire system it becomes important, if tuning is to be kept sharp in order to obtain the greatest "selectiveness" in wireless telegraphy, to attain the selectiveness by the use of associated resonant circuits in which the damping losses are made very much smaller. Returning to the

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TABLE V.—Distance between Transmitter and Receiver Varied. Receiver in paddock. Height of receiver air wire, 56ft. Height of transmitter air wire, 42ft. Current in transmitter air wire: mercury interrupter, 0·499 ampere; Grisson interrupter, 0·690 ampere. Spark gap, 4·55mm. Wave No. 3 (500ft.).

Distance between transmitter and receiver in feet.	Mercury interrupter. Tuned. Current in receiver air wire in micro-amperes.	Mercury interrupter. Tuned. Product, current × distance.	Mercury interrupter. Air wire only. Current in receiver air wire in micro-amperes.	Mercury interrupter. Air wire only. Product, current × distance.	Grisson interrupter. Tuned. Current in receiver air wire in micro-amperes.	Grisson interrupter. Tuned. Product, current × distance.	Grisson interrupter. Air wire only. Current in receiver air wire in micro-amperes.	Grisson interrupter. Air wire only. Product, current × distance.
428	1,466	0·628	489	0·2093	2,028	0 868	686	0·2935
825	668	0·551	225	0·1864	898	0 741	310	0·2567
1,588	305	0·485	101·5	0·1613	412	0·654	141	0·2240
2,614	169	0·442	58·6	0·153	238	0·623	77·6	0·2028
3,774	123 3	0 466	40	0·151	164	0·619	54	0 204
3,774	124·2	0·469	40·7	0·154	172	0·650	56 5	0 213
4,935	71	0·351	27	0·133	99·5	0·491	32	0 158
5,499	44	0·242	—	—	61·6	0·339	—	—
6,127	44·3	0·271	—	—	62·5	0·383	—	—
7,475	38·3	0·286	—	—	54	0·403	—	—

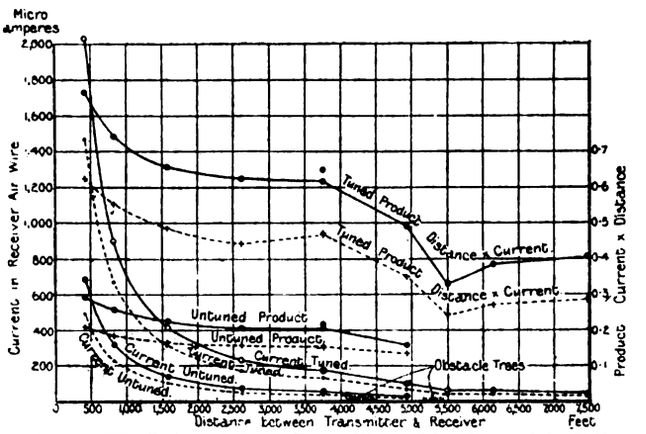
equation for the current, it is seen that the current flows as if an E.M.F. of 0·12 volt is induced in the air wire. Now this is a root mean square voltage, the mean not being taken over the time each set of oscillations continues, but over the time each set lasts, plus the time between it and the next set. It is improbable that the groups or sets of effective oscillations last much more than one three-thousandth of the time interval between them (taken on a basis of 50 effective cycles per train), so that the R.M.S. voltage induced during the oscillations cannot be much less than $0{\cdot}12 \times \sqrt{3{,}000} = 6{\cdot}6$ volts under the conditions of very strong signals used for these tests.

Voltage Produced at Coherer Terminals.—Though no precise measurements bearing on the point were made, it may be taken, in view of the manner in which the coherer receiver used at intervals during the experiments responded at the longer distances, that the E.M.F. of 6·6 volts given in the previous paragraph was about eight times stronger than necessary to get signals on that particular coherer. The critical R.M.S. E.M.F. during each train in the receiver antenna required to operate the coherer would, therefore, be about $\frac{6{\cdot}6}{8} = 0{\cdot}8$ volt. This was not the actual voltage applied to the coherer terminals, however, because the coherer was always connected in a secondary circuit tuned to resonance, in which it may be taken that the E.M.F. was magnified, perhaps, 10 times, giving 8·0 volts per train (R.M.S.). In this secondary resonant circuit a special form of construction has been adopted, and every precaution taken to reduce the damping to a minimum. To get an idea of the maximum voltage attained during a train of oscillations in this circuit, it is necessary to take into consideration the increment and decrement of the train. Allowing for this, it is thought safe to assume that an actual maximum E.M.F. of about four or five times the R.M.S. figure—viz., about 40 volts—should be available in the coherent resonant circuit to give good signals. As in practical work it would be necessary to provide a considerable margin above this figure, it is clear that the maximum voltages produced are not of a very small order.

Energy of Oscillations in Radiating System of Transmitter.—Seeing that it is necessary, in the case of the receiving oscillatory system, to assume a dissipating factor of 56 ohms, it is highly probable that a similar but somewhat larger dissipation factor is involved in the case of the transmitter radiating system. The radiation coefficient should be approximately the same in each case, the systems being similar, but there can be little doubt that dielectric losses and brush discharges due to the high tension at the transmitter would increase the dissipation to some extent. For the purpose of calculating the energy of the transmitter oscillations, the dissipation factor is, therefore, assumed at a venture to be 60 ohms, and the following figures are obtained for the different waves used in the experiments:

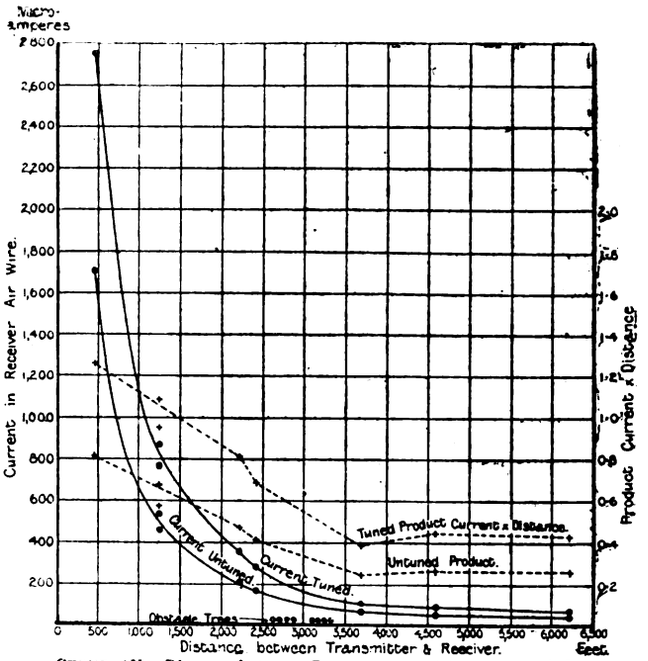
	R.M.S. current.	C²R watts.
Wave No. 1. Mercury interrupter	0 36	7·8
,, ,, 2. ,, ,,	0·486	14·2
,, ,, 3. ,, ,,	0·5	15·0

The greatest proportion of this energy picked up by the receiver was about one six-hundredth part at a distance of 100ft., and the smallest proportion somewhat less than one six-millionth part at a distance of 7,475ft. For the different waves the power used in the whole primary circuit of the transmitting apparatus varied between 100 and 200 watts roughly, so that only a small percentage of the applied energy was converted into useful oscillations in the radiating system.



CURVES III.—Distance between Transmitter and Receiver varied. Full lines Grisson Interrupter. Dotted lines Mercury Interrupter. Receiver in Paddock, Position A on Map.

Distance between Transmitter and Receiver Varied.—All the conditions at both the transmitting and receiving stations were kept as far as possible constant, and the distance between the two stations was altered by moving the transmitter. The successive positions of the transmitter are indicated on the map (Fig. 2). It was found impossible to get exactly the same current in the transmitter air wire at the different positions of the transmitter, keeping the spark-length fixed. With the mercury interrupter



CURVES IV.—Distance between Transmitter and Receiver varied. Receiver near Fish Ponds, Position B on Map.

the current varied ± 1 per cent. from the mean, and with the Grisson interrupter ± 1¾ per cent. in the first set of experiments (Table V. and Curve III.). In the second and third sets of experiments (Table VI. and Curves IV. and V.) the variations were much greater. Owing to the influence of screening and obstacles it is impossible to say what the law connecting received current with distance actually is, but a consideration of the curves obtained by forming the product of the received current multiplied by the distance and plotting this product

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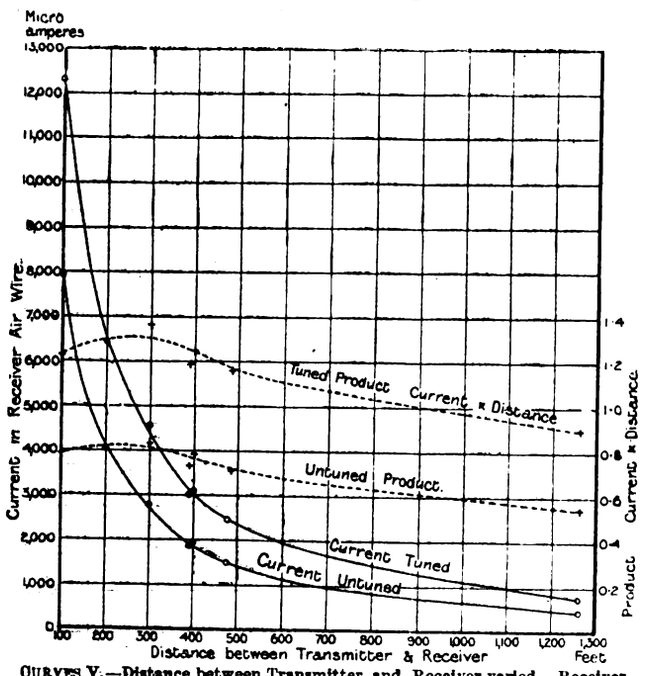
TABLE VI.—Distance between Transmitter and Receiver Varied. Receiver near fishponds. Height of receiver air wire, 55ft. Height of transmitter air wire, 42ft. Spark-gap, 7·08mm. Mercury interrupter. Wave No. 2 (400ft.).

Distance between transmitter and receiver. Feet.	Tuned. Current in transmitter air wire. Amperes.	Tuned. Current in receiver. Micro-amperes.	Tuned. Product, current × distance.	Air wire only. Current in receiver. Micro-amperes.	Air wire only. Product, current × distance.
100	0·501	12 320	1·232	7,910	0·791
200	0·507	6,435	1·287	4.043	0 809
300	0·558	4,548	1·364	2.786	0·836
391	0·531	3 013	1·189	1,881	0·736
400	0·541	3,108	1·243	1.969	0·788
476	0·508	2,442	1·162	1,498	0·714
1,260	0·541	715	0·901	433	0·546
457	0·507	2,755	1·259	1,707	0·811
1,245	0·508	766	0 954	460	0·573
1,245	0·508	872	1 085	536	0·668
2,238	0·539	358·5	0·803	210	0·470
2 238	0·550	360	0 806	211·5	0·474
2.420	0·506	283·5	0·686	168·5	0·408
3,700	0·517	105	0 388	66·5	0·246
4,600	0·558	96 5	0·444	57·5	0·265
6,220	0·563	69·5	0·432	42	0·261

against distance, indicates that in these tests the current has decreased in general rather more rapidly than inversely as the distance with increasing distances, though nowhere near so rapidly as inversely as the square of the distance.



CURVES V.—Distance between Transmitter and Receiver varied. Receiver near Fish Ponds, Position B on Map. Short Range Tests.

The effect of the obstacles, the trees, is very well shown in the product curves as well as the improvement in the conditions when the transmitter gets out in the open again from being directly behind an obstacle. The curves given clearly indicate that at close quarters the rate of decrease is much more rapid than at greater distances. Within the wave-length distance there is a very rapid decrease, which tapers off to a more uniform rate at about three wave-lengths in the case of the longest wave used in the experiments. For the shorter waves the results obtained were not so regular, but an approximately similar law holds.

(To be continued.)

PERSONAL.

Mr. W. Fennell has been appointed manager of the Wednesbury electricity undertaking at a salary of £180 per annum.

The President of the Board of Education has (temporarily) appointed Mr. S. Herbert Cox to the professorship of mining at the Royal School of Mines, South Kensington, vacant by the death of Sir Clement le Neve Foster. Mr. Cox was president of the Institution of Mining and Metallurgy in 1899-1900.

The Johannesburg Council has appointed Mr. J. A. McMullen station engineer.

The Yarmouth Town Council have increased the salary of Mr. F. L. Turner, tramways manager, from £180 to £230, and by annual increments of £10 to reach a maximum of £250.

We understand that Mr. W. A. Walker, chief assistant electrical engineer to the Kettering Urban District Council, has been appointed electrical engineer, in place of Mr. F. G. Bakewell, resigned.

Mr. D. P. Thomson has resigned his position as chief designer of the continuous-current section of the British Thomson-Houston Co., Rugby, in order to accept a post with the General Electric Co., of Schenectady, N.Y. Before leaving he was made the recipient of various presentations, including a complete set of Dickens's works and a cheque from the office staff, and a set of cutlery from the works offices.

DUDLEY ELECTRICITY ACCOUNTS.

The accounts of the Dudley Corporation electricity department for the year ended March 31, 1905, show a total expenditure on capital account of £77,562. Appended are abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	4,008	10	2
Distribution of electricity	216	12	6
Attending and repairs to public lamps	256	11	11
Rents, rates, and taxes	399	18	4
Management expenses, salaries, etc.	579	10	10
Special charges, insurances, etc.	76	3	0
	£5,537	6	9
Balance carried to net revenue account	5,170	12	9
	£10,707	19	6

Cr. Income.	£	s.	d.
By sale of current per meter	9,200	7	6
Public lighting	1,299	12	8
Rental of motors, meters, etc.	73	1	7
Sale and repairs of lamps	92	15	1
Sale and repairs of other apparatus	16	7	3
Sale of oil barrels, oil, etc.	25	15	5
	£10,707	19	6

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—mortgage loans, less repaid	56,737	18	2
Sundry creditors	4,558	3	0
Balance due to treasurer	9,504	0	5
Surplus—loans repayments	6,762	1	10
Revenue account—sundry creditors	921	3	4
Interest on loans accrued but not paid	232	4	0
Balance due to treasurer	2,143	7	9
Reserve account	1,000	0	0
Net revenue account—balance of profit	1,145	4	4
	£83,004	2	10

Cr. Assets.	£	s.	d.
Capital account—amount expended	77 562	3	5
Revenue account—sundry debtors for current	4,902	7	3
Sundry debtors for rental of motors, etc.	58	12	11
Other debtors	123	5	11
Stores on hand	357	13	4
	£83,004	2	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,768,686
Quantity sold	Private consumers by meter	364,496	1,505,971
	Public lamps	122,170	
	Tramway company	1,019,305	
Quantity used on works			140,213
Total quantity accounted for			1,646,184
Quantity not accounted for			122,402

Number of public lamps—56 arcs, 222 incandescents.

Total maximum supply demanded (kilowatts)—lighting 388, tramways 850.

CATALOGUES, ETC., RECEVIED.

PORTATIVE ELECTRICITY.—Portable Accumulators, Limited, 210, Shaftesbury-avenue, London, W.C., have sent us a price-list of their batteries for phonographs, piano-players, and other instruments.

ALLIANCE COMPANY'S LITERATURE.—Electric coal-cutting machinery and variable-speed motors are the subjects respectively of two illustrated pamphlets recently issued by the Alliance Electrical Company, Limited, 23, Grafton-street, W.

OVERHEAD LINE MATERIAL, ETC.—The latest catalogue of overhead line material, switchgear, etc., from the Electric Tramway Equipment Company, 89, Glover-street, Birmingham, shows a satisfactory growth of the firm's business if the increased bulk of this catalogue as compared with previous issues may be taken as an indication.

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THE PACIFIC CABLE CONFERENCE.

The report of the Pacific Cable Conference, 1905, which is signed by the Right Hon. A. Lyttleton, M.P., Lord Jersey, Sir William Mulock, and Sir Sandford Fleming, was issued last week as a parliamentary paper. From the appended text of the report the reader will observe that the committee consider the agreement between the Commonwealth Government and the Eastern Extension Telegraph Company should be amended before it is ratified so as to make it terminable in 1913.

In approaching the consideration of the questions referred to us in connection with the working of the Pacific cable, we have endeavoured to bear in mind that this enterprise was initiated, not merely as a commercial undertaking, but also and largely, for the purpose of promoting Imperial unity. We have deemed it of special importance that this, the first joint commercial enterprise promoted by the various self-governing States of the Empire, should be carried through with success, and have, therefore, aimed at removing all sources of friction between the partner governments, and have sought to accommodate such difficulties as have arisen in the spirit of reasonable compromise.

2. We find from statistics furnished by the Eastern Extension Telegraph Company and the Pacific Cable Board, which are summarised in the appendix to this report, that in the case of New Zealand and all the States of Australia, except New South Wales and Victoria, the Pacific Cable obtained approximately in the years 1903 and 1904 the share of the total traffic between Australasia and the United Kingdom, which was anticipated at the time when it was decided to lay the cable; but that in the case of the two colonies of New South Wales and Victoria the Pacific Cable has obtained a much smaller proportion of traffic than was anticipated; and we consider that this result must be attributed mainly if not entirely to the fact that the telegraph company has been granted special wires and has been allowed to open offices in Sydney and Melbourne under the New South Wales Agreement of Jan. 16, 1901, and the Commonwealth Agreement of June 8, 1903.

3. We do not think that any useful purpose would be served at the present time by discussing the action of the New South Wales Government in entering into the above-mentioned agreement, but it is sufficient to observe that when the Commonwealth Government took over the administration of the Postal and Telegraph Departments of the various States of Australia they found this agreement in existence, and considered themselves bound to recognise and carry it out, unless it could be varied by mutual arrangement between the Government and the company. Accordingly negotiations to that end were entered into, and with a view to the immediate termination of the New South Wales agreement and of certain agreements with other States it was agreed that concessions should be made to the company throughout all Australia, but for a limited term of years only.

4. This Commonwealth agreement was made subject to the approval of the Parliament of the Commonwealth, to be evidenced either by Act of Parliament or by the passing of resolutions affirming the agreement in and by each House. Such a resolution was passed by the House of Representatives on July 29, 1903, and was communicated to the Senate with a request for its concurrence therein. The Senate, after discussing the agreement at several sittings, finally adjourned the ratification on Sept. 8, 1903, with the object of securing that the whole matter should first be discussed at a conference between representatives of the Governments who are partners in the Pacific Cable, and the Commonwealth Government agreed in the following month that such a conference should be held, but owing to various unavoidable causes the conference could not be assembled until June, 1905. In the meantime the Australian Government allowed effect to be given to the agreement by permitting the company to open an office in Melbourne and giving them a special wire to that city.

5. The Commonwealth Government represents that their agreement is more favourable to the interests of the Pacific cable than the New South Wales agreement, inasmuch as the latter was one of indefinite duration, while the former can be terminated after a certain date by giving two years' notice in writing; but we consider it of the utmost importance that the date of the termination of the agreement should be settled now and not be left for decision in 1913.

6. Sir E. Barton claimed, in his letter to Mr. Seddon of June 1, 1903, that "by reducing the term of the agreement to a reasonable period, the Commonwealth has obtained for the Pacific Cable a very great advantage, which cannot fail to be of immense and increasing value," but we feel that this advantage is not definitely secured so long as any doubt remains whether the agreement will or will not be actually terminated after it has been in operation for 10 years. We, therefore, earnestly trust that the Commonwealth Parliament will not ratify the agreement unless Clause 25 is amended so as to read, "this agreement shall remain in force until Oct. 31, 1913, and no longer." The partners in the Pacific Cable will then be restored to the position in which they stood prior to the making of the New South Wales agreement, and will then be free to determine their policy unhampered by any agreements arrived at by any of the Governments without previous consultation with the other partners.

7. We are advised that the recital in the preamble of the Commonwealth agreement, that it is desirable to substitute one agreement for certain other agreements, including the New South Wales agreement and the similar agreement with South Australia, Western Australia, and Tasmania, cannot safely be relied upon to prevent the revival of those agreements on the termination of the Commonwealth agreement. We, therefore, think that an express provision, excluding such revival, should have been inserted in the Commonwealth agreement, and we trust that such a provision will be inserted before the agreement is ratified.

8. We understand, from statements made by Sir E. Barton in the House of Representatives on the occasion of the ratification by that House of the Commonwealth agreement, that the Commonwealth Government has undertaken to grant the Pacific cable equal facilities with the Eastern Extension Telegraph Company without any qualification, as soon as they are required. We consider that the Pacific Cable Board should forthwith be given such facilities and that the Board should take steps to secure the largest possible amount of Australian traffic by all legitimate methods of business competition. This would, of course, involve the Board in very considerable expense in connection with local offices and with advertising and canvassing, and we think it might be left to the discretion of the Pacific Cable Board to negotiate an amicable arrangement with the Eastern Extension Telegraph Company provided that no arrangement be finally concluded without the approval of the Governments concerned, nor unless the Commonwealth agreement is amended in the manner above suggested.

9. It has been suggested that the Commonwealth Government should reduce their terminal rate to the level of the rate for urgent internal messages. The majority of us are of opinion that the rate of 5d. per word is excessive, and we trust that the Government will see their way to reduce it.

10. We note that the Australian Government have undertaken to remit all customs duties and other charges (as specified in Clause 19 of the Commonwealth agreement with the Eastern Extension Telegraph Company), which have been or shall be levied on the Pacific Cable Board, and we hope that the Dominion Government will adopt a similar course.

11. In conclusion we desire to recommend, with a view not only to the prevention of any misunderstanding, but also to the maintaintenance of cordial and friendly relations between the Governments in respect of the Pacific Cable, that should any question hereafter arise in connection with terminal rates, or customs duties, or proposed concessions or privileges to any cable or telegraph company, or respecting any other matters likely to affect the interests of the Pacific Cable, such question should be referred to the Pacific Cable Board and the various Governments concerned for consideration before any final action is taken upon it.

12. The Pacific Cable being the first enterprise of the kind undertaken by a number of British Governments in partnership, it need occasion no surprise if at the commencement of the enterprise some questions should have arisen touching the obligations of the various partner governments towards the common undertaking, but inasmuch as they fully appreciate the far-reaching political consequences attendant on the success or failure of the Pacific Cable, we feel assured that the fullest possible effect will be given to the foregoing recommendations and suggestions which we respectfully submit for the consideration of His Majesty's Government and the Governments of Canada, Australia, and New Zealand.

The traffic statistics appended show a grand total of 2,784,220 words in 1904 (Eastern 1,889,359 and Pacific Cable 894,861), as compared with 2,636,357 words in 1903 (Eastern 1,824,397 and Pacific Cable 811,960).

TRADE NOTICES AND NOVELTIES.

Ferranti Single-Phase Transformers.

The accompanying illustration (Fig. 1) represents a Ferranti 30-kw., 2,000-volt, single-phase power transformer of a design which is the outcome of the company's long experience. The magnetic circuit of this transformer is of the core type, the sheet steel used in its construction being selected for its low hysteresis loss and freedom from ageing effect. Prolonged tests have shown that the loss due to hysteresis in this metal does not increase with time. The construction of the core is shown in Fig. 2. The joints are imbricated, and the core is held between brass clamp plates secured by bolts. The yokes

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are pressed between cast-iron yoke plates and the whole transformer supported between top and bottom plates by means of steel hanging bolts. The mechanical construction is thus very strong, while the electrical design results in good regulation. The drop on inductive load is kept low by sandwiching the windings—that is to say, the primary winding is partly inside and partly outside the secondary. Another point worthy of note is that the maximum efficiency is arranged to be at three-quarter load, this being thought the most suitable for the

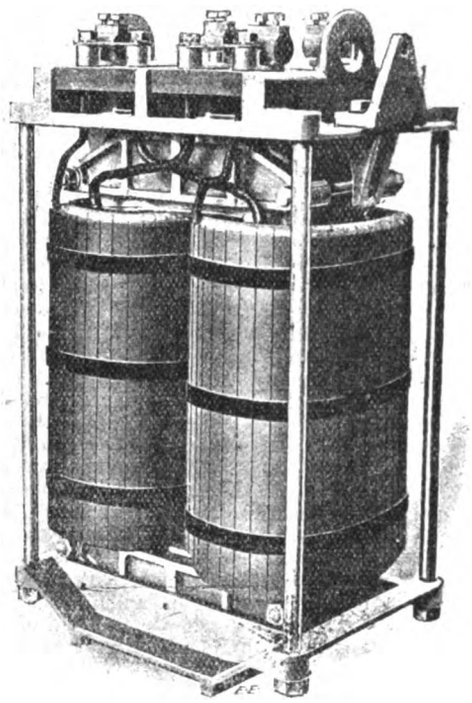


FIG. 1—Ferranti Single-Phase Transformer.

majority of electricity supply works. Particular care is also taken to secure ample cooling surface, air ducts being left between all the coils and between the coils and core, so that the otherwise inaccessible interior parts are efficiently ventilated. A maximum temperature rise of 45deg. C. above the surrounding atmosphere after a full-load run of eight hours is guaranteed. Transformers of similar design and construction are made by Messrs. Ferranti, Limited, in eight standard sizes, ranging in output from 50 kw. to 2½ kw., for four voltages—viz.: not exceeding 2,500 volts, 5,000 volts, 7,500 volts, and 10,000 volts respectively. They can all be contained in the firm's standard patterns of ventilated covers, sub-station tanks, street

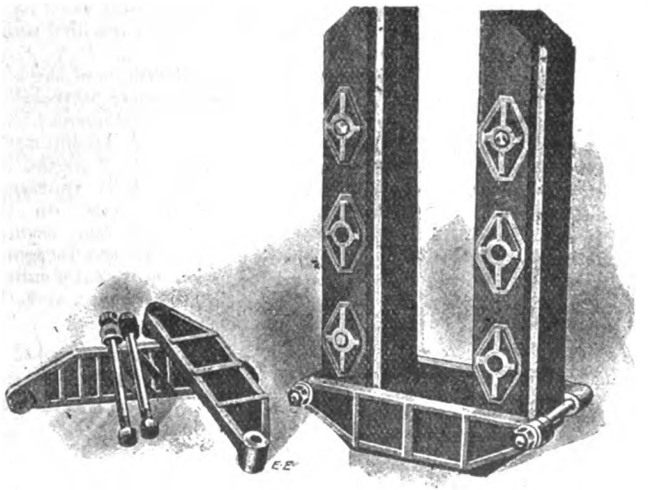


FIG. 2.—Core of Ferranti Single-Phase Transformer.

tanks, or simple watertight tanks, provided with glands for the cables as may be desired.

The "Ratqua" Rail Anchors.

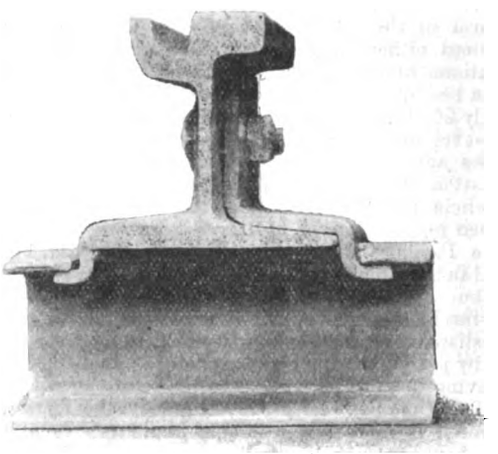
Illustrations are given herewith of the "Ratqua" rail anchors. These anchors are made in two types. No. 1 consists of a foundation plate in the form of an H-iron, the top flange of which at one end is turned up and over to make a forked grip on the bottom flange of the girder rail, and at the other end is slotted to take the fork of the "locking plate." This latter is formed so as to fit the outside of the girder rail, and when "locked" into the slot of the H-iron, is bolted with a single bolt to the web of the rail. No. 2 consists of a foundation plate in the form of an H-iron, the top flange of which is slotted at both ends. It carries two "locking plates," one on either side of the rail, both of which are bolted up to web of rail by a single bolt. This type of anchor is favoured by some engineers owing to the extra stiffness it gives to web of rail. As in the case of "No. 1," the tighter the "locking plates" are bolted up the tighter the grip of anchor on rail. It is claimed that both these types of anchor enable a rail to be taken out and replaced by simply removing the "locking plates," which operation in no way disturbs or shakes the H-iron plate in the concrete foundation. Moreover, the bolts are accessible, and not buried in concrete. In new track it has been found from actual experience that four anchors to each 45ft. length of rail are sufficient to prevent "pumping"—that is to say, one at 2ft. 6in. from each end of rail, and the other two at a distance of 13ft. 4in. apart centre to centre. The "Ratqua No. 2" anchor is specially recommended for use on an existing track which has been laid without anchors, and is

The "Ratqua No. 1" Rail Anchor.

showing signs of pumping. Messrs. Hurst, Nelson, and Co., Limited, Motherwell, are the sole manufacturers. We are indebted to the "Ratqua" Rail Anchors, 4, Victoria-terrace, Edinburgh, for the above particulars.

Lightning Arresters.

Some interesting information about lightning arresters for alternating and continuous current circuits is contained in pamphlet No. 182, just issued by the British Thomson-Houston Company, Limited, Rugby, to supersede Nos. 113 and 70. Tramway and railway motors are especially exposed to danger from lightning discharges, as the frames are always connected to earth. Discharges may take place from the line to earth conductors simultaneously at several points, and under these



The "Ratqua No. 2" Rail Anchor.

conditions the generator current, though not of sufficient E.M.F. to start an arc across the air-gap of the arrester, is capable of maintaining one or several arcs started by the lightning discharge. These arcs, if continued, would not only destroy the arrester, but would in many cases permit such an excessive flow of current as to overload or destroy the generator or other apparatus. Provision has been made in B.T.H. lightning arresters for extinguishing the arcs which would be formed in this manner. The company's alternating-current lightning arresters consist of a group of metal cylinders (Fig. 1) arranged with short air-gaps between them, and with a non-inductive resistance in series with the air-gaps. The action of the arresters is dependent upon the cooling effect of the metal cylinders, aided by the periodic

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passage of the generator current through zero value, and on the non-inductive series resistance being of sufficient value to limit the flow of the dynamo current, but not sufficient to impede the progress of the lightning discharge. These arresters have been standardised for all voltages up to 25,000 volts, and they have been designed for and successfully used on line voltages up to 60,000 volts. Owing to the fact that under numerous conditions destructively high potentials may exist between conductors on alternating-current circuits, it is often necessary to arrange a discharge path between the conductors, as well as from conductors to earth. A special arrangement of arresters has been

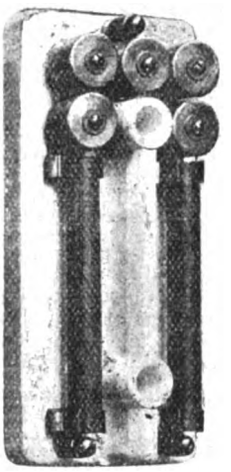

FIG. 1.—B.T.H. Type "GE" Alternating-Current Lightning Arrester, 2,000 Volts, Double Pole.

designed for this purpose, known as the "multiplex" arrester, the connections of which are shown for the particular case of a three-phase circuit in Fig. 2 herewith. The feature of the multiplex arrester, as contrasted with star or delta connected arresters for use on systems where the mid point is not earthed, is that suitable protection is afforded at the same time both for discharges between phases and for discharges to earth. Star-connected arresters do not provide adequate protection between phases, whilst delta-connected arresters do not provide for discharges to earth. The construction of an arrester for

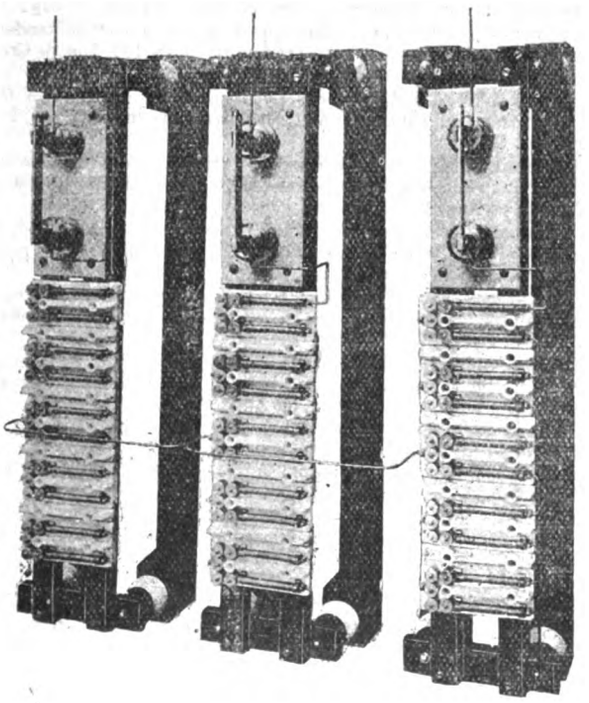

FIG. 2.—B.T.H. Type "GE" Alternating-Current Lightning Arrester, with Multiplex Connections for 12,500 Volts.

continuous-current circuits involves the same general principles as an arrester for alternating-current circuits, but in view of the fact that it is much more difficult to rupture a continuous-current arc than an alternating-current arc, some additional means are necessary for breaking the arc after a discharge has taken place. The magnetic blow-out type of lightning arrester, as supplied by the British Thomson-Houston Company, has been found to be most reliable for this service. The arrester consists of a single spark gap with a non-inductive resistance in series therewith to limit the discharge current. The spark gap is protected by the well-known magnetic blow-out, the coil of which is a shunt to a portion of the non-inductive resistance. The lightning discharge passes directly through the spark gap and resistance to the ground, and should any current from the generator follow the lightning discharge and tend to maintain the arc, such current will pass through the blow-out coil and produce a strong magnetic-field, thereby blowing out the arc. The magnetic blow-out arrester is furnished for lighting and power circuits from 60 to 375 volts, for railway and power circuits from 250 to 850 volts, and for series arc circuits from 2,000 to 6,000 volts. The box and cover of the arrester are made of glazed porcelain, and the spark-gap terminals are threaded, and attached to the lid of the box, thus affording a ready method of adjustment, positive grip on the terminals, and easy access for inspection and cleaning.

COMPANIES' MEETINGS AND REPORTS

GREAT NORTHERN AND CITY RAILWAY.

The fourteenth half-yearly meeting of this Company was held on the 4th inst. at the Westminster Palace Hotel, S.W.

The EARL OF LAUDERDALE, in moving the adoption of the report and accounts, stated that the receipts from all sources had increased by £9 730 during the six months ending June 30 last, as compared with the half-year ending Dec. 31 last. The average earnings per week were £1,778, as against £1,404 during the same period, showing an average increase of £374 per week. The passenger traffic was at at the rate of 245,830 per week, as against 201,062, or an increase of 44,768. These figures were exclusive of season tickets, and were most encouraging Since the opening of the line they had had a continuous increase, and he hoped that would be maintained in the future. He was glad that building operations in the districts between Wood Green and Tottenham were being extensively carried out. This all contributed additional traffic to their line, seeing that they had formed very convenient connections at Finsbury Park with the tramway services of that district. The arrangement for three-rate season tickets was in full operation, and payments were regularly made by the Great Northern Railway Co. to this Company. He wished to say, as the question was asked at the last general meeting in regard to the working expenses that the rate payable to Messrs. Pearson on this account, and until the Company took over the line, was 50 per cent. of the gross receipts. He did not see at present why, when they took over the line, this should be exceeded. Of course, they must clearly understand that whether this would really be so or not, must depend materially upon the increase or otherwise of the traffic; meanwhile, Messrs. Pearson had informed them that the ratio of working expenses to gross receipts had diminished. Since the opening of the line they were in the position which enabled them to deal with a large increase in traffic without materially affecting the working expenses. The number of passengers carried per car mile had increased from 5·65 to 7·68 as compared with last year. Provision was being made for additional rolling stock to meet the demands of the expected increase in the winter traffic. Contracts had been given for the supply of additional cars, and these would be delivered from time to time, commencing in October next. The directors were still of opinion that the extension to Lothbury should be proceeded with as soon as the raising of the necessary capital admitted of this being done.

The report was unanimously adopted.

TYNESIDE TRAMWAYS.

The half-yearly meeting of this Company was held last week at Newcastle, Lord Armstrong presiding.

The report stated that the surplus of receipts over expenses was £3 151. 10s. 3d., which, with the balance from last half-year of £58. 6s. 10d., made a total to the credit of profit and loss account of £3,209. 17s. 1d., and after deducting interest for debentures, loans, etc., there remained an available balance of £1,604. 9s. 2d. Out of this the directors proposed the payment of a dividend at the rate of 2 per cent. per annum, leaving £265. 14s. to be carried forward. Notwithstanding the electrification of the North-Eastern Railway, the surplus of traffic receipts over working expenses shows a material increase compared with any previous half-year. The sanction of Parliament has been obtained to the issue of the remaining capital of the Company, either as preference or ordinary shares. The question of depreciation will, as heretofore, be dealt with at the close of the financial year.

The report was adopted.

CHLORIDE ELECTRICAL STORAGE.

The report for the year ending June 30 shows a trading profit of £27,298. 3s. 3d. After deducting debenture interest, depreciation, and interim dividend on preference shares, the available balance for the year is £4,965. 6s. 11d., to which must be added £7,013. 13s. 4d. brought forward from last year, making a disposable balance of £11,979. 0s. 3d. The directors propose the payment of a dividend of 6 per cent. on the preference shares for the financial year, less interim dividend already paid, and a dividend of 8 per cent. on the ordinary shares, free of income tax, together amounting to £4,520, and to carry forward the balance £7,459. 0s. 3d. The retiring directors are Mr. W. Bannister and Mr. J. de Berniere Smith, who, being eligible, offer themselves for re-election. The auditors, Messrs. Parkinson, Mather, and Co., chartered accountants, also offer themselves for re-election.

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LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting of this Company was held at Liverpool on Tuesday, Sir William Forwood presiding.

The CHAIRMAN stated that for the first time in the history of the Company they had been unable to pay a dividend on the ordinary shares. The railway had been most successful in promoting and assisting trade and cheapening the expenses of the port. It would have been of still greater service to the port if the Dock Board had permitted it being constructed for goods as well as passenger traffic. Extensions of the line had been carried out from time to time, all proving valuable feeders, and there was no doubt that but for the introduction of the electrical tramways system by the Corporation the prosperity of the railway would have continued, and to-day it would have been one of the most flourishing concerns in the country. Little did the directors think that the most up-to-date method of traction would so soon have to give place to the electric tramway. That, unhappily, was their misfortune; but they had not stood idly looking on and taking this competition "lying down." They had done their utmost to remodel their methods, by accelerating the service and lowering the fares, in which direction they had gone as far as was prudent. Last half-year they carried nearly 4½ million passengers, the reduction from the best half-year being only 233,000 passengers, but the reduced fares gave them a considerably smaller return. They also suffered keen competition from the electric service on the Lancashire and Yorkshire Railway at the north end of the overhead system. In the endeavour to recoup their losses they were arranging for a through service of trains on the Southport line, which they hoped would restore a good part of the traffic they had lost.

The report was adopted.

CAPE TOWN CONSOLIDATED TRAMWAYS AND LAND.

The fourth ordinary general meeting was held at the offices, 1, London-wall-buildings, Baron Emile B. d'Erlanger presiding.

The CHAIRMAN reviewed the position generally, and quoted figures to show the severe period of industrial oppression through which the district was passing.

The report was adopted.

A resolution was afterwards passed approving the arrangements made by the Board for obtaining from Messrs. Erlanger and Co. and Messrs. Wernher, Beit, and Co., in equal shares, a loan, as and when required, to the amount of £26,000, carrying interest at 6 per cent. per annum, and authorising the directors to borrow from the same two firms any further sum which might be necessary for the Company's purposes.

NEW COMPANIES REGISTERED.

Patent Electric Carbonising Co., Limited.—Capital, £2,000. Objects: To acquire patent No. 4 593 of 1905, granted to S. Roberts, of the Observatory, Liversedge, Yorks., or any other patents relating to electric or other processes of carbonising wool waste, nails, rags, and fibrous substances, and to turn to account the same.

North Melbourne Electric Tramways and Lighting Co., Limited.—Capital, £200,000. Objects: To acquire the benefit of an Order in Council of the State of Victoria and its dependencies, entitled the "Town of Essendon and the Borough of Flemington and Kensington Electric Lighting and Power Order, No. 21, 1904," and of a further Order in Council, made on May 4, 1904, under the authority of the Tramways Act, 1890, relating to the construction of electric tramways in the town of Essendon and the borough of Flemington and Kensington, and to carry on the business of engineers, electricians, etc. Registered office: Worcester House, Walbrook, E.C.

Illuminated Signs, Limited.—Capital, £3,000. Objects: to carry on the business indicated by the title and that of electricians, suppliers of light and power. Registered office: 21A, Manor-street, Clapham, S.W.

E. Brook, Limited.—Capital, £5,000. Objects: to acquire the business of electrical engineers carried on at Threadneedle-street, Huddersfield, by E. Brook, and to carry on the same and the business of manufacturing electricians, mechanical engineers, etc. Registered office: Threadneedle-street, Huddersfield.

Liens Registered.

Northern Counties Electricity Supply Co., Limited.—A trust deed dated July 14, 1905, to secure £100,000 debenture stock, created by resolution of July 3, 1905, has been registered. Property charged: The company's freehold and leasehold lands and hereditaments at Cowpen Quay, Alnwick and Hirst, all in Northumberland, at Merrington, Felling, Shildon, Hartlepool, Heworth and Hebburn, all in Durham, and at Thirsk and Malton, both in Yorkshire, and its other assets, present and future, except uncalled and unpaid capital. Trustees—C. Emmott, Snow Hall, near Darlington; Major G. F. T. Leather, Hiddleston Hall, Belford, Northumberland; and F. Millburn, 6, Fenham-terrace, Newcastle-on-Tyne.

Electric Light Insurance and Maintenance Co. (1904) Limited. A charge on 150,000 electric lamps, dated July 27, 1905, to secure £500, has been registered. Holders: Wm. Whiteley, Limited, Westbourne-grove, W.

Ferranti Limited, Hollinwood, near Manchester.—Trust deed, registered Aug. 9, for securing £100,000 first mortgage debenture stock; trustees: H. R. Boyce, Winchester House, E.C., William Jones, of Manchester; charged on leasehold property at Failsworth and Manchester, the undertaking, and all other property and assets, present and future, including the uncalled capital; and debenture registered Aug. 9, for £50,000; holders: Parr's Bank Limited; charged similarly to the above debenture stock, but subject thereto.

LEGAL INTELLIGENCE.

DUST DESTRUCTOR.

In the Chancery Division last week Mr. Justice Farwell heard the action brought by the Attorney-General to restrain the Pontypridd Urban District Council from using any part of a plot of land situate at Gwern-y-gerwn, Treforest, near Pontypridd (which was acquired by the Urban District Council in 1902 from the trustees of the late Lady Llandover's will for the purpose of erecting a station for generating and supplying electric energy) for any other purpose than that for which it was acquired, and in particular to restrain them from erecting a dust destructor on a portion of the land which the trustees allege will cause a nuisance and deteriorate the value of the Llandover estate property in the neighbourhood.

Mr. DANKWERTS, K.C., for the defendants, contended that the destructor was admissible as part of the electric station plant because it was by the heat produced by the destructor that the necessary steam boilers of the station would be worked in the production of electricity. The learned counsel cited several authorities in support of his contention.

HIS LORDSHIP, in giving judgment, said that the proposition by the defence that they had power to use the land as they proposed was very wide-reaching and entirely contrary to the powers given to the Council as to the supply of electricity. He could not apply that principle to the present case. He could find nothing in the Electric Lighting Act which would allow him to treat them other than separately, and he, therefore, held that the action of the defendants was *ultra vires*, but he granted an injunction accordingly, with costs, but he made an order for no costs on the question of nuisance.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Sophia.—The District Finance Commission require tenders for telegraph material by Aug. 25.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Turn-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

Pentypridd.—The Urban District Council invite tenders for (Section A) permanent way. Tenders by 12 noon on Sept. 2.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct-coupled steam set.

Edinburgh.—Tenders are invited for the electric lighting installation at the mortuary buildings, High School Yards, Edinburgh, for the Lord Provost, Magistrates, and Council. Tenders by Sept. 11.

Paris.—The Post and Telegraph Department require tenders for rubber-insulated copper wire. Tenders to above, 103, Rue de Grenelle, by Aug. 24.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Zaragoza. Tenders by Sept. 12.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Malago (Malaga). Tenders by Aug. 19.

Swansea.—The Corporation invite tenders for switchboard, transformer pillars, transformers, switchgear, etc. Tenders by noon on Aug. 26. See advertisement.

Taunton.—The Corporation invite tenders for a water-tube (straight) marine-type boiler, superheater, economiser, pipe extensions, etc. Tenders by Sept. 2. See advertisement.

Acton.—The Urban District Council invite tenders from manufacturers for the supply of arc lamp carbons and house fuse-boxes for a period of 12 months. Tenders by Aug. 21.

Larne (Ireland).—Tenders are invited for lighting the public streets and roads of the urban district of Larne by means of coal gas or electricity for three years from Aug. 1, 1906. Tenders by 10 a.m. on Sept. 2.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10.000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Chelmsford.—The Town Council invite tenders for lighting the public streets and public clock within the borough with electricity, gas, or other illuminating power for three or five years from March 25, 1906. Tenders by Sept. 8.

Earsdon (near Newcastle-on-Tyne).—The Urban District Council invite tenders for work in connection with the electric lighting of part of the district. Tenders by Aug. 18 to Mr. Alfred Dale, clerk, 85-86, Howard-street, North Shields.

Paris.—The Waterworks Department of the Municipality require tenders for supply and erection of motors, pumps, and generators for the proposed waterworks at Chantilly. For particulars apply to above authority. Tenders by Oct. 12.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

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Ashton-under-Lyne.—The Electricity Committee invite tenders for (Section A) one 500-kw. direct-current generator; (B) one water-tube boiler with superheater, to be worked in conjunction with a refuse destructor; (C) two superheaters for Lancashire boilers. Tenders by 12 noon on Sept. 2. See advertisement.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23. See advertisement in previous issue.

RESULTS OF TENDERS.

Manchester.—The Corporation have accepted the tender of Veritys Limited for their "Aston" motors for the 2, 3, and 4½ h.p. sizes.

Darlington.—The Corporation have accepted the tender of W. E. Dove and Co. for "Aston" motors, to be supplied by Veritys Limited.

Baroda.—The tender of Rowland Carr and Co. for the supply of arc lamp columns and carriers has been accepted by the Huzur Public Works Department for Baroda State.

Middlesex.—The County Asylum Authorities have placed with the Hart Accumulator Co., Stratford, London, the order for renewing battery at Wandsworth Asylum with 112 of their standard lighting-type cells.

Burton-upon-Trent.—The following tenders have been accepted for alterations and additions to the electric lighting, and also for alterations to be made to the heating apparatus at the town hall: Gough and Felgate, Uxbridge-street, Burton-upon-Trent, heating, £138. 14s. 9d.; J. Richards, High-street, Burton-upon-Trent, electric lighting, £199.

Islington.—The Borough Council have accepted the following tenders: Willans and Robinson, one 1,500-kw. steam turbo-generator, exciter, condensing plant, etc. (the alternator to be of Dick-Kerr's manufacture), £8,258; Balcke and Co., one natural-draught cooling tower in two sections, £1,118; John Spencer, Limited, 800ft. of 20in.-diameter steel rivetted pipe for circulating mains, together with 12 bends of the same diameter, £466. 12s.

Grimsby.—The following tenders have been received for electric lighting of the new highways yard:

Central Electric Co.	£96	4	0
D. J. Dolby	94	9	10
Robinson and Emerson	89	15	0
Northern Electrical Co.	85	0	0
A. C. Dickens and Co., Grimsby (accepted)	68	14	0

Accumulators.—The A.B.P. Accumulator Co. report the following orders: 27 cells, 82 type, 7 plates, 210 ampere-hour battery, for Riston, Lancashire; 55 cells, 83 type, 9 plates, 280 ampere-hour battery, for South Wales; 58 cells, 89 type, 21 plates, 700 ampere-hour battery, for Pudsey, Yorkshire; 230 cells, 86 type, 15 plates, 490 ampere-hour battery, for India; 254 cells, 86 type, 15 plates, 490 ampere-hour battery, for India; and also a maintenance contract from the Barnstaple Town Council for five years, at £120 per year.

Grimsby.—The Highways and Public Works Committee have received the following tenders for the fixing of an electric pump in the Doughty subway:

W. H. Allen and Son	£121	0	0
Crompton and Co.	88	0	0
D. J. Dolby	81	10	0
A. C. Dickins and Co.	59	8	0
Gwynne and Co.	95	0	0
Indiarubber and G. P. Telegraph Works	98	0	0
Northern Electrical Co.	72	0	0
Pulsometer Engineering Co.	96	0	0
Mather and Platt	90	0	0

Port Louis (Mauritius).—Messrs. Johnson and Phillips, of Old Charlton, Kent, have obtained the complete contract for the power generating plant and high-tension overhead transmission line for transmitting the energy generated over a distance of four miles for Port Louis, Mauritius, which includes the following plant: 2,700 foot run of 34in. diameter steel water pipes and fittings; 75-kw. single-phase alternator, with exciter, direct coupled to Pelton wheel of 103 b.h.p.; main and distributing switchboards; high-tension transmission line material, consisting of steel poles, overhead line wire, porcelain insulators for carrying line wire, lightning arresters, etc.; two 40-kw. single-phase transformers for transforming down to low tension; low-tension network main for street lighting, consisting of bare overhead line wire, insulators for carrying same, insulated cable for connecting to street lights; 1,000 incandescent lamp brackets, complete with necessary fittings and lamps for fixing on posts.

BUSINESS NOTES.

TRACTION.

Perth.—It is reported that the cars are ready for delivery as originally designed.

Belfast.—The work of reconstructing the central portion of the tramway system was commenced on Wednesday.

Bombay.—The introduction of electric traction on local trains in Bombay is being discussed.—*Indian Engineering.*

Dundee.—A post-card *plébiscite* is to be taken on the question of Sunday running, all replies to be sent in by Sept. 2.

Hastings.—There was a big rush for the trams round about Bank Holiday. From Aug. 4 to 10 no fewer than 186,896 passengers were carried.

Bath.—The Rural District Council and the promoters of the Lansdown light railway have practically agreed upon terms for road widenings.

Huddersfield.—The Tramways Committee have resolved to ask the Council to pay the employés at the rate of time and a quarter for Sunday labour.

Weymouth.—Apparently the Town Council have not yet made up their minds as to applying for powers to construct an electric tramway, the matter having been referred to committee.

Cleckheaton.—The Board of Trade have intimated that they are unable to assent to the application of the British Electric Traction Co. for leave to abandon their Spen Valley scheme. The company has been granted a month to make further arrangements.

Birmingham.—The tramways extension scheme entered upon another phase on Monday, when the process of reconstructing the line in Hurst-street, south of Bromsgrove-street, was commenced.

Musselburgh.—The success of the electric car service has been quite beyond the expectations of the management, and now after only nine months' traffic an extension of carshed accommodation is required. Four new cars, just delivered, make a total of 14 at the depôt.

Dewsbury.—On the Dewsbury, Batley, and Birstall steam tramways, the first of the kind established in this country, the final journey with that form of traction was made last week. The roads are now in the hands of workmen, who are preparing them for electric traction.

Notification.—A communication appeared in the Press the other day from Mr. W. Gentry Bingham, 80A, King's-road, Brighton, to the effect that the transfer of the electric lighting and tramways concession to the Bombay Electric Supply and Tramways Co. is subject to his approval.

Pontypridd.—On Saturday night the electric car service was brought to a standstill, owing to one of the overhead wires becoming disarranged. Mr. Teasdel, the engineer, was fortunately passing at the time, and at once took steps to have the wire repaired, which was done in a comparatively short time.

Felixstowe.—The trial trip of the three new electric cars which are to run on the new pier at Felixstowe took place on Monday morning, Mr. Lambert, the electrical engineer for the Coast Development Corporation, being present. The trip was perfectly satisfactory, and the Board of Trade inspection is expected to take place in a day or two.

Sunderland.—The tramway company are pushing their extension rapidly forward, and it is expected that in a very short time electric trams will be running direct from Sunderland to Hetton, by way of Houghton-le-Spring. The company have only been at the work for six weeks, and in that time they have made a lot of progress. The rails are now laid practically into Hetton.

Light Railways.—The Board of Trade have confirmed the following orders made by the Light Railway Commissioners: Bath Electric Tramways (Light Railway Extensions) Order, 1905, authorising the construction of a light railway in the rural districts of Bath and of Keynsham, in the county of Somerset, being an extension of the existing and authorised undertaking of the Bath Electric Tramways, and the County of Middlesex Light Railways (Extension of Time) Order, 1905, amending the County of Middlesex Light Railways Order, 1901.

Blackpool and Fleetwood Tramroad.—The report for the half-year ended June 30 last states that, including the sum brought forward from last half-year, the balance of profit, after providing for debenture interest, is £3,852, and the directors recommend a dividend at the rate of 4 per cent. per annum, which will absorb £3,000, writing off a sum of £500 to depreciation reserve and £288 to general reserve, leaving a balance of £64 to be carried forward. The number of passengers carried during the half-year was 802,150. Receipts from all sources amounted to £10,389.

Stockport.—Colonel von Donop, representing the Board of Trade, last week inspected the new Lord-street line, a special car containing the inspector, members of the Tramways Committee, and officials, running over the new line, which is a comparatively short length. The inspector expressed himself as satisfied with the trial. Much satisfaction has been caused in Gorton and district now that the Urban District Council has been authorised to lay new tramways along Reddish-lane, Hyde-road, Wellington-street, and Gorton-lane. By the new route Stockport will be connected with Reddish, Gorton, Openshaw, etc.

Gosport.—At the meeting of the Urban District Council a letter was read from Mr. J. F. Glenn, engineer to the Provincial Tramways Co., with regard to the tramway scheme. Mr. Glenn explained that the Stoke-road line would be commenced in about three months' time, and with regard to the Fareham line, he pointed out that the company had considerable difficulty with the War Department in respect to a piece of land near the present terminus. The price demanded by the War Department was something like £1,250 an acre, and as that was

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quite impossible he had decided to lay the lines at the side of the road as near to the War Department hedge as possible.

Leeds. — Some members of the Tramways Committee visited Calverley the other day and looked over the route of the proposed tramway between the village and the Leeds boundary at Rodley—the present terminus of the municipal system. The Calverley District Council have obtained a provisional order for constructing tramways in their area, but they are inviting the Leeds Corporation to take over these powers and extend its own system along the mile and a half of roadway between Rodway and Calverley village. Nothing definite has been settled, but the Tramways Committee, which is said to be favourably disposed towards the scheme, will shortly have the matter before it.

Salford.—From the annual report, just to hand, of the Corporation trams for the year ending March 31 we observe that the income amounted to £209,672, leaving a gross profit of £74,780. Out of this capital charges, etc., absorb £38,105, a sum of £16,168 is accounted for by rents paid to other authorities, £8 934 is placed to depreciation account, and £13 000 is handed over to the borough fund. The car miles were 4 884 590; the passengers, 39,213,560; units of energy consumed, 6,927,805; average traffic revenue per mile, 10·29d.; average working expenses (excluding power) per mile, 4·51d.; average working expenses (including power) per mile, 6·62d.; percentage of expenses to receipts, 64 per cent. It is gratifying to note that the figures as to traffic show a steady increase.

Sheffield.—At the meeting of the City Council the lord mayor proposed a resolution to appoint a committee to consider the subject of the tramway finances, and particularly the question of the adjustment of fares, and the further development of the tramway undertaking. His Lordship expressed the opinion that the adjustment of the fares was absolutely necessary if the finances of the undertaking were to be maintained on a sound basis. There was no tramway system in the kingdom which carried its passengers so far for 1d. as they did in Sheffield, with the result that the revenue was insufficient to meet the proper charges for renewals. Eventually the following resolution was carried: "That the question of tramway finance, and particularly the adjustment of fares, and its relation to the future development of the tramways undertaking, be referred to the Tramways Committee with instructions to report thereon."

Leith.—The Board of Trade inspection of the first section of the new electric tramway system in Leith was made on Saturday by Colonel Von Donop, among those present being Mr. James More, tramways engineer; Mr. W. P. Rutherford, electrical engineer; Mr. John Wilson, tramways manager; and Mr. W. Relph, assistant tramways engineer. After Colonel Donop had inspected the car at the depôt, the journey to Craighall-road was begun. At one or two places on the route, Colonel Donop had the car stopped in order to examine and make inquiries regarding details of the overhead equipment, and the placing of the poles. Everything appeared satisfactory, and after the car was taken back to the foot of Leith-walk, and thence again over the Leith-walk section to Pilrig, Colonel Donop, it is understood, expressed himself satisfied with the inspection. It is probable that cars will be running on a part of the system this week.

Parliamentary Bills.—At the eleventh hour the North-East London Railway Bill, to which we referred last week, was agreed to by the House of Commons and allowed to be proceeded with, the Lords' amendments being acquiesced in. The Newry, Keady, and Tynan Light Railway Bill was also passed. The Tramways Orders Confirmation (No. 1) Bill came before the Committee on Unopposed Measures last week, the Deputy-Chairman of Committees (Mr. Laurence Hardy) presiding. The Bill confirms orders made provisionally by the Board of Trade empowering the Corporations of Bradford, Leeds, Keighley, and Pudsey to construct tramways. Mr. Bonnor Maurice explained that there was a contest in the House of Lords because the railway companies did not consider that they were sufficiently protected. The clause objected to had been struck out of the Bill and new ones inserted. These had been agreed to by all the parties interested, as well as by the Board of Trade. The Bill passed through committee, and was sent for third reading in the Commons.

Inquest.—Dr. Gordon Hogg held an inquest last week at Teddington on the body of Arthur Henry Scott, carman, of Elm-road, Kingston. Deceased was in charge of a load of hay in Hampton Court-road, and was sitting on the shaft when the van was run into by a tramcar. He was thrown off and struck by the car, receiving such serious injuries on the body that on arrival at Teddington Cottage Hospital he was found to be dead. The evidence of John Macdonald, driver of the electric car, was to the effect that the night was dark, and he could not see the van until within half a car's length of it. He saw no light on the van. He sounded his gong, and stopped the car within a length and a half, but it struck the rear of the van, startled the horse, and the deceased fell to the ground. The tramcar was going at about eight to nine miles an hour. Other witnesses stated that they heard no gong sounded, but the conductor corroborated the driver's statement that it was sounded. The jury returned a verdict that deceased died from an accidental fall from a van, but they considered the driver of the tramcar was to some extent to blame for not observing the van.

Heywood.—At the monthly meeting of the Corporation the town clerk reported receipt of sanction from the Board of Trade to the borrowing of £37,200 for the electrification of the tramways, to be repayable partly in 30 years and partly in 20 years. Councillor Popple (chairman, Tramways Committee) proposed the adoption of the Committee's report. He was sorry he could not say absolutely that they had arranged for the working of the Heywood trams by their neighbours. They had all but arranged with Bury; he might say that they had practically settled with Bury, and they had not lost heart with Rochdale. They had had many meetings and pleasant discussions, and to some extent some stormy discussions, and the Heywood representatives felt they could adopt either Bury's suggestion, if Rochdale would fall in; or they could adopt Rochdale's suggestion if Bury would fall in with it, but they could not have two systems, one on the one side of the borough and one on the other. He thought, however, he could say confidently that before they had another monthly meeting the thing would be arranged for the working of their system either by one neighbouring authority or by the two. If they could not agree with Rochdale, Bury was quite prepared to take over the whole system, including the Hopwood section. The minutes were approved.

Bury.—In the annual report of the borough engineer (Mr. A. W. Bradley) for the year ended March 31 last some interesting figures are given concerning the cost of the tramway track entrusted to Mr. Bradley. It appears that the net estimated expenditure after the routes had been definitely decided upon was £92,902. 6s. 7d., and the actual cost was £88,290. 1s. 10d., or £4,604. 4s. 9d. less than the estimates. The figures would have been even more favourable than they are but for one or two heavy contingencies having to be met which were not provided for in the estimates. The main amounts under this head are £1,489. 9s. 6d. for car depôt tracks and £708. 2s. 6d. for extra paving required by the Lancashire County Council in Tottington. Other extras included in the actual expenditure were an outlay on the temporary track and maintenance at Blackford Bridge during the rebuilding, part of which outlay will be recovered from the County Council, and the cost of repaving Crostons-brow owing to the alterations to the feeder bridge. The cost of work on the different sections, as ascertained by measurement at the prices of the contractor who carried out the earlier work, would have been £31,082. 10s. 8d., and the actual cost was £29,516. 4s. 9d., a difference in favour of the Council doing the work itself of £1,566. 5s. 11d. Mr. Bradley expresses the opinion that the Corporation have got full value both in labour and materials employed, and that the quality of the work was not inferior to that of a contractor. It was also completed within the time fixed.

Liverpool.—At the fortnightly meeting of the Tramways Committee the traffic returns for the fortnight ended Aug. 5 were submitted, and showed that the receipts amounted to £22,874. 19s. 5d., an increase of £157. 15s. 2d. over the corresponding period of last year; the passengers carried numbered 4,913,607, an increase of 79,809; and the mileage run was 474,156 miles, a decrease of 3,809. The general manager, Mr. C. R. Bellamy, submitted the following traffic return for the five days ended Bank Holiday, Aug. 7, covering the period of the Agricultural Show at Wavertree, together with the figures for the corresponding period of last year. The following are the increases in the receipts—viz.: Thursday, Aug. 3, £25. 10s. 1½d.; Friday, Aug. 4, £215. 12s. 9d.; Saturday, Aug. 5 £297. 4s. 9d.; Sunday, Aug. 6 £51. 15s. 4½d.; Monday, Aug. 7, £260. 16s. 10½d.—total, £850. 19s. 10½d. The mileage run for the Bank Holiday amounted to 45,945 miles, against 44 588 last year, an increase of 1,357, or 3 per cent. The passengers carried on the same day numbered 529,132, being an increase of 35,984 over the same day last year, or 7·3 per cent., while the receipts amounted to £2,702. 19s., against £2,412 2s. 1½d last year, an increase of £260. 16s. 10½d., or 10·7 per cent. The total mileage for the five days amounted to 182 469 miles, an increase of 7,466 miles over the corresponding period of last year, or 4·3 per cent. The passengers carried numbered 1,962,784, an increase of 141 045, or 7·7 per cent.; while the total receipts amounted to £9,478. 19s. 8d., against £8,627. 19s. 9½ d. last year, an increase of £850. 19s. 10½d., or 9·9 per cent. The receipts during the Agricultural Show would doubtless have been better but for the bad weather. The receipts for the Bank Holiday constitute a record, with the exception of Coronation Day.

London County Council.—The extension of tramways in the North of London is rapidly approaching completion. Hitherto the trams from Highgate-hill downwards have only come as far as the Archway, while those going northwards in that direction have turned off at the corner of Junction-road. Now, however, rails are being laid down from the Arch to Junction-road, which will thus fill up the gap of about a quarter of a mile and effect an important connection between the two systems. A large and representative South London Protest Committee on the House of Lords' rejection of tramways over the bridges is being formed, and includes Mr. J. W. Benn, M.P., Mr. John Burns, M.P., Mr. R. K. Causton, M.P., Mr. Will Crooks, M.P., Mr. J. Cumming Macdona, M.P., Dr. Macnamara, M.P., Mr. J. P. Nannetti, M.P., and the Mayors of Lambeth, Southwark, Woolwich, Deptford, Camberwell, Battersea, and Lewisham, with Councillor W. Westcott, of the Reformers' Club, St. Agnes-place, Kennington Park, S.E., as hon. secretary (*pro tem.*). A meeting will be called as soon as possible to decide what action shall be taken. There has been a baseless rumour in circulation that the County Council had abandoned the proposed Lordship-lane tramways because of the impossibility of getting cars beneath the railway bridge at Lordship-lane. The roadway will have to be lowered, as has been done on the Streatham line at Brixton Station, and on the Tooting line at Clapham-road Station. The County Council is proceeding with widenings, etc., in connection with the trams over Denmark-hill. At the meeting of the North Metropolitan Tramways Co. on Wednesday the agreement with the County Council for the surrender of the balance of the company's lease was ratified. At a meeting on Wednesday of the South London Protest Committee, referred to above, the association was formally called into existence, and it was decided to use every effort in support of the Bill, which the committee hoped the County Council would reintroduce next session.

North-Eastern Railway.—At the half-yearly meeting of this company last week, Sir Edward Grey, who presided, stated that the dividend was ¼ per cent. less than for the corresponding period of last year. From the report it would be seen that there had been a falling off in the gross receipts of £28,184, but a reduction in the expenditure of £31,292, leaving an increase in the net receipts of

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£31,080. It was not, therefore, the falling off in the gross revenue which was the cause. From the capital account it would be seen that they had to pay interest upon considerably more capital than was the case a year ago, and it required £36,000 more to pay a dividend at the same rate as a twelvemonth back. The real cause, therefore, of the reduction of the dividend was the increase in their capital. Had their capital remained the same as it was a year ago they would have been able to pay the same dividend. Turning to the electric train working at Newcastle, the Chairman said they had now a year's figures to work on, and comparison with the last year of steam working showed a gain in passengers of 20·9 per cent., and in receipts of 17·6 per cent. So far electrification of these suburban lines had resulted in some increase of net revenue and convenience to the public. In reply to a question as to whether motorcars were to be run in Hull streets in opposition to trams, Sir Edward said the company had no special plan in their minds when they obtained powers, and they had not yet developed any large scheme for making experiments. They should take the utmost care that none of their experiments were futile ones likely to be costly to shareholders. During the past half-year the company spent £36,000 in the Newcastle district on electric power and lighting, which had nothing to do with the electrification of the railway. This was part of a large expenditure they were incurring in substituting electric power for steam power in their Gateshead shops, the new warehouses in New Bridge-street, and all works of that kind in the Newcastle district. When it was completed they would be able to do away with the steam power they were now using, and by having electric power and lighting in their works they estimated that there would be a saving as compared with the older methods. The report, recommending a dividend at the rate of 4¾ per cent., was adopted.

Glasgow.—At the meeting of the Corporation last week, Mr. Hugh Alexander moved the adoption of the tramway accounts for the past financial year, particulars of which appeared in our issue of the 4th inst. He stated that he had not any wonderful tale to tell, but he could congratulate the members on the year's business. The revenue had risen by about £40 000, and out of that they had £10,000 of clear surplus. One little matter was not quite so satisfactory. The earning capacity per car-mile was steadily falling. Some years ago he had warned the house not to expect a growing increase in the surplus. During the past five years the earning capacity had fallen 1½d. That was due, not as some of their friends would be telling them, to their cars being run too far into the country, but because they had placed upon the streets something like 186 cars more than they had five years ago, and were travelling something like 88 miles more; and those two figures showed an increase far and away out of proportion to the natural increase in the population. The meaning of that was that the citizens within the tramway area were getting a much better service—a much more frequent and a much more desirable service—than formerly. The question of depreciation had been well looked after. The natural depreciation—or rather, he should say, the normal depreciation—had been met. They had set aside £81,000 for depreciation, which figured out at 3 per cent., not on an attenuated capital, but on their whole capital used since the tramways were inaugurated. They had not attempted to write down the depreciation on £1,783,000, which was their net liability to-day. In addition to that they had set aside £72,176, equalling 2½ per cent., for the renewal of the permanent way, which was considerably in excess of anything they set aside before. Notwithstanding that they had laid aside £450 per car mile to renew the track, it had been borne in upon the general manager and the committee that after using the track for five years they would require more than £450 per annum per car mile to renew the track when the time came to do so, and, therefore, on this occasion they laid aside £500 per car mile. After all that had been done, and £25 000 had been handed over to the common good, they had still a surplus of £93,000. Out of that they proposed to set aside £68,000, equal to 2¼ per cent., for special depreciation. When they took the normal depreciation, the fund for renewal, and the special depreciation, they had out of their working for the year just passed laid aside no less than 8 per cent. of the total capital employed. That was evidence that the tramway undertaking was being conducted on perfectly safe lines. After some discussion as to an extension of ½d. fares, the report was adopted. The inhabitants of Newton Mearns have appointed a second deputation to wait upon the Corporation in reference to an extension of the line.

Liverpool Accident.—The inquest upon the victims of the accident on the electrical section of the Lancashire and Yorkshire Railway was held last week, and we extract the following particulars of the evidence from the *Liverpool Post*: William Rimmer, the driver, said he had been in the employment of the company for 17 years. The Coroner: When you approached Hall-road, am I right in saying that you came to four signals—the outer distance, inner distance, outer home, and inner home?—Witness: Yes; the outer distance signal was "on"—that is, against the train. Am I right in saying that you are allowed to pass the outer distance signal even when it is against you?—Yes; you are allowed to pass them. You are also allowed to pass the inner distance signal. Witness added that the outer distance signal—No. 40—was against him. Was the inner distance signal against you?—Whilst I was travelling the 500 yards between the outer distance and inner distance signals the inner distance signal was taken off. That is the one for Hall-road. The Coroner: I do not want to press you, but do not you know as a matter of fact it is physically impossible to take off No. 39—the outer home signal—and give you a free road unless No. 38 is right for the main line?—Witness: When I got to the outer home signal the signalman was at the window of his box waving his green flag I put off the current and blew my horn to find out whether the signal was for me, and the signalman waved the flag continuously, showing it was for me, and I put on the current again. When I got to the end of the platform the inner home signal was then thrown on, I had not very much room, and at the time I noticed that the points were set for the middle siding. I at once shut off the current and applied the brake with all the speed I could. I had not sufficient room to pull up.—The Coroner next directed the attention of the witness to the rules and regulations for signalmen, and particularly to the regulation which stated that when a signal became defective or was not working efficiently, a competent person must be placed at the signal post with a hand signal. He asked the witness to point to anything in the rules which warranted him in accepting the signal.—The Witness said he took it for granted that the flag was for him. The pointsman was a competent man.—The Coroner: Can you show me in these rules anything that entitles you to accept a green flag waved violently from the cabin window as a signal for anything?—Witness: Oh, yes.—The Coroner: Well, I cannot find it.—Witness: If he had intended me to stop he would have given me the red flag.—Counsel for the company: You passed without receiving the verbal instructions required by this notice?—Witness: Yes, sir.—The foreman of the jury asked if the method of signalling used on this occasion had ever been used before.—Witness replied that when he was "firing" he remembered seeing it done several times.—Mr. Fletcher (the driver's solicitor): Was there any doubt in your mind as to your duty to obey the signalman?—Witness: It was my duty to obey the signalman.—The Coroner: You have raised a very serious point, Mr. Fletcher. Is it going to be seriously contended that when a motorman is in charge of an electric train and sees the signal against him, that he is going to pass a home signal with the waving of a green flag from the cabin window?—Mr. Fletcher: I think from this notice he is entitled to do so.—William Boote, the signalman, said that on the day of the accident he signed on at half-past twelve noon, and his duty would cease at at 8.30 p.m. When the Hall-road train which preceded the express was safely into the middle siding, signals 37, 38, 39, and 40 were against the express. It was not possible to get No. 40 signal down in favour of the express unless he first of all closed up the points. Both distance signals were against the driver. The Coroner: The driver told us that when he passed the outer distance signal, which was against him, he came to the inner distance, and that was for him. Could the inner distance signal be for him without the points being set for the main line?—Witness: That is mechanically impossible. He then he says he came to No. 38?—It was against him for a time, but No. 38 could have been in his favour, although the points were set for the main line. When he came to the home signals they were against him?—Yes. Were they bound to be against him mechanically?—Yes; I tried to work the home signal and the electric lock prevented me. Witness said that to get the express train on he waved a green flag. When he found the home signal would not work he tried several times to reverse the signal in favour of the driver. He also reversed the points several times to try and effect this. When he waved the green flag the express was almost at a standstill at the home signal 50 or 60 yards away. He did not say anything to the motorman, and he used no words when he waved the flag. The express then came on and went into the middle siding.—The coroner then called witness's attention to the regulation with regard to a properly qualified person waving a flag at the signal post when a home signal broke down, and asked him to point to any regulation authorising him to wave a green flag from the cabin.—Witness, in reply, said he did not want to delay the express, and he had no one to send down to inform the station-master.—The Coroner: Have you ever brought on a train in the same way as you did on this occasion?—Witness: No, sir, but the station-master has sent a train past the signals.—That was on verbal instructions after communication with you. Yes.—With the home signals against the approaching train the facing points are against the main line?—Yes. Does that not prove that being in a state of uncertainty you should have sent a hand signalman to look at these points and come and tell you, and then you must give instructions as to what the train must do?—Yes. You do not allege, do you, that there was anything in these rules which justifies you in doing what you did?—No. Witness stated that he was perfectly sober, but lost his head. He had three times complained in writing to the company of being overworked. He admitted that he would not have been reprimanded for stopping a train when the signal was against it if the matter were properly explained. An inspector stated that there was no rule that a man would be fined if he stopped an express train. He had had no application to him to put a boy in the cabin to help the signalman to do the booking. Mr. C. B. Byles, signalling superintendent, explained the system of signalling adopted on the electric system, the fundamental principle of which was a duplication of safeguards, and at any failure the signals got into a position showing safety. The Coroner, in summing up, said that the magnitude of the disaster should not influence the verdict of the jury. Nothing had come out in the enquiry to show that the machinery provided by the railway company was at fault. The only thing that it was suggested had been defective was the lock, and that was an extra precaution so as to inform the signalman whether the points were in order or not. The signal machinery was simply perfect if those in charge of it only obeyed what it said to them in dumb language. But in this case the signalman lost his head, he got hold of a green flag and waved on the train. The jury would have to study the rules and say whether he did right. The evidence of the other signalman was that it was against all rules and regulations, and the jury would have to say whether that was the prime cause of the disaster. They would also have to consider the conduct of the motorman. He suggested to the jury that the motorman should have disregarded the signal given by the signalman. If they found these men had been negligent they would have to say whether their conduct was censurable or culpable. Before they were satisfied that they were culpable they would have to find that these men had acted recklessly and without caring what the consequences were.—The jury found that the accident was caused by a mistake on the part of the signalman Boote and the

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driver Rimmer, through an error of judgment, censurable but not criminal. They recommended the abolition of facing points, that motor guards should be made acquainted with the working of motors, and that signalmen and drivers should be periodically examined to test their knowledge of the rules.—Counsel for the company intimated that the company will not dispute civil liability for the accidents.

LIGHTING AND GENERAL.

Wednesbury.—Current is now to be supplied to consumers by slot meters at the rate of 4d. per unit.

Burrelton.—A committee has been appointed for the purpose of obtaining a telephone call office for the village.

Willington.—The Durham Electric Power Distribution Co. are applying for a provisional order for Willington.

Ryde (Isle of Wight).—The accounts of the Ryde Electric Lighting Co. for the year ending December, 1904, show a profit of £62.

Dunfermline.—The Fife Electric Power Co.'s generating station at Townhill, Dunfermline, was formally opened on the 15th inst.

Brandon.—The County of Durham Electric Power Distribution Co. intend to promote a provisional order for lighting in the Brandon district.

Worthing.—An inquiry has been held into the application of the Town Council for sanction to borrow £3,300 for electric lighting purposes.

Chatham.—A draft agreement with the Kent Electric Power Co. for making the trench in the streets for the company's cables has been approved.

Horncastle.—Permission has been granted the General Post Office to erect an overhead line of telephone wires from Horncastle to Woodhall Spa.

Canary Islands.—In consequence of the recent breakdown of the Canary Islands cable, the Spanish Press very strongly recommends the laying of a second cable.

Cleckheaton.—An inquiry has been held into the District Council's application for sanction to borrow £4,000 for the purposes of the electricity undertaking.

University College, London.—The courses of instruction in mechanical, civil, municipal, and electrical engineering begin on Tuesday, Oct. 3. Full particulars appear in another column.

Manchester.—The lord mayor (Sir T. Thornhill Shann) on the 14th inst. opened an exhibition in the Drill Hall, Wilmslow, designed to illustrate the various uses to which electricity may be put.

London Gazette.—The partnership between Frederick William Rutton May and Edwin George Kennicott Calder, electrical engineers, 4, Newington-causeway, London, has been dissolved by mutual consent.

Ryton.—The Urban District Council have consented to the application to be made by the County of Durham Electrical Power Distribution Co. for a provisional order authorising them to come into the Ryton District.

Scarborough.—The Town Council propose to purchase electrical plant, in order to replace manual labour in stone-breaking, gravel screening, and other work. The saving of ½d. on the rate is expected to result from this move.

Lowestoft.—The Electric Lighting Committee's last report shows that during July 12 new consumers have been connected to the mains, representing 338 8-c.p. lamps. There are now 639 consumers, representing 32 119 8-c.p. lamps.

West Auckland.—We understand that the Cleveland and Durham Electric Power Co.'s tender, of 37s. 6d. per lamp inclusive of all costs, is under favourable consideration. A parish meeting has decided in favour of the proposal by a large majority.

General Post Office Exhibit.—The General Post Office will at the electrical exhibition at Olympia next month show their complete loan exhibit illustrating the growth of the electric telegraph, which was displayed at the recent St. Louis Exposition.

Charing Cross, West End, and City Electricity Supply Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 5 per cent. per annum for the half-year ended June 30, 1905. Warrants will be posted on the 15th inst.

South Metropolitan Electric Light and Power Co.—The transfer register of shares of this company will be closed from 18th to 31st inst., both days inclusive. The interim dividend to June 30 upon the 7 per cent. cumulative preference shares is payable 31st inst.

Dundee.—The electric lighting of the reading-room, free library, and art galleries is being considered, and the suggestion has been made that, instead of the electric current being generated on the premises as is done at present, the town's supply should be used.

Dumbarton.—The Electric Supply Corporation have ordered the mains for Dumbarton. At the next meeting of the Town Council it will be moved that provision be made to put in mains in the principal streets for the purpose of providing these streets with electric light.

Electro-peat Coal.—A plant for the manufacture of electro-peat coal has now been erected at Kiberry Bog, near Athy, co. Kildare, upon the estate of the Duke of Leinster, and will be in operation before the end of the present month, when the fuel is to be placed upon the market.

Sale of Plant.—The South Shields Guardians offer for sale a storage battery. Offers, in writing, should be delivered at the office of Mr. J. W. Coulson, clerk to the Guardians, by Sept. 1 next. Particulars of this and of a sale of two sets of triple-expansion engines, 1,750 h.p., will be found in another column.

Mather and Platt.—After transferring £30,000 to reserve (making it £230,000), the directors, in their report, recommend a further dividend of 3½ per cent., together with a bonus of 3 per cent., making a total distribution of 10 per cent. for the year ended June 30, and leaving a balance of £21,238 to be carried forward.

Yarmouth.—Nineteen applications for electric light on the route of the Gorleston and Southtown tramway have been received, which, if granted, will produce an estimated revenue of £130. Cables are to be laid from the Half-Way House, through High-street, to the Lowestoft-road terminus, at an estimated cost of £530.

Removal.—Messrs. Knight and Co. inform us that in consequence of the great increase in their business they have removed to much larger and more commodious premises which have been specially built for them at 227 to 239, Tooley-street, S.E., where in future their business will be carried on under the style of Chas. Knight and Co., Limited.

Special Work.—We are informed that the London electric firm of George-street, Croydon, make a speciality of direct-current dynamo and motor repairs and rewindings, having made special arrangements for the rapid execution of such work. A recent job for the complete renewal of a 10-kw. commutator has been done by this firm in two days.

Correspondence Classes.—Particulars will be found in another column with regard to the system of teaching electrical and mechanical engineering science by correspondence, exercises, drawings, and instructions, successfully carried on by Prof. Jamieson, at 16, Roslyn-terrace, Kelvinside, Glasgow. We note that correspondents may enrol at any stage and time.

Oswestry.—The Postmaster-General has informed the Council that he had requested the National Telephone Company to provide a direct circuit between their exchange at Oswestry and the Post Office trunk exchange at Wrexham, and this should meet Oswestry's requirements. He could not open a Post Office trunk exchange at Oswestry, nor could he undertake to extend the boundaries of the Wrexham exchange area, in which Oswestry was situated.

Aberaron.—The Council and the South Wales Electrical Power Co. are corresponding with regard to the terms upon which the Council would be prepared to allow the company to run their power mains in the district. They propose to pay the Council a sum equal to 2½ per cent. of the total received for energy supplied, provided that the maximum payment of £50 per annum should not commence until the beginning of the third year's supply. The Council desire the £50 should begin to run from the beginning of the second year.

Cardiff.—Mr. Arthur Ellis, manager of the electric lighting department of the Cardiff Corporation has reported to his committee that he had been asked to quote for a supply of electric current to the Great Western Railway Co., who proposed to use the town supply not only for lighting but for all power purposes in their sidings between Roath and Canton. About 1,600 h.p. would be required for motors. At present the company are using nearly a quarter of a million units, but this will be greatly increased in the future. The Council decided to offer the same terms as to the Ely Paper Works.

Agencies.—Mr. Norman Hamilton has opened business at 19, Waterloo-street, Glasgow, as agent (in Scotland) for Thomas Parker Limited, Wolverhampton, Kelvin and James White, and Jessop and Appleby Bros.—Messrs. Zschocke's Engineering Co., Kaiserslautern, Palatinate, have appointed Messrs. T. Sugden Limited of 180, Fleet-street, London, E.C., as sole agents in Great Britain and Ireland for Zschocke's patent water coolers, blast furnace gas purifying and similar plants. Messrs. Sugden have a branch office in Cardiff and are represented in Birmingham, Lancashire and Yorkshire, Newcastle, Glasgow, Llanelly, and Belfast, etc.

Taunton.—The following notices of motion have been tabled: (1) that, in consideration of the electric light works having a deficit of over £60 on last year's working, and, nothing having been put by for depreciation (over the small sum for sinking fund), which according to the committee's own showing on the boiler it is proposed to sell is 5½ per cent.—£220 off £376, it being now worth £156—no further loan should be sanctioned until sufficient is charged to the consumer to pay working expenses and meet such depreciation; (2) that the resolution passed at the special meeting of the Council on July 21, 1905, to sanction a loan of £5,000, be rescinded.

India.—*Indian Engineering* says the Railway Board has sanctioned the fitting of the two saloon carriages of His Excellency the Commander-in-Chief, the manager's saloon carriage, and six first and second class carriages for service on the Karachi Quetta run with Stone's batteries for supplying electric power for fans and light on the North-Western Railway. An estimate for the extension of electric lighting in Government House, Madras, is under consideration. The cost works out to Rs.34,216, and a provision of Rs.35,000 has been made in the budget for the work. The roadmaking to the new powerhouse for the proposed Mussoorie hydro-electric scheme is nearly complete. About 20 firms up to the present have evinced a desire to tender, but some of them may change their minds. There is plenty of time yet.

Stock Exchange.—The Stock Exchange Committee have appointed Aug. 23 special settling day for County of Durham Electrical Power Distribution Company's 40,000 ordinary shares of £5 each, £2 paid, Nos. 10,001 to 50 000, and 30,000 5 per cent. preference shares of £5 each fully paid, Nos. 20,001 to 50 000; and have ordered the undermentioned securities to be quoted in the official list: County of Durham Electrical Power Distribution Company's 40,000 ordinary shares of £5 each, £2 paid, Nos. 10 001 to 50 000 and 30,000 5 per cent. preference shares of £5 each fully paid, Nos. 20,001 to 50 000; Metropolitan District Railway Company's further issue of £100,000 4 per cent. perpetual debenture stock. Application has been made to allow South Staffordshire Mond Gas (Power and Heating) Company's 33,346 ordinary shares of £10 each, fully paid, Nos. 1 to 3,334 and 4,001 to 34,012 (renewed special application), to be quoted in the official list.

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Catalogues.—The 1905 edition of Verity's catalogues contains following sections: Department I.—(P) plant and alternating-current machinery; (M) continuous-current dynamos and motors; (C) main switches, switches, and controllers; (L) arc lamps. Department II.—(A) accessories; (S) wires, cables, and supplies; (R) heating appliances; (B) bells and telephones. Department III.—(A) ornamental fittings; (B) plain fittings; (C) fittings, accessories. They will be forwarded post free to our readers from Verity's Limited, 31, King-street, Covent Garden, London; 3, Queen-square, Bristol; Hardman-street, Deansgate, Manchester; 33, Highbridge, Newcastle-on-Tyne; 40, Bath-street, Glasgow.

King's Lynn.—At last week's meeting the engineer reported that since the previous meeting applications had been received for 105 additional lamps of 8 c.p. or equivalent, making a total of 21,384 from private consumers, and that there are two additional consumers, making a total of 525. He also reported that he had asked the General Electric Co. to quote for apparatus for the switch-board in connection with the generator. An offer of £60 from Messrs. Fielding and Platt for the gas-producer as it stands was accepted. The following report was submitted: Units generated, June 1905, 25,065 (1904, 23 252); total units sold to private consumers (light and power), 15,823 (13,759); units sold at lighting rates, 4,820 (4,102); units sold at power rates, 11,003 (9,657); cost of fuel, stores, repairs, and wages at station, £111. 10s., £113. 2s.; cost per unit generated, 1·0675d. (1·1683d.); wages of lamp-lighters and outside staff, £16. 13s. 7d. (£20. 8s. 11d.).

Wisbech.—Mr. Southwell has been appointed chairman of the Electric Lighting Committee for the ensuing year. The Local Government Board have informed the Council with regard to the application for sanction to borrow £25,000 for electric lighting purposes, that the Board of Trade are not prepared to give their consent under Section 11 of the Electric Lighting Act, 1882, to the proposed agreement between the Town Council and the National Electric Construction Co. They added that if the Town Council desire to raise a loan for the purpose of providing an electric lighting undertaking, and then to transfer the undertaking for a period of years to a company, the Council should seek further powers enabling them with the consent of and by deed to be approved by the Board of Trade to transfer their powers, duties, and liabilities subject to such exceptions and modifications as may be specified in the deed. The Board of Trade would then be prepared to consider an application for their consent to a deed of transfer on the above lines.

Doncaster.—An inquiry has been held into the application of the Corporation for powers to borrow a further sum of £7,172 for the extension of their electrical undertakings. The Town Clerk (Mr. R. A. H. Tovey) stated that although the Corporation had been reluctant to spend over and above what they had authority to spend, they had been compelled to spend a certain amount of money on the extension of their tramway system. It was necessary that they should have sufficient energy to deal with the special race week traffic. Last year they had managed to get through with their present plant. To avoid the risk of breakdowns they had decided to put down another boiler and engine at an estimated cost of £2,250 for the machinery. Then the foundations were estimated to cost £200, the steam pipe and exhaust, switchboard, etc., making a total of £6,420. The former cost of work done had exceeded the estimate by £11, and sundry expenses since had amounted to £741. They hoped to be able to have the additional energy ready for generation for the September race week. The tramways were owned by the Corporation. In Doncaster they had one power station for both lighting and traction. In 1901 the Corporation had generated 90,000 units, last year they had generated 973,266 units. That had been largely due to the tramways undertaking, but the demand for electric lighting had also increased. The profit made over and above expenses during the past year had amounted to £4,007, less interest and redemption, or £850 with interest and redemption. The average charge made by the Corporation for electrical energy was 4·4d. per unit, 2d. for power and 1½d. per unit for tramways. Private consumers were charged 2d. per unit for the first 5,000, 1½d. per unit for the second 5,000, and 1½d. per unit for the third 5,000.

Parliament.—The following private Bills have received the Royal assent: Aberdeen Urban District Council (changed from Aberdare Tramways), Accrington Corporation, Andover Lighting and Power, Baker-street and Waterloo Railway, Birmingham Corporation, Blackpool Improvement, Bolton Corporation, Bootle Corporation, Bristol Corporation, Central Electric Supply, Charing Cross, Euston, and Hampstead Railway, Chelsea Electricity Supply, Colne Corporation, County of London Electric Supply Co., Croydon Corporation, Dublin United Tramways, Ealing Corporation, Edgware and Hampstead Railway, Gosport and Fareham Tramways, Great Northern, Piccadilly, and Brompton Railway (No. 1), Great Northern Railway, Great Western Railway (Additional Powers), Great Western Railway (New Railways), Halifax Corporation, Hastings Tramways, Littlehampton Urban District Council, Liverpool Corporation, Llandrindod Wells Urban District Council, London and North-Western Railway, London County Council (General Powers), London Southern Tramways, London United Tramways (Extension of Time), Loughborough Corporation, Mansfield Corporation Metropolitan and Great Central Railway Companies, Metropolitan District Railway, Metropolitan Electric Supply Co. (Acton District), Metropolitan Electric Supply Co. (Various Powers), Metropolitan Electric Tramways, Metropolitan Railway, Mexborough and Swinton Tramways (Extension of Time), Morley Corporation, Newcastle-upon-Tyne Corporation, North-Eastern Railway, North-East London Railway, North Metropolitan Electric Power Supply, Nottingham Corporation, Oldham and Saddleworth District Tramways, Rhondda Urban District Council, Rhymney Railway, Rotherham, Maltby, and Laughton Railway, Sandgate Urban District Council, Shepton Mallet Gas Co. (Electric Lighting), Shropshire, Worcestershire, and Staffordshire Electric Power (changed from Shropshire and Worcestershire Electric Power), Skegness Water, Southampton and Winchester, Southend and Colchester Light Railways, South Lancashire Tramways, South Wales Electrical Power Distribution Co., Stockport Corporation, Swansea Corporation, Tralee Urban District Council, Tyneside Tramways and Tramroads, Ulster and Connaught Light Railways (changed to Newry, Keady, and Tynan Light Railway), West Cumberland Electric Tramways (Extension of Time), Weybridge and Walton-upon-Thames Electric Supply, Whitby Urban District Council, Whitechapel and Bow Railway, Wigan Corporation, and Woolwich Borough Council. The following provisional orders confirmation Bills have received Royal assent: Electric lighting provisional orders (Nos. 1 to 9), Bury (Rural), Conway, Golbourne, Haydock, Hipperholme, Little Lever, Southall-Norwood, Spalding, Whitwood, and Whitworth; Ballaghaderren; Woolwich; Denny and Dunipace, Grangemouth, Inverness, Pollokshaws, Renfrew, Rutherglen, and Uphall; Andover, Barnsley, Hessle, Litherland, Little Hulton, Penmaenmawr, Ravensthorpe, Stratford-upon-Avon, Surbiton, and Tewkesbury; Barnet, Brockenhurst, Farnham, Gosport and Alverstoke, Houghton-le-Spring, Lichfield, Ludlow, Lytham, St. Alban's, and Ware; Bishop's Stortford, Dover, Hemsworth, Marlborough, Tottington, and Woking; Airdrie, Coatbridge, and Cults and District. Tramways orders confirmation (Nos. 1 and 2), Bradford, Gorton, Keighley, Leeds, Liverpool, and Pudsey; Colchester, King's Norton and Northfield, Luton, Portobello and Musselburgh, and Southampton. Also Scotland: Paisley District Tramways and Wemyss Tramways.

Tottenham.—The agreement which has just been entered into by the Tottenham District Council for the transfer of its powers under its provisional order (obtained in 1902) to the North Metropolitan Electric Power Supply Co. provides that the company shall before Oct. 1, 1906, carry out all necessary works to give a full and proper supply of electrical energy within the compulsory area, and also in certain additional streets. Further distributing mains are to be laid by the company on the requisition of the Council, or of owners or occupiers, and in any notice under Section 25 of Electric Lighting Clauses Act, 1899, the company shall not specify any sum exceeding 8 per cent. upon the cost. Before commencing the works, the company undertakes to submit to the Council full particulars of the system of supply and distribution which it proposes to adopt for the reasonable approval of the Council, the energy to be distributed under the provisions of the order solely from sub-stations or feeding points within the district. The company agrees to reimburse the Council the expense it was put to in obtaining the order and in opposing the company's Bill, and also the amount which, with the consent of the company, or under an order of a court of law, the Council may pay to its late consulting engineer, together with the costs properly incurred by it in defending, at the request of the company, any action brought by him in connection therewith. The charges for the supply of energy are to be: public lighting—2d. per unit between dusk and midnight and 1d. per unit between midnight and dawn, or at the rate of 1½d. per unit for lamps kept alight from dusk to dawn, provided that the Council enter into a contract for the lighting of not more than 110 lamps of an average consumption each of 600 watts for 10 years; private lighting—6d. per unit for the first 100 hours maximum demand, and 2d. per unit for subsequent consumption, or, in the alternative, a flat rate of 5d. per unit; power or heating (if separately metered)—4d. per unit for the first 100 hours maximum demand if 5 h.p. is not exceeded, and 1d. per unit for subsequent consumption. Energy supplied to the Council for public purposes other than street-lighting is to be charged at 10 per cent. less than to private consumers. At the expiration of the first and every subsequent period of seven years, the Council can require a revision of these rates, and in the event of a difference the terms are to be settled by reference to arbitration. If the Council erects a generating station in connection with its refuse destructor, it can compel the company to purchase the energy at the price of 1·43d. per unit metered at the switchboard, but the cost of laying the necessary mains to the company's sub-stations or feeding points must be borne by the Council. At the end of each year after the expiration of 10 years, the company is to pay the Council half of the net profits in excess of a sum of 5 per cent. upon the amount expended by the company in the area of supply, but if the net profits in any previous year have not amounted to 5 per cent., the company will be entitled to make good the deficiency out of the receipts for any subsequent year before the net profits are ascertained. The Council has power, upon giving six months' notice, to require the company to sell to it the undertaking (*a*) at the end of 10 years or of a further period of five years upon paying the capital expended, and a sum equal to one-tenth of that amount, and also refunding the sum paid by the company as the costs of the Council in obtaining the order and in opposing the company's Bill, etc.; (*b*) at the end of 1930 and upon the expiry of every subsequent period of 10 years on the same terms with the exception that the Council would not have to pay a sum equal to a tenth of the capital expenditure; and (*c*) at the expiration of 42 years upon the terms mentioned in Section 2 of the Electric Lighting Act, 1888, the company to hand over on the completion of the purchase the undertaking in good condition and repair. If the Council elects to purchase at the end of 10 or 15 years it will be bound to take its supply in bulk from the company. If it exercises the option on Dec. 31, 1930, or at the expiry of any subsequent period of 10 years, it can call upon the company to supply in bulk. The Council consents to the company supplying electrical energy for power purposes to any company, body, or person within the Council's district, but consumers using less than an average of 30 units per day throughout the year, and whose premises are less than 440 yards distant from the distributing main laid by the company under the order are exempted from the operation of this clause. After the determination of the agreement, the company will pay the Council 5 per cent. of the gross receipts to be derived from the supply of electrical energy for power within the district.

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PROVISIONAL PATENTS, 1905.

AUG. 3.

15871. An improved box for enclosing switches, fuses, or the like. George Owen Donovan, 126, Chester-road, Erdington, Birmingham.

15890. Improvements in or relating to switches for electrically driven motors. John Stratton and Ernest Alexander Claremont, Throstle Nest House, Old Trafford, Manchester. (Complete specification.)

15910. Improvements in vapour electric apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

AUG. 4.

15940. An improved type of four-way disconnecting street-box for the distribution of electricity by single, triple-concentric, or three-core mains. Thomas Henwood, 14, Pelham-square, Brighton.

15945. Novel or improved electromagnetic motor. Henry Ramsden Mortell and Leo Liberiate Mortell, Gough-chambers, Savile-street, Hull.

15969. Improvements in coin-freed apparatus for the supply of electric current. John Hikeley and the Newcastle-upon-Tyne Electric Supply Company, Limited, 46, Lincoln's-inn-fields, London. (Complete specification.)

15993. Improvements in electrical ignition apparatus. Harold Ernest Copp, 77, Colmore-row, Birmingham.

15996. Improvements in or relating to globes or the like for electric lamps or other purposes. Ernest Bohm, Birkbeck Bank-chambers, Chancery-lane, London.

16008. A method of increasing the capacity of electric accumulators. Max Roloff, 18, Southampton-buildings, Chancery-lane, London.

16024. Improvements in and relating to telephone office systems and to methods of establishing connections therein. Clement Lean, Thanet House, Temple Bar, London. (Deutsche Telephonwerke, R. Stock and Co., G. m. b. H., Germany.) (Complete specification.)

AUG. 5.

16057. Improvements in and relating to magneto-ignition apparatus for use with internal-combustion engines. Josef Gawron, 51, Deansgate-arcade, Manchester. (Date applied for under Patents Act, 1901, Aug. 6, 1904, being date of application in Germany.) (Complete specification.)

16063. Improvements in rheostats, controllers, and starting switches for electro motors. John Richardson Craig, jun., 26, Renfield-street, Glasgow. (Complete specification.)

16072. Improvements in or relating to electric cells. Alfred Loebl, 111, Hatton-garden, London. (Complete specification.)

16075. Improved means for supplying and cutting off currents of high potential to and from conducting lines. Siemens-Schuckertwerke G. m. b. H., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 23, 1905, being date of application in Germany.) (Complete specification.)

16079. Improvements in or relating to interrupters for making and breaking electric circuits. Albert Lewis Davis, 70, Chancery-lane, London. (Complete specification.)

16080. Improvements in or relating to interrupters for making and breaking electric circuits. Albert Lewis Davis, 70, Chancery-lane, London. (Complete specification.)

16083 Improvements in electric telegraph apparatus for transmitting indications corresponding to a transmitter handle. Joseph Robinson, 1, Queen Victoria-street, London.

16088. Improvements in or relating to means or apparatus for supplying electric current to telephonic apparatus. Edward Alfred Graham, 46, Lincoln's-inn-fields, London.

AUG. 8.

16123. An improved galvanic battery. Richard Joseph Crowley and Frederick Fitz Payne, 27, Chancery-lane, London.

16134. Improvements in or relating to electric furnaces. Charles Haswell, Arthur John Cridge, and Andrew Bashforth, 111, Hatton-garden, London.

16143. Improvements in and relating to electro-capillary recording apparatus. Axel Orling and Frederick William Corby, 61, Chancery-lane, London.

16179. Improvements in or connected with electrical ignition gear for internal-combustion engines. Frederick Richard Simms, 4, South-street, Finsbury, London.

AUG. 9.

16221. Improvements in or relating to the mounting of electricity conducting rails. La Société Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny et Cirey, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 7, 1904, being date of application in France. (Complete specification.

AUG. 10.

16249. Improvements in the method of constructing and laying underground mains for the distribution of electricity. Percy Nicholas Hooper and Alexander Duckham, Phœnix Wharf, West Ferry-road, Millwall, London.

16273. Improved means for coupling conduit pipes as used in the laying of electric wires and for like purposes. Albert Powell, 55, Market-street, Manchester.

16292. Improvements in or relating to starting devices for electric motors and the like. Martin Kallmann, 111, Hatton-garden, London. (Complete specification.)

16296. A combined advertisement column, fire-alarm, and police telephone. Carl Anton Andreasen, 73, Cheapside, London.

16300. Improvements in enclosed electrical machines for effecting the ventilation thereof. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

16301. Improvements in electric arc lamps. Walter Claude Johnson and Mads Peter Thomsen, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

16303. Improvements in alternating-current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16304. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States).

AUG. 11.

16324. A new or improved electrically-controlled circuit breaker. Ernest Turner, 213, Second-street, Trafford Park, Manchester.

16357. Improvements in arc lamps. André Blondel, 111, Hatton-garden, London. (Complete specification.)

16358. Improvements in or relating to the electrical operation of typesetting, typewriting, and like machines. Alfonso de Gessler, 111, Hatton-garden, London.

16373. Improvements in or connected with electric switches. Karl Schmahl, jun., 173, Fleet-street, London.

16397. New or improved disengaging mechanism for the controlling devices of shunt-circuit arc lamps. Oscar Efrém and August Sidler, 31, Bedford-street, Strand, London. (Complete specification.)

16398. Improvements in alternating-current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

AUG. 12.

4166A. Improvements in induction coils. Robert Bines, 46, Lincoln's-inn-fields, London. (Date applied for under Rule 5 of the Patents Rules 1905, Feb. 28, 1905.) (Complete specification.)

4167A. Improvements in telephone systems. Robert Bines, 46, Lincoln's-inn-fields, London. (Date applied for under Rule 5 of the Patents Rules 1905, Feb. 28, 1905.) (Complete specification.)

16404. An improved system of distributing electric power for traction purposes, regulated by signals and the like. Thomas Hackett Wright, 285, Upper Brook-street, Manchester.

16425. Improvements in gas and electric lamps or fittings. George Arthur Walker, 7, Staple-inn, London.

16434. Improvements in electric dental engines. Ernst Klapproth, 4, South-street, Finsbury, London. (Complete specification.)

16435. Improvements relating to transmission systems for wireless telegraphy. Simon Eisenstein, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Aug. 31.

1904.

16751. Galvanic batteries. Pörscke and Wedekind.

17059. Electromagnetic controlling devices especially applicable for use in automatic weighing apparatus. Darrah and Hackett.

17534. Construction of mechanical ear for electric trolley wires or the like. Phillips.

17601. Rotors of alternating-current machines. Zani and Dick, Kerr, and Co., Limited.

18937. Means and appliances for operating electrolytic cells. Hargreaves.

19574. Electric motor control systems. British Thomson-Houston Company, Limited. (General Electric Company.)

19589. Electric-magnetic mechanism, particularly applicable to railway signalling apparatus. British Thomson-Houston Company, Limited. (General Electric Company.)

20413. Hangers and ears for electric conductor wires. Heap, Bailey, Heap, Richardson, Billington, Haydock, Jones, and Brierley.

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20552. Dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

20609. Electric meters and measuring instruments. British Thomson-Houston Company, Limited. (General Electric Company.)

21242. Electric arc lamps. Gross.

21640. Apparatus for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, Berry, and Ewen.

21641. Safety devices in connection with radio telegraphic transmission circuits. Marconi's Wireless Telegraph Company, Limited, Berry, and Ewen.

21722. Rail joints and electrical bonds connected therewith. Radford.

21729. Swivelling coupling for electric cables. Phillips and Parkin.

21892. Electric arc lamps. Lewis.

21895. Electric telegraphs. Siemens Bros. and Co., Limited, and Grimston.

27246. Electrical measuring instruments. Siemens Bros. and Co., Limited, and Holmes.

1905.

1919. Brush-holder for dynamo-electric machines. Burke.

2426. Electrical resistances. Leonard.

2816. Automatic lubrication of trolley wheels for overhead system of electric traction. Bedford.

9219. Coherers. Magini. (Date applied for under International Convention, May 8, 1904.)

11605. Retransmitting and reinforcing telephone currents on lines, also used for telegraphic purposes, or otherwise liable to have currents of relatively low frequency passing over them. Kingsbury. (Western Electric Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¾-6 xd
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2⅞-2⅞
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1½-1⅝
—— 4½ per cent. 1st Debenture Stock	100 ..	92-95
—— 4½ per cent. 2nd Debenture Stock	100 ..	78-81
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	3 ..	1¼-2 xd
—— 5 per cent. Debentures	100 ..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1½-1⅝
—— "A" Shares, 01-017,139	5 ..	2-2⅛
—— 5 per cent. Debentures	100 ..	89 94
—— 4 per cent. Deb. Stock, Red.	100 ..	83-88
Electric Construction, Nos. 1 to 112,100	2 ..	⅜ ⅝
—— 7 per cent. Cumulative Pref.	2 ..	1⅝-1¾ xd
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	93-96
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	11½-12½
—— 4½ per cent. Preference	5 ..	5⅜-5⅝
—— 4½ per cent. Debentures	100 ..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15 16
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Telegraph Construction and Maintenance	12 ..	31½-33½
—— 5 per cent. Bonds	100 ..	101-103
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	11⅜-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11½-12½
—— 4½ per cent. Debenture Stock, Red.	100 ..	105-107
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	10 10½
—— 7 per cent. Preference	5 ..	9⅜-10½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9 9½
—— Nos. 60,001-80,000	5 ..	8⅜-8½
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	6¾-7½
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4 13/16-5 1/16
—— ditto (1903) 40,001-80,000	5 ..	4⅝-5⅛
Chelsea Electricity Supply	5 ..	6-6½
—— 4½ per cent. Debentures	100 ..	108-110
City of London, Ordinary	10 ..	10½-11
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	105-106
County of London Electric Supply, Ordinary	10 ..	8⅛-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100 ..	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	99-102 xd
Havana Electricity, 1-15,000	10 ..	8¼-10¼
Hove Electric Lighting, Ord., 1-13,000	5 ..	7⅜-8¼
Isle of Wight Elec Lt. and Pwr., 4½ p c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	⅜-½
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11⅜-12⅜ xd
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	97-100 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10½
London Electric, Ordinary	3 ..	2-2⅛
—— 6 per cent. Pref.	5 ..	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 100,001-300,000	5 ..	10-10¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	99-101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5 ..	7⅜ 8½ xd
—— do., 57,0 0-75,000	5 ..	7⅜-7½
—— 5 per cent. Pref., 1-57,00	5 ..	6 6⅛ xd
—— do., 57,0 0-75,0.0	5 ..	6-6⅛
Notting Hill Electric Lighting	10 ..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6⅛-7
—— 4 per cent. Debenture Stock	100 ..	98 100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-104
Smithfield Markets Electric Supply, Ord 1-12,000	5 ..	2⅜ 2½
—— 4 per cent. Debenture Stock	100 ..	76-10 xd
South London, Ordinary	5 ..	3⅛-4
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16-15/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	106-109
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	3⅛-14⅛ xd
—— 7 per cent. Pref.	5 ..	14-9 xd
—— 5½ per cent. Deb.	100 ..	97 99
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5⅛-5⅜
Westminster, Ordinary	5 ..	12⅛ 13 xd
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5 ..	6⅛-6⅜
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 ..	5⅜-6
—— Ord.	5 ..	8⅛-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100 ..	104-106
Barcelona Tramways, Ord., 1-20,000	10 ..	13⅜-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9,-10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101 xd
—— 4½ per cent. Red. Deb. Stock	100 ..	97-102 xd
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75.000	5 ..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	96-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	105-108
—— Ord. Pref.	100 ..	99-102
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	102-105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	8⅛-8⅜ xd
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-124
—— 4½ per cent. 2nd Deb. Stock	100 ..	97-99
Buenos Ayres and Belgrano Trams.	5 ..	3 3⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 7/16-5 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	106-107
—— Prov. Cert., all paid	100 ..	101-104
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	96-98
Calcutta Tramways, 1-102,268	5 ..	9⅛-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-109
Cape Electric Tramways, Nos. 1-480,000	1 ..	1⅜-1⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4¾-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14½ xd
—— 6 per cent. Cum. Pref.	10 ..	15-16 xd
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13½-14¼ xd
—— 6 per cent. Pref., Nos. within 1-60,0.0	10 ..	15-16 xd
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 ..	2½-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9⅜-10½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	99-102
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	102-104
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	⅛-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	104-106
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	£1,000 ..	101-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104 xd
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum Pref	10 ..	9⅛-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8⅜-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,152 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 ..	90-92
—— 4 per cent. Pref.	100 ..	101-103
—— ,, ,, deferred	100 ..	77-80
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	120-123
—— " " " '95	100	119-122
—— " " " '01	100	115-118
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	98-99
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid.	Last price.
	£	£
Telephones.—		
National Telephone, Preferred	100	109-110 xd
—— Deferred Stock	100	106-108 xd
—— 5 per cent. Cum. First Pref.	10	12½-13½ xd
—— 6 per cent. Cum. Second Pref.	10	12-13 xd
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5½ xd
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	103-105
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1	1½-1¾

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 12	1,709	1,688	+ 21	− 720h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	" 5	414	449	− 35	—	8	8	" 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	" 13	1,161	1,057	+ 104	− 554	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	" 12	353	328	+ 30	+ 854	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	" 9	1,023	1,141	− 117	+ 552	24	24	" 25	48,875	8,661,720	986,953	1·35	11·89	2,035	7·44
Blackpool Corporation	" 10	2,825	2,589	+ 235	+ 231	17½	17½	" 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	" 12	2,216	1,910	+ 306	− 1,593	16½	16½	Dec. 31	31,846	2,385,677	579,264	3·28	13·19	—	7·27
Bolton Corporation	" 13	2,041	1,885	+ 156	+ 1,361	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,384	6·14
Bournemouth Corporation	" 9	2,203	1,564	+ 639	+ 3,166	16 82	16 82	" 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	" 12	4,901	5,116	− 215	—	77	77	" 31	—	—	—	—	—	—	—
Brighton Corporation	" 13	2,110	1,369	+ 741	+ 750h	9	9	" 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	" 11	6,493	5,212	+1,281	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	" 12	1,270	1,215	+ 55	—	10 60	10·60	March 31	—	—	—	—	—	—	
Burton Corporation	" 13	405	417	− 14	− 701	8½	8½	" 31	17,850	3,878,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	July 29	2,207	2,255	− 47	+ 649	26†	—	" 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	Aug. 12	221	219	+ 5	− 411	8·5	8·5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	" 12	5,312	5,386	− 74	− 753h	6	6	" 31	347,588	44,875,547	1,281,214	1·66	65·10	57,931	35·80
City and South London Railway.	" 13	2,174	2,214	− 40	− 272h	6½	6½	" 31	—	—	—	—	—	—	—
Colchester Corporation	" 10	341	358	− 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	" 10	581	571	+ 10	+ 732	15½	15½	" 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	" 11	247	243	+ 4	+ 205	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	" 12	344	317	+ 27	—	4½	4½	" 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	" 11	187	141	+ 46	— h	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	" 11	4,514	4,172	+ 342	—	47	46	" 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	" 11	1,483	1,205	+ 278											
Dundee City Tramways	" 9	857	833	+ 24	—	22	22	May 15	—	—	—	—	—	—	—
East Ham Corporation	" 12	1,091	789	+ 302	+ 1,425	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6·79
Glasgow Corporation	" 12	15,315	14,218	+1,097	+ 8,006h	144½	143	May 31	756,480	195,767,519	17,945,585	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	" 9	1,871	1,950	− 79	+ 857	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	" 12	1,541	1,429	+ 112	+ 260	35	35	" 31	69,938	12,838,180	1,666,262	1·24	9·71	1,923	—
Hull Corporation	" 12	3,020	2,190	+ 829	+ 589	27	26	" 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	" 31	—	—	—	—	—	—	—
Ilkeston Corporation	" 9	140	151	− 11	− 471	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	" 9	209	240	− 31	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	" 12	6,953	5,833	+1,119	+ 3,556	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,223,507	1	9·79	—	4·82
Liverpool Corporation	" 5	11,576	11,764	− 188	—	103	103	" 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	" 13	1,802	1,703	+ 99	− 419h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	" 5	15,556	15,918	− 362	+46,919	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	" 10	194	184	+ 10	—	2½	2	—	—	4,740	850,121	1·33	10·13	2,370	—
Manchester Corporation	" 12	13,097	12,594	+ 503	+10,544	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Nelson Corporation	" 12	139	135	+ 4	+ 265	—	2½	" 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	" 12	4,110	3,588	+ 522	+ 2,665	50	45	" 31	197,849	43,069,934	4,336,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	" 13	1 684	1,216	+ 468	—	—	34	" 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	" 5	2,571	3,341	− 770	− 1,000	—	29	" 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	" 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	" 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·98
Rotherham Corporation	" 3	440	645	− 205	—	9½	7½	" 31	23,569	5,251,472	593,054	1·07	9·53	2,612	7·49
Salford Corporation	" 15	4,021	4,455	− 434	—	70½	—	" 31	214,111	39,213,560	4,884,580	1·28	10·29	—	—
Scarborough Tramways Co.	July 22	343	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 13	5,240	4,698	+ 542	+ 5,401	—	52½	" 31	—	—	—	—	—	—	—
Southampton Corporation	" 9	1,347	1,166	+ 180	—	—	18	" 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	July 5	472	435	+ 37	+ 407	—	9	" 31	—	—	—	—	—	—	—
Stockport Corporation	Aug. 11	968	591	+ 377	—	—	10½	" 31	—	—	—	—	—	—	—
Sunderland Corporation	" 13	1,728	1,424	+ 304	+ 623	—	20	" 31	—	—	—	—	—	—	—
Swindon Corporation	" 9	249	—	—	—	—	4½	" 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Wallasey U.D C.	" 12	1,092	927	+ 165	+ 467	11·85	10·5	" 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	July 13	342	332	+ 10	+ 175	7½	—	" 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	Aug. 10	2,285	1,178	+1,107	+12,122	46	8·62	" 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	" 2	803	1,003	− 200	—	—	7½	" 31	—	—	—	—			

† And 98 miles of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures.

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NOTES.

New Publication. — "Wireless Telegraphy and Hertzian Waves," by S. R. Bottone. (London: Whittaker and Co. 3s.). The author presents the public with an excellent treatise, chiefly elementary, of the phenomena of electric waves, and their use for telephonic communication. Students should find it a useful guide.

Personal.—At the funeral of Mr. W. E. Langdon on the 17th inst., the Council of the Institution of Electrical Engineers was represented by Mr. W. M. Mordey, vice-president), Mr. W. H. Patchell (vice-president), and Mr. G. C. Lloyd (secretary). Sir William Preece, who is absent in South Africa, was represented by his son, Mr. A. H. Preece.

Wireless Telegraphy.—In consequence of forest fires, floods, and the atmospheric conditions, it has been found extremely difficult to maintain telegraphic communication in the regions of the Lower Yukon, Alaska, and the Government is preparing to instal a wireless system. Experiments, which have so far proved successful, are being carried on.

Junior Institution of Engineers.—Vol. xiv. of the *Record of Transactions* contains the papers read during the twenty-third session, with the discussions, and an account of the visits of inspection made by the members. There is also a lot of information upon the history, membership, and finance of the institution, which will be found interesting and useful for reference.

Natural Gas Production.—The approximate value of the natural gas produced and sold in the United States, as reported to the United States Geological Survey, is given as about £8,000,000. Pennsylvania, Ohio, Indiana, and Kansas were the most prolific States, the products from the first-named representing nearly half the total. These figures do not take into account the natural gas produced in Canada and consumed in the United States.

Rubber.—The report of the British Consul at Para gives some information upon the practice of adulterating rubber. It was observed that a latex obtained from a tree entirely different from the "Heveas" is employed for this purpose, and even as a substitute for rubber altogether. The demand for rubber has led for some years past to an increase of adulteration, the plant used being plentiful in the Para district. These products are apparently of a tolerably serviceable character, and the substituted plant (the "Tapurú") is fruitful of growth, but the material is rather less elastic than the genuine article.

Cable-Laying.—The cable steamer "Colonia," which started on Saturday to lay the Commercial Cable Company's fifth Transatlantic cable from Canso, N.S, to Waterville, Ireland, appears to be in rather a bad way. The shore end of the cable was successfully dropped, and the steamer then put to sea, when the weight of the cable and the strong tide drove her on the rocks almost at high water. An unsuccessful attempt to float the "Colonia" was made on Monday, but the following day she was got off, the holes in her having previously been closed. It is expected that she will proceed to the Halifax Government Dock.

Telegraph Poles.—An inquest was held at Paddington last week on a telegraph wireman who succumbed to injuries received through the falling of a pole which he was repairing. The pole fell in consequence of the cast-iron base breaking. Evidence showed that the pole was carrying much less than its "breaking weight," and that the flaw could not have been detected by external examination. The end of the steel pole was some 2ft. above the ground line, so that the cast-iron base took all the stresses. The jury returned a verdict of accidental death, but suggested that the steel tubes should extend through the iron base into the ground. This is the procedure followed in all tramway work, where the cast-iron base is used for ornament only.

The Franklin Bicentenary.—It will be 200 years on Jan. 17 since Boston, U.S.A., witnessed the birth of Franklin, and it is but fitting that the American Institute of Electrical Engineers, in conjunction with the old-established New York Electrical Society, should take a prominent part in the celebrations which will doubtless mark the event. Franklin's fame as a scientist has been somewhat obscured by his celebrity as a politician, and, saving for his invention of the lightning rod—which is perhaps more correctly attributed to Procopius Diviss—he is remembered rather as a founder of the Great Republic than for his scientific research. Yet he deservedly holds a high place in the annals of science as a pioneer of the modern uses of electricity, and the fact that he had not a little part in the severance of our Transatlantic cousins from the Mother Country will not deter electrical men on this side from participating, at least in the spirit, in the recognition of his valuable efforts in the cause of science.

Telephonic Intercommunication.—An agreement is announced between the Post Office and the National Telephone Company by which intercommunication will be afforded over the Newcastle area. In the case of a call involving the use of both systems, a charge of 1d. per message will be payable by the person originating the call. Besides the four exchanges in the Newcastle proper area, the Post Office has 10 exchanges in the adjoining districts. The rates of subscription to the Post Office system are £3 per annum and 1d. for each call, whether involving the use of one or both systems; or £7. 10s. per annum (plus £1. 5s for each additional quarter mile of wire beyond a radius of half mile from the nearest exchange), with a charge of 1d. for each call involving the use of the company's system. This arrangement between the two undertakers is of interest as showing that the authorities at St. Martin's-le-Grand have finally decided upon co-operation in regard to the oldest of their telephone stations, which was designed by Mr. A. W. Heaviside.

Electric Lighting in New York. — The New York Edison Company has come in for a good deal of criticism from the American Press and public in regard to the conditions of its service, but the reduced charge for current of 5d. per kilowatt-hour enforced by the Government at the instance of the recent committee of investigation has not deterred the company from continuing its policy of supplying consumers free with arc lamp carbons and renewing all incandescents, although the reduction in the price of current is estimated to represent a loss of £200,000 a year. This gratuitous supply of lamps is a factor which should be borne in mind when instituting comparisons between the rates prevailing in America and in this country, and it is a practice that we should like to see imitated here. It would do better justice to electricity as an illuminant, and the undertaker would probably find his additional outlay and cost of supervision well repaid in the long run, as seems to have been the case with the New York Edison people.

Leasing of Provisional Orders.—The Frome Urban District Council, having obtained a provisional electric lighting order, came to the conclusion that the best policy would be to lease the undertaking, and negotiations were accordingly entered into with Edmundson's Electricity Corporation, by which the latter, having laid down the system with capital provided by the local authorities

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would carry on the concern for a period not exceedin 25 years on agreed terms. To carry this arrangement into effect the Council find it necessary to apply for a supplementary provisional order, as, by a recent decision of the High Court, it was laid down that the prohibition against the assignment of a provisional order without express powers applies also to leasing. The latter type of transaction does not, perhaps, lend itself so readily to "trafficking" as the former, but it is just as well to close up the loopholes, and to make it clear that the local authorities are still responsible for the due carrying out of obligations of the order in spite of leasing the same.

Electric Lighting versus Gas.—Another addition to this controversy, and to the misrepresentation which it has entailed, occurred at the half-yearly meeting of the Bristol Gas Company the other day. The chairman, in contrasting the cost of electric lighting with that of some 1,200 displaced gas lamps, gave the figures as £9,600 and £3,100 respectively. In a letter to the local Press Alderman Pearson, chairman of the Corporation Electric Lighting Committee, exposes the glaring error of this comparison. The £3,100 simply represents the cost of the gas consumed, while, as the chairman of the gas company must surely be aware, the sum charged for electric lighting includes the cost of standards, lamps, mantles, connections, renewals, and repairs. Not only this, but the amount comprises provision for interest and sinking fund, so that the further assertion of the gas company's chairman that "there was capital expenditure in addition" looks like adding insult to injury. A good deal more will be heard before the last word has been written on this familiar question, but meantime it is to be hoped that the opponents of electricity will have more regard for facts than has always been the case in the past.

Olympia Exhibition.—The many arrangements in connection with the approaching exhibition are nearing completion, and the prospects for a highly successful show are most promising. We understand that at their last meeting the committee decided, in order to encourage the use of electrical energy for cooking purposes, to offer substantial prizes for the best and most efficient cooking apparatus. It is proposed to award the prizes for (1) the best completely fitted kitchen and (2) for the best single apparatus. With the view of affording all manufacturers of cooking apparatus an opportunity of making suitable preparation for this competition, the executive committee have decided to accept exhibits for the prize cookery section up to and including Saturday, Oct. 14; the judging will take place during the last week of the exhibition. Forms of entry can be obtained on application to the organising managers of the Olympia Electrical Exhibition, 119, Finsbury-pavement, E.C. This is a step in the right direction, for anything which tends towards popularising cooking by electricity is deserving of every support, and, no doubt, all firms who make a speciality of electrical cooking apparatus will embrace this opportunity of bringing their specialities well to the front.

Trolley Wheels.—Report No. 23 (price, 1s.) of the Engineering Standards Committee deals with trolley wheels and wire, and after carefully considering the information placed at their disposal the committee have come to the conclusion that no attempt should be made to standardise any particular design or shape of trolley wheel. They have, therefore, confined themselves to recommending a groove of a certain section, but point out that in recommending this section as standard they are not restricting engineers to the use of any particular design of wheel, but are rather suggesting that the overhead work be so arranged as to permit the standard trolley wheel groove being employed. Regarding wire, it has not been deemed advisable to go further in the direction of standardisation than the recommendation of the minimum tensile breaking strength, which is 24 tons per square inch for the gauges of wire in general use. The following are the dimensions recommended as the section of the standard trolley wheel groove: width, 1⅜in.; depth, ¾in.; angle, 65deg. We trust that these standards will be adopted by trolley wheel manufacturers. The committee consists of Messrs. A. P. Trotter, F. C. Armstrong, J. Burbridge, Philip Dawson, F. F. Higginson, E. R. Hill, J. H. Rider, H. M. Sayers, A. M. Sillar, J. J. Steinitz, and A. H. Walton.

Electric Railway up Mont Blanc.—Our French contemporary *L'Industrie Electrique* gives particulars of a company for constructing an electric railway up Mont Blanc, which was registered in Paris in June last. The object of the company is the construction and development of a railway between the station of Fayet-Saint-Gervais and the top of the Goûter Needle, in conformity with the concession held by the company. In due course this line will be extended until it eventually reaches the summit of Mont Blanc. The concession for the construction of this extension is also held by the company. Other branch lines and extensions to subsidiary peaks are included in the company's powers, and may be made in due course. The capital of the company, however, is only 1,000,000fr., and we hardly think this sum, equal to about £40,000, sufficient for even the first part of the work contemplated, but under the articles of association the capital of the company can be increased at any of the general meetings of the shareholders. We notice that all the directors of the present company are French. The company takes over the whole of the preliminary work carried out by the previous society which obtained the concession for the construction of the line. Our contemporary gives no information as to how soon the work foreshadowed is to be commenced.

Heavy Tram Traffic.—The plaint of "A Would-be Passenger" which appeared in the daily Press the other day as to the difficulty of entering the London United Tramways cars at week-ends and holidays, especially on the Hampton Court line, lends support to his plea for the introduction of the queue system. Anybody who has stood at the Shepherd's Bush terminus on a Saturday or Sunday, to say nothing of a bank holiday, can testify to the scramble, sometimes approaching a free fight, for the privilege of travelling in the cars. The correspondent mentioned above states that he witnessed the wreckage of hats, the tearing of coats and dresses, and even the infliction of a severe wound. All this is an eloquent, if not very edifying, appreciation of the company's service, but much of the present inconvenience might be obviated by the introduction of the queue system, which has been found to work excellently at Blackfriars Bridge. The same writer also complains of the dangerous practice of starting the cars while people are endeavouring to mount them. The fact is that the large crowds at Shepherd's Bush often continue their attempt, regardless of the bell, to mount the cars after they are full up—another argument in favour of the queue system. Incidentally, this state of affairs affords further evidence that an efficient service creates new traffic. Before the London United Tramways laid down their system there was a horse service from Shepherd's Bush to Acton. No such grievances as the above were heard in those days!

Standard Telegraph Material.—The Engineering Standards Committee has issued its report (No. 16) regarding telegraph material. The committee (which consisted of

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Messrs. J. Gavey, H. A. Kirk, H. Hartnell, Llewellyn Preece, F. Gill, T. Ireland, H. Jackson, J. Sayers, A. H. Howard, and F. Jacob) considered it inadvisable, in the present state of the industry, to make any attempt to standardise submarine or underground cables. They also considered it unnecessary to touch upon the question of standardising telegraphic or telephonic apparatus. Regarding copper conductors, the committee have formulated standards regulating the mechanical strength of the copper, resistance, specific gravity, and temperature coefficient. A variation of 2 per cent. is allowed in regard to both resistance and weight, and an additional allowance of 1 per cent. is made in respect of the resistance of tinned copper conductors. For the purpose of compiling the tables, a lay involving an increase of 2 per cent. in each wire (except the centre wire) for the total length of the cable is taken as the standard. The definitions are supplemented by tables of standard sizes for hard-drawn copper wire and of commercial annealed copper conductors. A valuable collection of definitions and specifications, with tables and diagrams, is given in relation to iron wire for the conducting line, for mechanical purposes, and for binding, arm-bolts, nuts and washers, stay swivels, truss and brace rods and truss tie, tie and brace bolts, stay rods and tighteners, insulator spindles, cup-holders (single and double), and tensile test-pieces. The price of the report is 10s. 6d.

Bombay.—The Indian Government has sanctioned the issue of a license to the Brush Electrical Engineering Company for the supply of energy for all purposes except traction. The area covers the city, town, and island of Bombay, but excludes Government buildings. The maximum rate which may be charged is Rs.20 for any quantity of energy for all purposes up to 40 units, and for each subsequent unit eight annas. A fairly wide range of systems is sanctioned, comprising: (1) (*a*) A continuous-current supply at a pressure not exceeding 230 volts between the adjacent conductors of a three-wire system; (*b*) a continuous-current supply at about 550 volts for power purposes where the approval of the local government is given. (2) (*a*) A low-pressure alternating-current three-phase supply at a pressure not exceeding 240 volts between phases and at a frequency of 50 complete periods per second. (*b*) A high-pressure alternating-current three-phase supply at about 500 volts and at a frequency of 50 complete periods per second for power purposes where the approval of the local government is given. (3) An extra high-pressure alternating current three-phase supply at about 5,000 volts between phases and at a frequency of 50 complete periods per second, the neutral point of the generators being, with the approval of the local government, connected to earth. The local government are at liberty to issue regulations dealing with these systems, and, as provided by the Indian Electricity Act, they may exercise their option of purchasing the undertaking after 42 years and at the end of each decade thereafter. The licensees may transfer the undertaking at any time with the consent of the local government.

A New Method of Damping Galvanometers.—A simple method of damping a galvanometer to a known and adjustable extent is described in the *Annalen der Physik* by Mr. W. Einthoven. It consists in connecting a condenser in parallel with the galvanometer. If a potential difference is applied to the terminals of the galvanometer when no condenser is present, and assuming that the inertia of the needle is negligible the deflection will instantaneously reach its steady value, but if a condenser of capacity, C, is in parallel with the galvanometer the deflection will gradually increase from zero to its steady value, A, along a logarithmic curve. If a is the value of the deflection t, seconds after the voltage is applied $a = A\left(1 - e^{-\frac{t}{w'c}}\right)$, where e is the base of the natural logarithms, and w' is the combined resistance of galvanometer, and supply circuit, or $w' = \frac{w_a\ w_i}{w_a + w_i}$ where w_a = resistance of supply circuit and leads and w_i = galvanometer resistance, $w'\,C = T$ is the time constant of the deflection and by increasing either w' or C the deflection can be delayed to any desired extent. The writer shows by means of examples that even when the inertia of the needle is not negligible it is possible to select a value for T, which shall just cause the limit between an oscillating motion and a periodic motion to be reached, and that the value of the capacity necessary for this gets less as the tension of the galvanometer support is increased. By means of a sub-divided (plug) condenser a convenient and exact adjustment of the degree of damping becomes possible, but the application of the method is obviously only practicable in the case of high-resistance galvanometers with short time of swing, such as would be used in the measurements of current changes of very short duration.

Lightning Arresters.—A patent has been granted to Messrs. Siemens Bros. relating to lightning arresters of the horn type, so arranged as to prevent excessive voltage in electric circuits. This is effected by utilising auxiliary sparking gaps, with resistances or self induction devices located in parallel with the main gap. Reference to the first diagram discloses an auxiliary sparking gap, 1, arranged in parallel with the main gap, 3, the auxiliary gap generally having the electrodes, *e'*, pointed, and placed in closer proximity to each other than the rounded main electrodes, *e*.

FIG. 1.

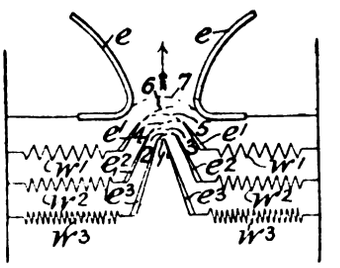

FIG. 2.

This plan permits of greater space in the main gap than hitherto, the arcs being formed progressively from 1 to 3, and arc 1 becoming immediately extinguished on the formation of arc 3. Reference to the second diagram shows the operation of the arrangement with a number of auxiliary sparking gaps in parallel with the main gap. The auxiliary gaps are at gradually increasing distances apart as they recede from the main gap, and the pointed formation also gradually diminishes, as does the strength of the corresponding resistances. The gaps are bridged by arcs in the order 1 to 7, as indicated in the second diagram. Lightning conductors are among the appliances which this arrangement is designed to improve.

A Large Bavarian Power Scheme.—An interesting opportunity of utilising water power in the Bavarian Alps has been reported upon by a Swiss engineer, Mr. Jeanjaquet, in conjunction with a German engineer, Mr. Schmick, of Darmstadt. If the scheme is carried through, it is estimated that sufficient electrical energy will be obtained from the water to drive the greater part of the Bavarian State railways. The idea is to utilise two lakes which are situated in the mountains near each other, but with separate watersheds. They each discharge into the River Isar, but by separate outlets. The lake which will be used as a reservoir is named Walchen. The surface of

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the water in this lake is about 6½ square miles, and the maximum depth of the water in it is over 600ft. The height of the lake above sea-level is 2,635ft. The lake of Kochel, into which the water can be diverted, is about 660ft. lower, and the direct distance between the two lakes is only some 2,200 yards. A tunnel would have to be made through the hill which divides the two lakes. The scheme, however, goes further than this. The watershed draining into Lake Walchen is not a very large one, and would not provide the desired power regularly. A few miles south of this lake there is the River Isar, which in its upper reaches flows from west to east. The level of the river is considerably above that of the lake, and hence it is proposed to divert a certain portion of the water into the lake by means of another tunnel through the dividing hills. This water can then be stored in the lake, which will form a splendid natural reservoir. This, combined with the high fall obtainable, makes the scheme an exceedingly attractive one, and we trust that it will be sanctioned and the works constructed. The lower portion of the River Isar, between the point where it would be diverted into the lake and Munich, is exceedingly rapid, and contains a number of falls which have already been harnessed for industrial purposes. This scheme, however, could be so arranged as not to interfere with these, as the volume of water passing down the river would be rendered more uniform than at present in consequence of the storage reservoir described above.

Educational Science.—The subject selected for his address by Sir Richard Jebb, president of the Educational Science Section of the British Association, was "University Education and National Life." Sir Richard commenced by tracing the extension of university education during the Victorian era. Not only had Oxford and Cambridge opened their doors to the community in a much larger degree than formerly, but other foundations had sprung into existence. So far as the new universities in great cities were concerned, it might be said that they were predominantly scientific, and they also devoted special attention to the needs of practical life, professional, industrial, and commercial—a state of affairs which was extending itself to the older universities, especially Cambridge. Dealing with higher education in South Africa, Sir Richard said: "If I am not mistaken, there is in South Africa a genuine and a keen desire for efficient education of the highest type. A sound liberal education is desired for all who can profit by it, whatever their future callings are to be. But the practical and immediate need for the organising of the highest teaching is felt, I believe, more particularly in regard to three great professions—the profession of engineering, in all its branches; the profession of agriculture (including forestry); and the profession of education itself, on which the intellectual future of South Africa must so largely and directly depend. Unstinted gratitude is due also to the University of the Cape of Good Hope. The primary needs of daily life in a new country make demands for certain forms of higher training—demands which may be unable to wait for the development of anything so complex and costly as a teaching university. It is necessary to provide a training for men who shall be able to supervise the building of houses, the making of roads, bridges, and railways, and to direct skilled labour in various useful arts and handicrafts. The first step in such a provision is to establish technical schools and institutes." Sir Richard paid a high tribute to the German technical foundations, and considered that, in the absence of similar institutions here, some of their functions might be included in the curriculum of the newer universities. He made some interesting observations on the part which science plays in the higher education, lending, as it does, a practical element to the more ornamental side of intellectual achievements, such as literature. In conclusion, he emphasised the need of well-organised secondary schools, so that pupils shall be prepared to fully benefit by university teaching.

Power Factor in Induction Motors.—In the *Electrical World* of New York Mr. A. A. Averrett has a contribution upon the question of whether, other features being equal, three-phase or two-phase induction motors have the higher power factor. The author advances arguments in favour of the former. Three-phase and two-phase motors are actually wound six-phase and four-phase (60deg. and 90deg. windings) respectively. The operating conditions for induction motors are somewhat similar to those

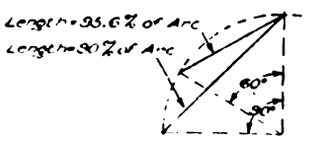

FIG. 1.

for six-phase and four-phase rotary converters, in which the six-phase winding gives better results than the four-phase winding. The reason for the superiority of the three-phase 60deg. winding lies in the fact that the ratio of effective turns to actual turns is as the chord to the arc. This ratio is $\frac{3}{\pi}$ in 60deg. windings, while in two-phase (90deg) windings the ratio is $\frac{2\sqrt{2}}{\pi}$. In other words, the 60deg. winding has 95·6 per cent. of the actual turns effective, while the 90deg. winding has only 90 per cent. of the turns effective. Fig. 1 graphically illustrates this advantage of the three-phase over the two-phase winding, by showing how the length of the chord approaches the length of the arc more nearly in the chord which subtends an angle of 60deg. than in the chord which subtends an angle of 90deg.

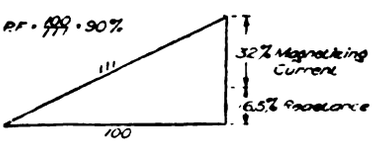

FIG. 2.—Method of Finding Power Factor.

A typical General Electric three-phase motor having a power factor of ·90 at full load and ·83 at half load will, the author states, have about ·32 magnetising current, ·165 reactance, and a stationary impedance current of about 5·75 times full-load current. The same motor if wound two-phase will have ·36 magnetising current and the same reactance (·165) at full load, which will give a power factor of ·89; while the half-load power factor will be ·80. Mr. Averrett concludes that two-phase motors have inherently a lower factor than three-phase motors, though it is possible to show as favourable a power factor for the two-phase as for the three-phase winding by the use of an excessive amount of material and at the expense of efficiency.

Telegraphy and Telephony at the Peace Conference.—With a view to coping with the needs of the Russian and Japanese peace envoys and supplying the Press with the latest news, extensive preparations were made for the handling of telegraph and telephone messages at Portsmouth, U.S.A., by the Western Union Telegraph Company, the Postal Telegraph-Cable Company, and the New England Telephone and Telegraph Company. The large amount of Press matter and the official communications anticipated between the envoys and their respective Governments called for unusual means of handling the

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situation, and on Saturday, Aug. 5, two days before the arrival of the Russian and Japanese plenipotentiaries, the arrangements were practically finished. Both the Western Union and Postal Companies established auxiliary telegraph and cable offices at the Hotel Wentworth, Newcastle, where the envoys are staying. The Western Union office is equipped with four quadruplexes, three duplexes, and 11 single loops, besides special private loops in the Japanese and Russian suites, whence direct communication is maintained with the Atlantic cables at Newfoundland, *viâ* Canso, and also with the Western Union offices in New York. From this latter point the Japanese diplomatic matter was sent *viâ* land lines to San Francisco over a direct circuit. From San Francisco messages were transmitted *viâ* the Pacific cable through Honolulu, Midway, Guam, Manilla, and Hong Kong to Japan. Facilities for the work of 25 extra operators were available at the Hotel Wentworth, which is connected by direct wire with the Halifax-Rye Beach cable station at Rye Beach, N.H., as well as with the land lines of the Western Union Company. An extra office, largely for the use of newspaper correspondents, was set up opposite the main office. About 1,500 cells of gravity battery are installed in this building and 25 extra operators can be put at work if necessary, besides 15 operators in the main office. Two special circuits for the use of the envoys and their staffs were also installed between the Portsmouth Navy Yard and the main office. The Postal Telegraph Cable Company's arrangements correspond closely to those made by the Western Union. An auxiliary office at the Wentworth with four quadruplexes, three duplexes, ten single loops and private loops to the envoys' suites was installed, the hotel being connected with the main office on Congress-street, Portsmouth, by a 22-wire aerial cable about 3½ miles in length. All the Wentworth service is looped through this main office, which is connected by direct wires with the Postal and Commercial Cable offices in New York. Russian messages were expected to pass *viâ* the Commercial cables to San Francisco, and thence *viâ* the Pacific cable, which the company controls, to Hong Kong and Japan. The main office at Portsmouth contains the company's "portable quads," which are transported from place to place in order to meet emergency calls, and also three $\frac{1}{10}$-kw. portable dynamos mounted on boxes equipped with rollers. These dynamos are supplied with 125-volt direct current from the Rockingham County Light and Power Co.'s station in Portsmouth, and are designed for 115 volts primary and 380 volts secondary current. Fifty extra operators can be accommodated if necessary at the postal offices, and two navy yard circuits are also in place for postal service. The New England Telephone and Telegraph Co. has doubled its trunk line facilities between Portsmouth and Boston, making a total of eight circuits available. It has also placed in commission one special toll circuit between Portsmouth and Worcester, Mass., for New York and Washington traffic. Two additional recording operators are ready for business at the Portsmouth central offices, an additional station has been set up at the Hotel Wentworth, and three extra stations at the navy yard for the exclusive use of the conference. This is another notable instance of the utility of the telegraph and telephone, and nobody showed greater appreciation of it than the big dailies.

Alternating-Current Motors—A design of alternating-current motor of the commutator type intended to obviate sparking has been patented in this country by Mr. R. McNeill, of New York. The rotary armature, A, shown in the first diagram, which we reproduce from the *Official Patents Journal*, is provided with two or more independent circuits, which are connected to alternate bars, c_1 c or c_1' c', on the commutator, so that each is always connected to a pair of brushes, b b or b' b', but cannot be short-circuited by any of the brushes, thus obviating sparking. It will be seen in Fig. 1 that the circuits are arranged quite independently of each other, but this plan is not essential so long as the electrical independence of the circuits between brushes of the same polarity is observed. For instance, the method of interconnecting three circuits, as shown in Fig. 2, may be employed. Any number of brush

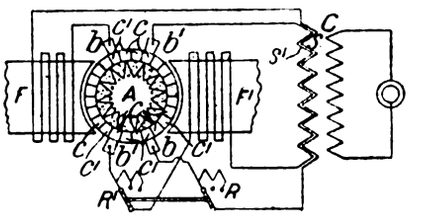

FIG 1.

circuits may be used. The armature windings may be in series with the field windings, F F', and are supplied with currents of the same phase, obtained for example, by means of two similar secondaries, s s (Fig. 1), on a transformer, C. Alternatively, the armature circuits may be energised independently of the fields, the field current counteracting the greater reactance of the field circuit, and thus producing

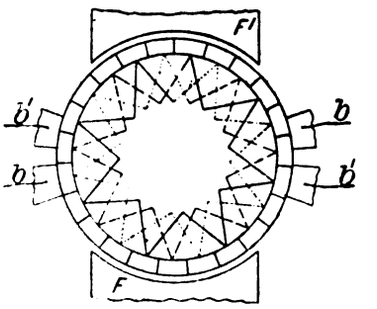

FIG. 2.

synchronism of the armature and field magnetisations. Any suitable arrangements may be used for producing similar currents in the armature circuits and a leading current in the field circuit. The two arrangements of separate field and armature circuits and series connected field and armature circuits may be combined in the one motor. This arrangement allows of the field and armature magnetisations being brought more nearly into phase than

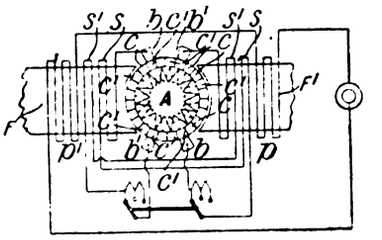

FIG. 3.

can be accomplished by other methods. A rheostat, R R' (Fig. 1), choke coils, or a switch connected to taps in the secondaries, s s', may be provided for starting or speed varying purposes. In Fig. 3 is seen a motor having the field wound with coils, p p' and s s', which act as transformer primaries and secondaries respectively. Parallel or series connections of similar coils on the two parts, F F', of the field magnet may be employed. Either the armature or the field magnet may operate as rotor.

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THE ERITH ELECTRIC TRAMWAYS.

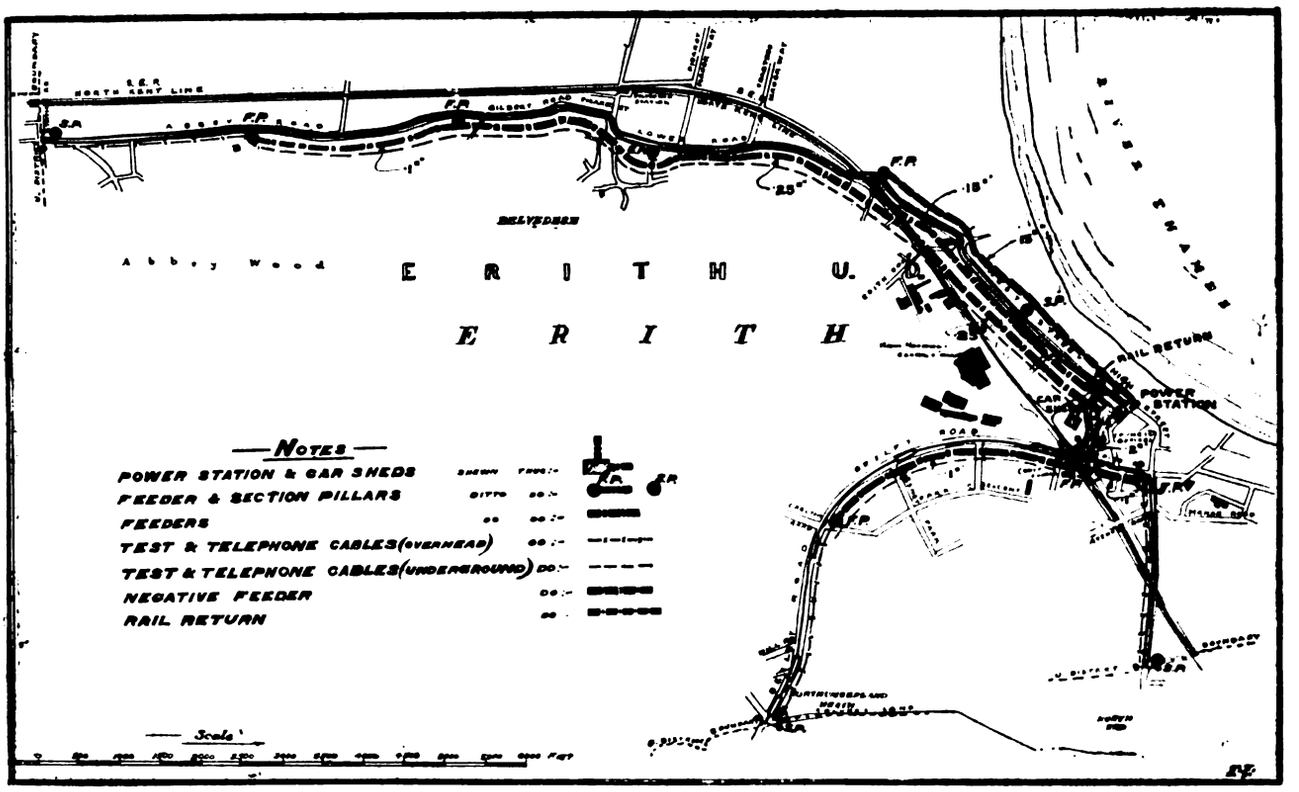

FIG. 1.—Route Map of the Erith Council's Tramways and of the Feeders supplying the same.

The sections of the tramways of the Erith Urban District Council which are to be opened on Saturday next will be of service for local traffic, but their full usefulness will not be realised until certain tramways in adjoining areas have been constructed. The original scheme for which parliamentary sanction was sought in 1903 was a complete one, and would have provided for a cheap means of communication with Woolwich and London. The routes now constructed are shown in the map given herewith, from which it will be seen that there are practically three lines radiating from the centre of Erith. The longest of these goes to Abbey Wood and ends at the boundary of the London County Council. In the scheme drawn up by Mr. W. C. C. Hawtayne, the consulting engineer to the Council, and included in the 1903 Bill, this line was continued to Wellinglane, where it joined the Bexley tramway to Woolwich. The extension in question was to pass along a new road made by the Woolwich Co-operative Society through their private property, but it lay within the Woolwich borough area and also within the county of London. Opposition was, therefore, brought against this Bill, and was so far successful that the London County Council are now bound to construct the line in question. Should they not do so within a predetermined time, the Erith Council may undertake the work. This link would complete the connection by tramway between Erith and London, but its great usefulness would be for traffic between Woolwich and Erith.

The present system is connected to the Bexley Council's line by a physical junction, and through running is to be arranged. The details as to the through service are not yet fixed between the two Councils, but as it will be of great value to both, no difficulty should arise. The junction between the systems is at Northumberland Heath. The third line goes to North End, near the Dartford district. It is possible that this may eventally be extended and linked up to the Dartford tramways now under construc tion, but it would involve the making of a new road for the purpose. The Erith tramways may for the time being be considered as an isolated system, which will have a considerable traffic due to the large number of workmen employed in the engineering works in the centre of the district, who will now be able to live farther from the factories. The through system to Bexley will be of special service in this respect.

In the Bill authorising the construction of the tramways powers to make street improvements were included, several

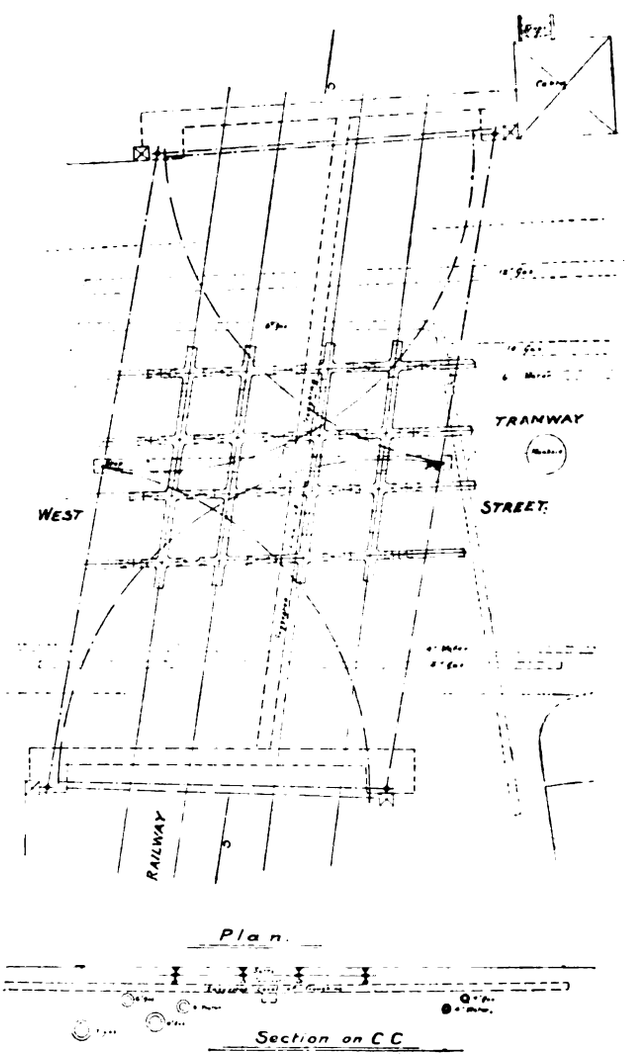

FIG. 2.—Plan of Special Work supplied by Messrs. Hadfields for crossing Siding to Parishes' Ballast Wharf. The Special Gates are also indicated.

of which are of great value apart from the electric car service. The most important of these is the bridge over

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the South-Eastern Railway which replaces a level crossing. This work, too, has been carried out by Mr. Hawtayne.

which is developing into the main traffic route from Erith to London. The South-Eastern and Chatham Railway is

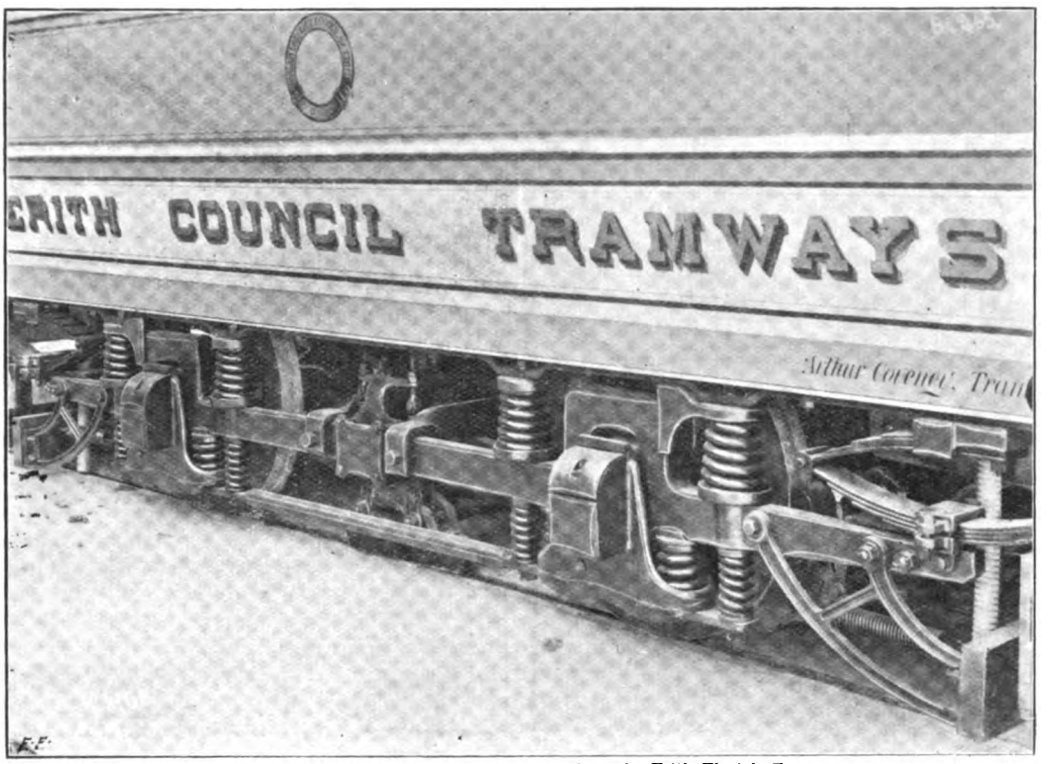

FIG. 3.—The Mountain and Gibson Truck used on the Erith Electric Tramcars.

The need for such a road diversion is emphasised by the fact that a boy was killed by a train on a level

throughout this section approximately a surface line, and the crossing is also at a very acute angle. To keep the

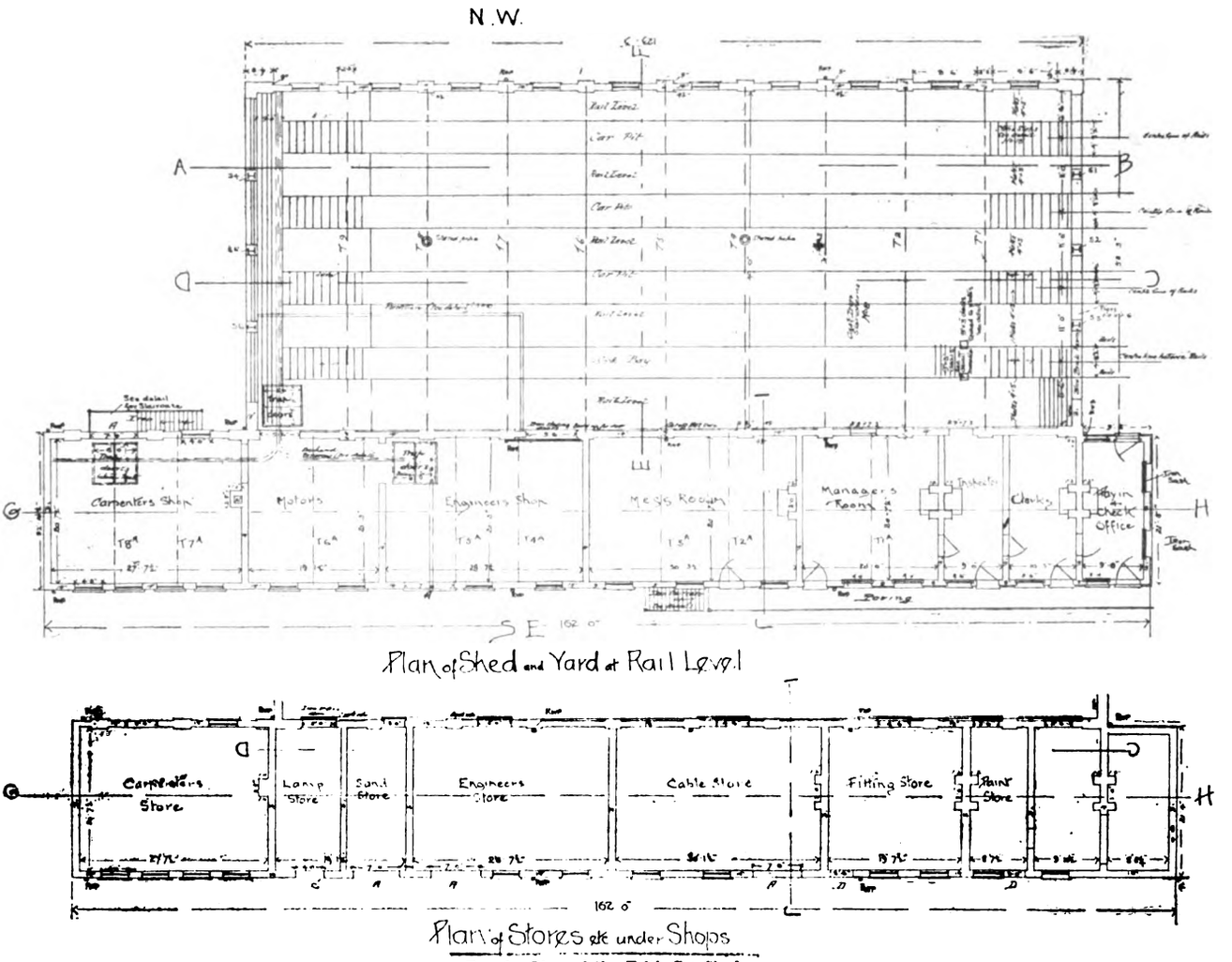

FIG. 4.—Plan of the Erith Car Sheds.

crossing in Erith the day after the official inspection of the tramways. This crossing occurs on the Lower-road,

approach gradients as flat as possible, it was essential that the depth of bridge deck should be kept very small. The

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existing double line of railway is crossed by a span of 26ft. on the square and 40ft. on skew, two side spans, 14ft. 6in. on square and 22ft. 3in. on skew, being formed to allow of a future doubling of the railway. The bridge is designed to carry ordinary road traffic and a trolley car weighted up to 32 tons on a 12ft. by 6ft. wheel base. Trough flooring with parapet girders allowed of the shallowest deck construction, and was decided on, the troughing being Messrs. Dorman-Long's E max. in centre span and E min. in side spans. The

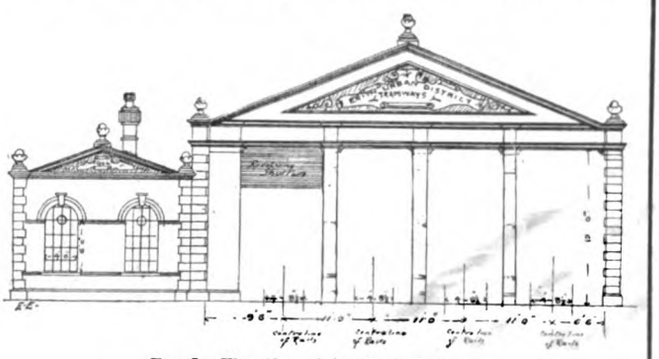

FIG. 5.—Elevation of Car Shed Entrance.

gradients of approaches were thus kept to 1 in 24·8 on the west side and 1 in 30 on the east. The bridge foundations were carried through clay and peat of the old marsh land to ballast at a depth of about 12ft., and as those for the intermediate piers were close to the running road of the South-Eastern and Chatham Railway careful timbering was necessary. These pier foundations, each 80ft. long, were carried out in 20ft. lengths, heavy baulks being placed under the rails adjacent to each length. The contract for this bridge was placed last summer in the hands of Messrs. W. Pattinson and Sons, Limited, of 50, Parliament-street, Westminster, who carried out the whole of the work without

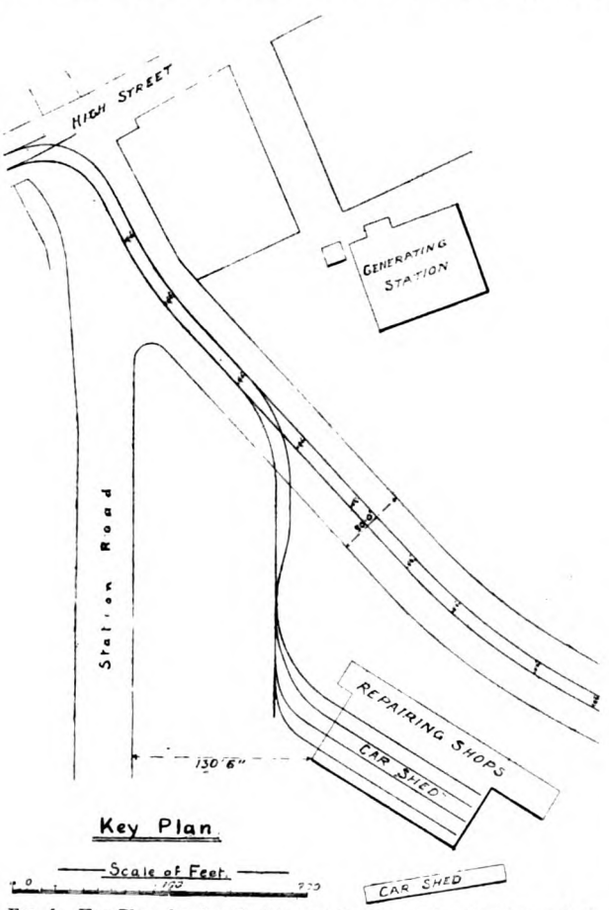

FIG. 6.—Key Plan showing Positions of the Generating Station and Car Sheds on the Council's Estate.

in any way interfering with the traffic on the South-Eastern and Chatham Railway. Mr. J. Pluck acted throughout as clerk of works.

The contracts for the supply of rails, etc., and the construction of all track work and the conduits were placed in the hands of Messrs. R. W. Blackwell and Co., Limited, Messrs. Bolckow, Vaughan, and Co., Limited, being sub-contractors for the supply of rails and fastenings, Messrs. Hadfield being the sub-contractors for all points, crossings, and special work. The Associated Cement Company, Limited, supplied all the cement used. The lines at present constructed have a route mileage of about 4·7, and an equivalent single-track mileage of 8·4 miles, the whole of the main line from Abbey Wood to Erith being double track. Connection is made with the Bexley tramway system at Northumberland Heath. The rail joints are fished and anchored with Cooper and Howard Smith's anchor joints, intermediate anchors being also used in the middle of the rails, which are No. 3 B.S. 100lb. per yard and 60ft. in length. The centres of the tracks are laid 8ft. 6in. apart except on curves, where this distance is increased to allow of the increased overcharge of the cars. Though only 6ft. wheel-base truck cars 28ft. long are at present in use, the track has been laid down to give the clearance required for the large London County Council bogie type of car. The rails are laid on a bed of 6 to 1 Portland

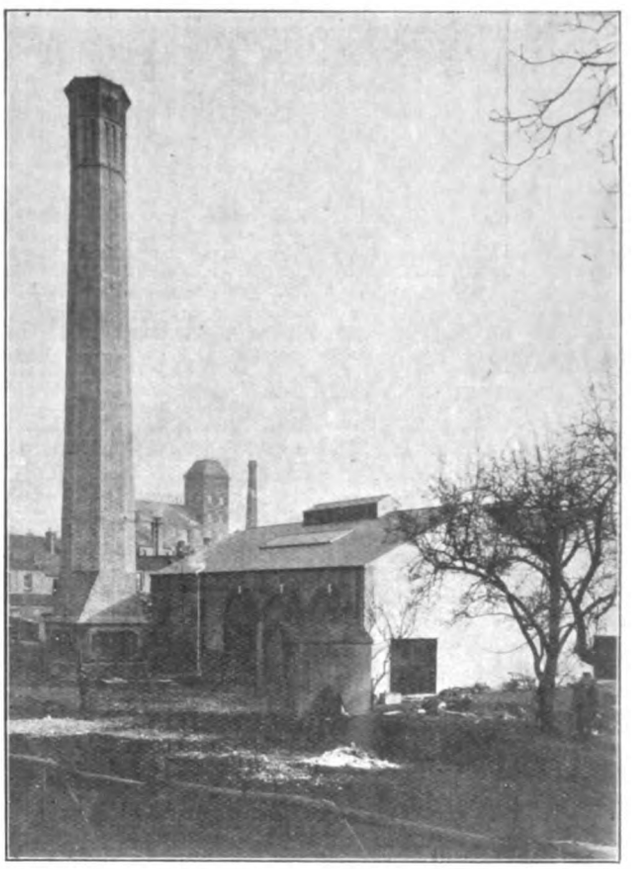

FIG. 7.—View of the Erith Electricity Works.

cement concrete, having a minimum thickness of 6in. As the road from Abbey Wood to Erith follows for the most part the old track running along the edge of the marshes, the bottom is often very soft, and where necessary the thickness of concrete has been considerably increased. The paving setts are 5in. Norwegian granite in the majority of the route, but through Erith proper and to Belvedere Guernsey granite is employed. Black butt and jarrah wood is used in front of places of worship, schools, etc. The joints of the paving were racked and run with pitch for half their depth, and grouted with Portland cement and sand for the remainder, but where paving was carried out in frosty weather to prevent delay, pitch was used for the whole depth. The standard points used in passing places are straight run in, with a 200ft. radius run out, which give very easy running, and it is expected that the saving in wear and tear on the cars and track will amply repay the increased cost of these points, which are of manganese steel and 15ft. long. On sharp curves the groove of rail is increased from $1\frac{1}{8}$in. to $1\frac{1}{4}$in., and the B.S. No. 3 C rail 106lb. per yard is employed. Double bonding of 4/0 crown bonds is used at the rail joints, and

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long bonds are carried past all points and crossings. Cross bonds in track and inter-track bonds every 40 yards. Conduits, with three or four ways, are laid under the track to allow of the cable system being drawn in, and draw boxes of ample size are constructed about 100 yards apart, or at such shorter distances as will allow of straight runs for the conduits between the boxes. The steepest grade on the systems is 1 in 20 and the sharpest curve 40ft. radius. In West-street there are two level crossings, at Messrs. Parishes' ballast wharf and at Messrs. Cory's wharf respectively. The crossings (Fig. 2) are of manganese steel with the usual groove for tramrail and a groove 2in. wide and 1¾in. deep for siding rail, this groove being contracted at the point of crossing to 1⅝in. wide and 1½in. deep to reduce the bump to trucks and cars passing over. The clerk of works for the track construction and overhead work was Mr. J. W. B. Carruthers.

and lightning arresters, were supplied by the Callender's Cable Company, and are of their standard type.

The present rolling-stock consists of 14 double-deck cars, carried on four-wheeled trucks as illustrated in Fig. 3. These cars and their equipments were supplied by the British Westinghouse Company, the bodies being made by the Brush Company and the trucks by Messrs. Mountain and Gibson. The wheels and axles were made by Baker and Co., and the whole of the electrical equipment by the Westinghouse Company. The cars are 28ft. long over fenders by 7ft. over-all width. The brakes on the cars consist of the ordinary hand ratchet type and the British Westinghouse magnetic track brake. Messrs. Mountain and Gibson were responsible for the trigger type of life-guards used on the cars, and also for the trolleys which have the wood trolley heads. Seven of the cars have top deck covers. The direction indicators are of the revolving

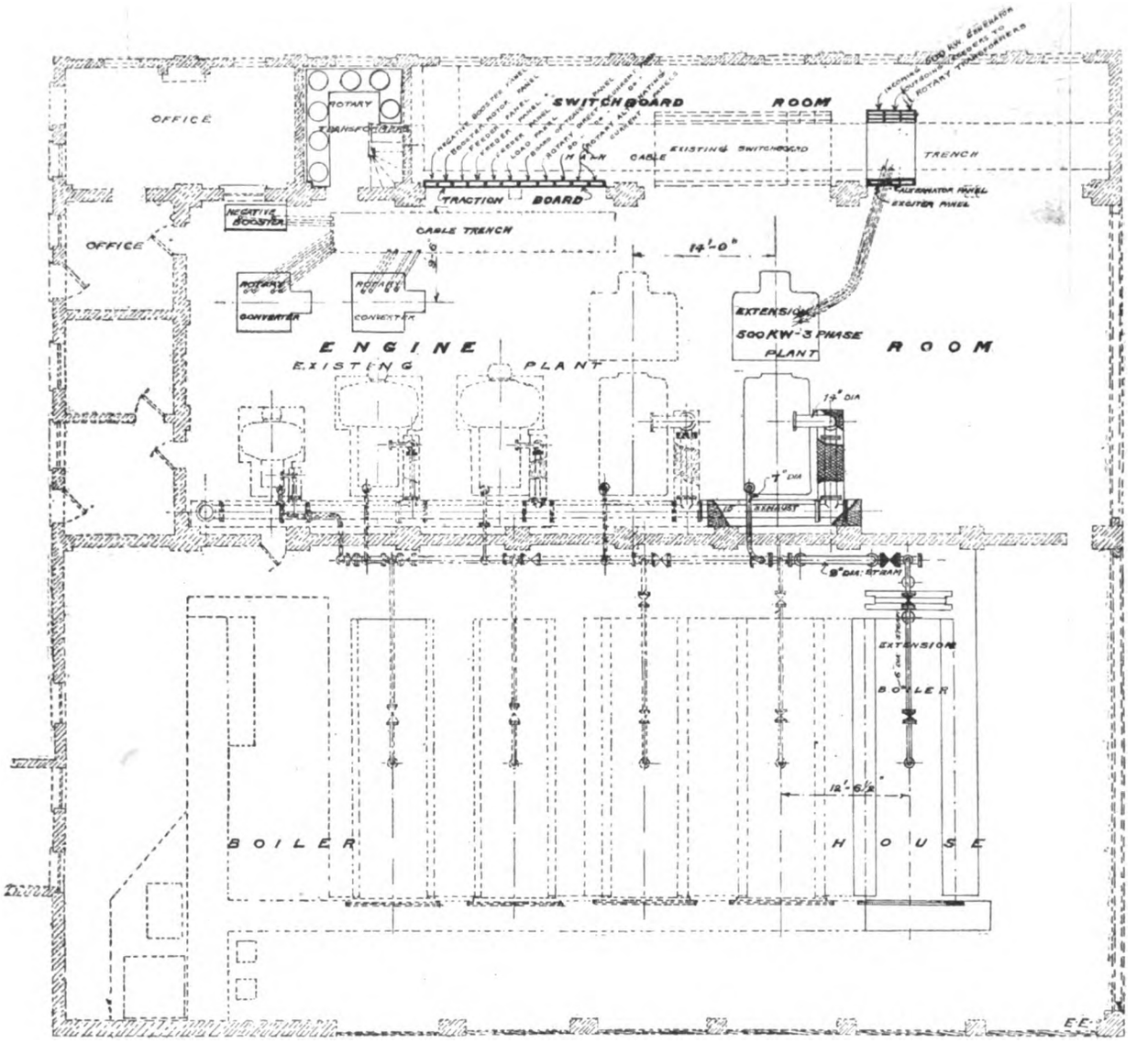

FIG. 8.—Plan of the Erith Electricity Works with the Latest Extensions shown in full lines.

The overhead equipment was provided by the Brush Electrical Engineering Company. The bracket-arm construction with side poles is used throughout except at curves and junctions, where span construction is adopted. The bracket arms vary in four sizes between 10ft. 6in. to 16ft. 6in. in length. The poles are 31ft. long, of which 25ft. is above ground. These poles were supplied by Messrs. Stewart and Lloyds through the Brush Company, and are of three sizes as follows: light poles, 731lb. in weight; medium poles, 923lb. in weight; and heavy poles, 1,206lb. in weight. The flexible system of suspension is adopted throughout with trolley wire of copper 3/0 S.W.G. The guard wires are of stranded galvanised steel. The poles are earthed at every fifth standard, where guard wires are used. The cars are of the Phillips type, and sectional insulators are placed at half-mile intervals. The section pillars, fitted with the necessary controlling switches, telephone plugs, blind type, with incandescent lamps for illuminating them at night. The lighting of the cars is done by 17 100-volt lamps of 16 c.p. per car, arranged on three circuits. The stairways to the upper decks are of the reversed type. The Council have also purchased a track sweeper and watering car manufactured by Messrs. Mountain and Gibson, and equipped by the British Westinginghouse Company with the necessary electrical gear.

The car-sheds (Figs. 4 and 5) are situated on the Council's Walnut Tree Estate, on which the various municipal undertakings are accommodated. Fig. 6 shows a block plan of the same. The power-house is divided from the car-sheds by the new road made through the estate. The sheds have four tracks, and can accommodate 16 cars. The tracks are carried on pillars, so that there is a clear basement under the shed, which greatly facilitates inspection and repairs. Offices for the tramway manager and his staff are pro-

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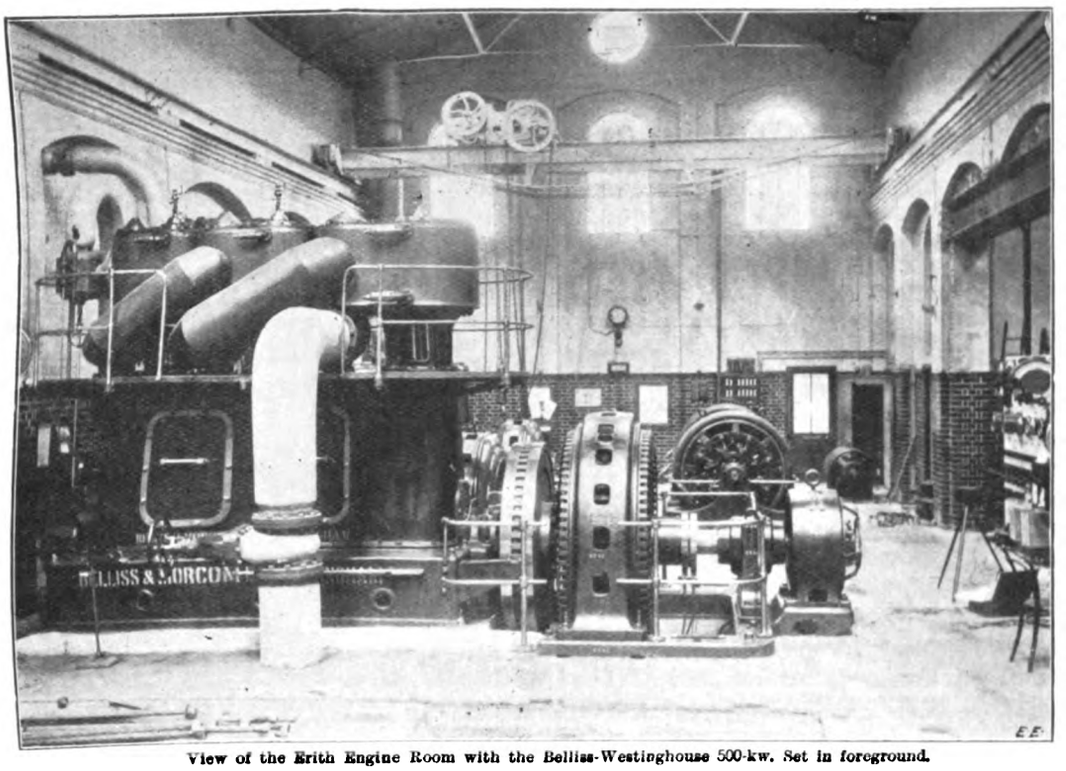
vided, and a messroom for the men. Repair shops complete the accommodation on the ground floor. In the basement various stores have been arranged, as shown in the plan.

and Construction Company, who first supported the undertaking by laying down motors of 120 h.p. This firm has since increased to a considerable extent the number of three-phase motors in use, and has avoided in this way the



View of the Erith Engine Room with the Belliss-Westinghouse 500-kw. Set in foreground.

The power station at Erith, Fig. 7, was the first to be laid down in this country for the distribution of electrical energy on the three-phase system by a local authority. We described it fully in our issue of June 23, 1903. The adoption of this system by Mr. W. C. C. Hawtayne, the consulting electrical engineer, has been amply justified by the power load which has been obtained from the manufacturing laying down of more boilers and generating plant. Their consumption now has passed 250,000 units per annum, and the bulk of this is consumed during the day, when the lighting load is small. Messrs. Vickers, Sons, and Maxim now take 100 h.p. from this system under a five years' agreement, and the Co-operative Society have installed motors with an aggregate of over 60 h.p.

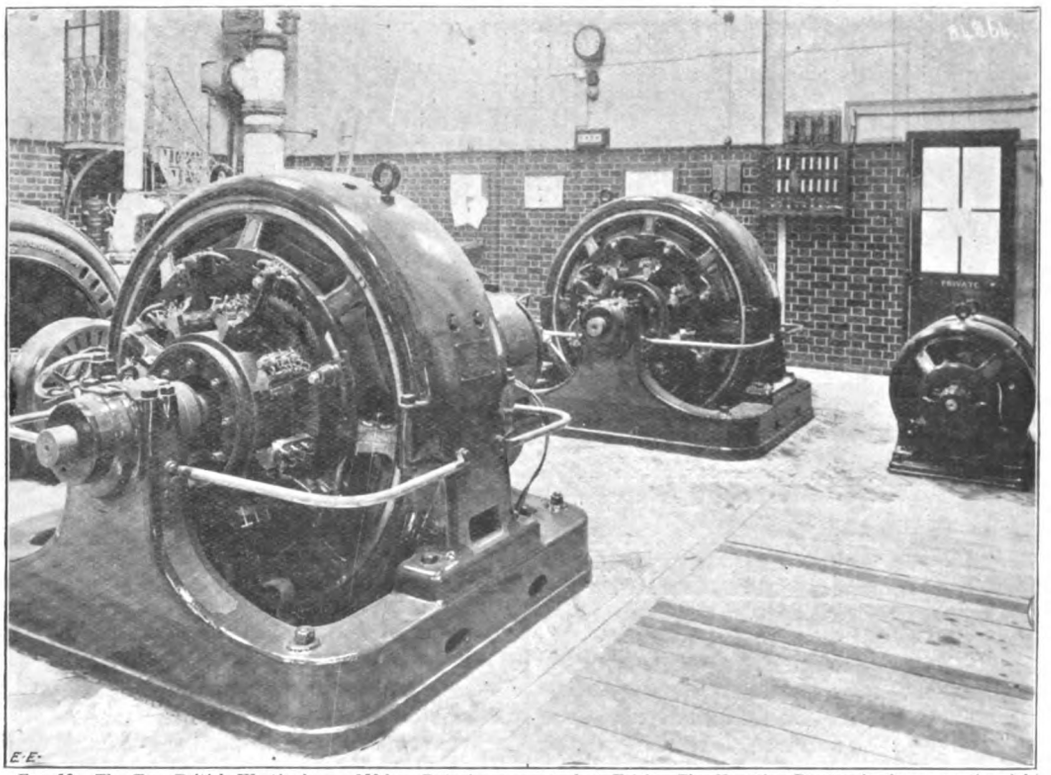


Fig. 10.—The Two British Westinghouse 150-kw. Rotaries as erected at Erith. The Negative Booster is shown on the right.

works situated within the Erith district. Many of these works have found it more economical to take their supply from the Urban District Council's station than to put down or extend their own electrical systems of distribution. Amongst the largest consumers is the Callender's Cable

The tramway load now to be supplied has necessitated the laying down of more plant, as can be seen from Fig. 8, but the generating plant is still of the three-phase type, and the lighting, power, and traction loads will all be supplied from the same high-tension switchboard. Two

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rotary converters are used to change the three-phase currents into direct current. These are placed within the generating station, but the complete scheme involves the use of another rotary in a transforming station in Upper Belvedere. This station has been constructed as a kiosk, and is at present used for lighting work only, but the space for the rotary converter is reserved.

Including the new plant, the generating works now contain five Lancashire boilers, two of which are 28ft. by 8ft., by Spurr, Inman, and Co., rated at 6,000lb. per hour each and hand-fired. The remaining three, also 28ft. by 8ft. 6in., are by Yates and Thom, rated at 7,500lb. per hour each, and fitted with Bennis compressed-air stokers and Sugden's superheaters capable of superheating the steam to 100deg. F. above normal temperature. The boilers are fitted with main and auxiliary steam-valves, spring-loaded and dead-weight safety-valves of ample areas, duplicate feed valves, and injectors capable of maintaining full feed supply. The boilers are fed by two steam-pumps of Hall's compound make of 1,500 and 1,800 gallons per hour respectively, one motor-driven triple-ram pump of Pearn's make and 1,500 gallons per hour, and one tail end pump on the condenser of 1,500 gallons per hour capacity—all of which deliver through Rankin's pressure filters, there being two of these installed. The boilers are covered with Haacke's composition, and set with Poulton's curvilinear blocks and covers.

Steam Alternators.—There is one of 50 kw. and two of 150 kw. each of the International Electric Engineering Company's make, driven by Allen compound engines, and two of 500 kw. each of British Westinghouse make, driven by Belliss triple-expansion engines; all are capable of giving 20 per cent. overload for one hour. The exciters are direct driven on a continuation of the rotor shaft. The alternators are arranged with revolving fields. Fig. 9 shows the engine-room with the new plant in the foreground.

The two rotary converters (Fig. 10) are of 150 kw. capacity each. They have been placed at the end of the station occupied by the smaller steam alternators. Room has also been found there for the negative booster, which is also of the Westinghouse type, and is capable of dealing with 7·5 kw. As regards the switchboard, the high-tension gear is arranged with front and back panels separated by a 3ft. gangway. All high-tension apparatus is contained on the back framework and panels on cubicle system, the switch handles and all measuring instruments are placed on the front panels. All the panels are of white marble. The original board, made by the International Engineering Company, was extended by the General Electric Company, and further extended and partly rearranged by Messrs. Kelvin and James White. The low-tension board contains tramway feeders and Board of Trade panels, rotary converter, and negative booster panels. From this switchboard the cables, indicated in Fig. 1, are led to the tramway system. This work has been done by the Callender Cable and Construction Company. The cables are of the vulcanised bitumen type drawn into conduits laid under the track. The total length of these feeders is 2½ miles, and their section varies from ·1 up to ·25 square inch. The testing and telephone cables are carried overhead on the last half-mile section of each route.

Such is the equipment of the Erith tramways, which are to be formally opened on Saturday under the management of Mr. A. Coveney. Mr. P. W. Masson, as chairman of the Tramway Committee, has had a great deal to do with the carrying through of the scheme, and we are sure that neither the Council nor their consulting engineer, Mr. W. C. C. Hawtayne, will be content until the system is linked up to the London County Council tramways south of the Thames.

FOCHABERS ELECTRIC LIGHTING.

An interesting water-power plant for the electric lighting of Gordon Castle, the Scottish seat of the Duke of Richmond and Gordon, and also of the village of Fochabers, is nearly completed. The engineers carrying out the work are Messrs. Drake and Gorham, Limited. The interest in the scheme lies in the fact that the water of the Spey is to be used to provide the necessary energy. The works in question are situated on the banks of the Spey, about half a mile above the bridge at Fochabers. Ample water power is available, but, in common with other water plants in the United Kingdom, the normal fall of 14ft. decreases considerably in time of flood. In consequence of this the plant has needed to be designed on ample lines, so that the turbines can give their full output when the water in the tail race rises 6ft. or 7ft. Horizontal turbines, supplied by Messrs Carrick and Ritchie, of Edinburgh, are used. The open lade from the intake to the power-house is some 1,300 yards long, and has been constructed in concrete. The soil through which the lade had to be dug was nearly all loose gravel, which necessitated the lining of the sides and bottom with concrete. The width of the lade is 15ft. and the depth of water in it will be 3ft. The intake is at a natural pool in the river, and the quantity of water taken from the stream is such a small proportion of the total volume that there was no need to construct a dam in the river bed. The lade terminates in a large wooden tank, from the bottom of which the turbines are supplied by means of cast-iron pipes.

The turbine-house proper is built with concrete, and is provided with watertight doors so that the shafts can be withdrawn at any time. Of the two turbines now installed the larger will pass some 3,880 cubic feet of water per minute and the smaller one 2,300 cubic feet. Their horse-powers working on a 10ft. head are respectively 50 h.p. and 30 h.p. Their diameters are 27in. and 21in. respectively. Both these turbines drive dynamos by means of belts, the dynamos being placed at a much higher level, so that they are well above the highest flood ever recorded.

Two dynamos are provided, each with a series as well as a shunt winding, a plug being provided for cutting out the series winding when the machines are used for charging the accumulator. In order to prevent mistakes, the switch-board has been so arranged that the machines cannot be switched on to the accumulator unless the series winding has been first cut out.

The distribution is on the three-wire system, with 400 volts between the outer conductors. The accumulator will be used only for the castle, the village lighting being run direct from the dynamos, the turbines being fitted with electric governors and the dynamos slightly over-compounded to make up for the loss in the feeders. A compound-wound balancer is also provided, and to this is coupled the booster for charging the battery. The battery consists of 214 hanging-type cells in glass boxes of 360 ampere-hours capacity.

The distribution is effected by means of paper-insulated cables, lead-covered and armoured, laid direct in the ground. The wiring in the houses in the village is being carried out by means of vulcanised rubber wire run on insulators. Originally it was intended to light the castle only, but the inhabitants of Fochabers petitioned the Duke to light the village as well.

Mr. Delmar Morgan has been responsible to Messrs. Drake and Gorham for the supervision of this work, as it comes within the Glasgow district, of which he has charge. The same firm have just completed the lighting of Goodwood House, the Duke of Richmond's southern home. In this case, water not being available, suction producers and gas-engines have been used.

THE WITWATERSRAND DEEP ELECTRICAL PLANT.

There is little doubt but that mines offer a grand field for electrical power. This is especially the case in regard to the big groups of mines on the Rand and in South Africa generally, where the conditions favour the adoption of up-to-date methods and render conservatism impossible. Now that electric driving of stamp batteries has entered the range of practical politics, we may possibly be on the eve of great developments in this direction. It is, however, unwise to be prophetic in these days. The scope of this article is rather to describe one of the many electrical plants which have been actually installed—to be precise, the plant on the property of the Witwatersrand Deep Gold

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Mining Company, Limited. The construction for the mills (200 stamps) has only recently been completed, and the same may be said of the electrical installation, which is, therefore, of the most modern type. It may be explained here for the information of those unacquainted with the district or conditions under which the various properties are managed and worked, that the mines on the Witwatersrand stretch almost in a line 30 miles east and west of Johannesburg. It would be more correct, perhaps, to say a double line, as the deeps are all some few hundred yards south of the outcrop mines. All the mines are owned and worked by some seven or eight companies, each having a head office in Johannesburg, where are to be found the directors and mining consulting engineer, mechanical consulting engineer, electrical consulting engineer, and the secretary for the group. One mining house may own some 20 or 30 mines, and on each property or mine there is a general manager, secretary, underground foreman or mine captain, mechanical engineer, electrical engineer, compound manager, surface foreman, etc. On one or two mines the mechanical and electrical engineer are combined in one person. On others there are very small electrical plants, and the mechanical engineer has a foreman electrician under him. On a few mines the electrical engineer is both consulting and resident engineer. On others, again, the mechanical and electrical engineers are independent of one another, each looking after his own particular department. At present electricity is used chiefly for lighting, underground pumping, and driving workshop machinery, but it is fast finding a much more extended application, and in the opinion of those best able to judge the near future will see the large majority, if not all, of the mines equipped with electrical machinery not only for the purposes just enumerated, but also for driving stamp batteries, etc.

Reverting to the Witwatersrand Deep electrical installation, the main generating plant consists of two tandem compound horizontal engines by Douglas and Grant, of Kilcardie, each direct coupled to a 250-kw., three-phase, 50-cycle, 1,100-volt alternator of the Brush Electrical Engineering Company's revolving-field type, and one 430-kw., 1,100-volt, 50-cycle three-phase Curtis steam turbo-dynamo set by the American General Electric Company. All of these sets work condensing, the condensing plant for the first-mentioned being placed behind the engines. A feature of these horizontal engines, one of which is shown in Fig. 1, is the heavy flywheel with which each is provided. This, it will be seen, is mounted centrally between the engine and alternator. The position of the duplicate unit is to the right of the set shown in Fig. 1 at the south end of the engine-room. Although of nearly double the output, the relative compactness of the turbo set (Fig. 2) will be at once appreciated. The diameter of the turbine at the base is 8ft., and it stands 12ft. high in the north-west corner of the engine-room. Its rated output is obtained at a speed of 1,500 r.p.m., and with a steam pressure of 140lb. The Wheeler condenser which serves this set is placed in the pit shown in the foreground of Fig. 2. It has 2,800 square feet of cooling surface, and works in conjunction with a 10in. by 10in. Edwards air-pump. The theoretically possible vacuum obtainable with this condenser is equal to 24·5in. of mercury, while the

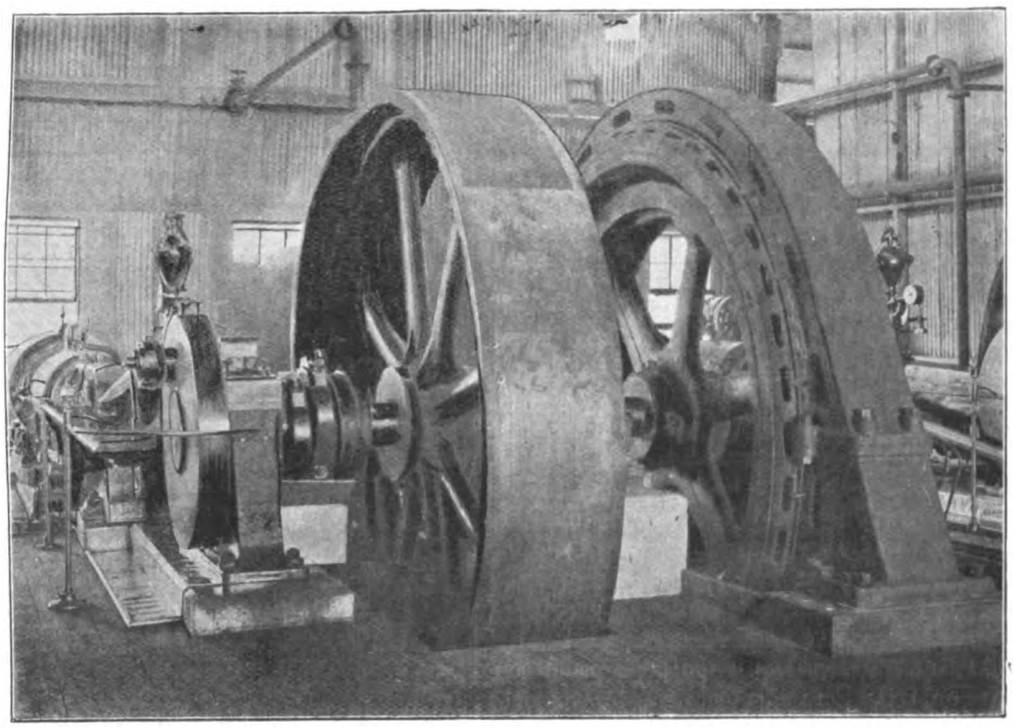

FIG. 1.—250-kw. Steam Alternator, South End of Engine Room, Witwatersrand Deep.

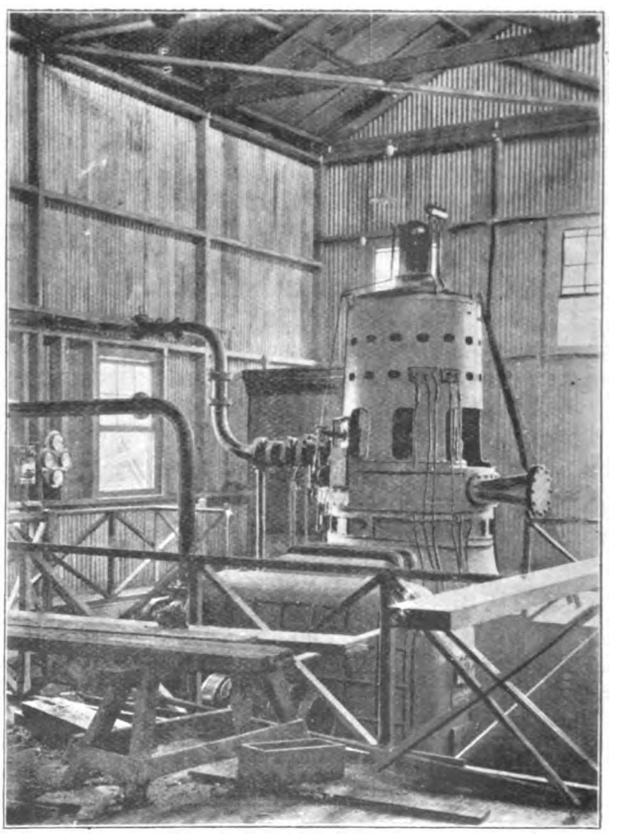

FIG. 2.—430-kw. Curtis Steam Turbo Set, North-West Corner of Engine Room, Witwatersrand Deep.

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equivalent of 24in. was actually obtained on full load and 22½in. on three-quarter load during tests.

Excitation for the main generators is furnished by a four-pole dynamo (Fig. 3) yielding current at 100 to 130 volts pressure, and direct driven by a three-phase 47-h.p. motor. A 12-h.p. steam exciter serves to supply the initial excitation, after which the motor-generator set is switched in. The north-east corner of the engine-room (Fig. 3) further contains a 100-kw., three-phase, 30-cycle induction motor-generator, used as a synchronous motor for improving the bad power factor caused by the large number of small induction motors installed and many of the large ones being underloaded; a 200-kw. three-phase transformer, which supplies a transmission line to the Knight Central gold mine, 2½ miles distant; a 50-kw., three-phase, 1,100-to-110-volt transformer for lighting; a 30-kw., three-phase, 1,100-to-130-volt transformer for a like purpose; and a 1-kw. motor-generator used to charge accumulators for mine signals. A portion of the main switchboard and the separate switchboard for controlling the 40-kw. motor-driven exciter also appear in the illustration. The 200-kw. transformer serving the Knight Central transmission line is of the step-up and step-down type, being wound for transforming from 1,100 to 2,200 or 4,400 volts, and *vice versa*.

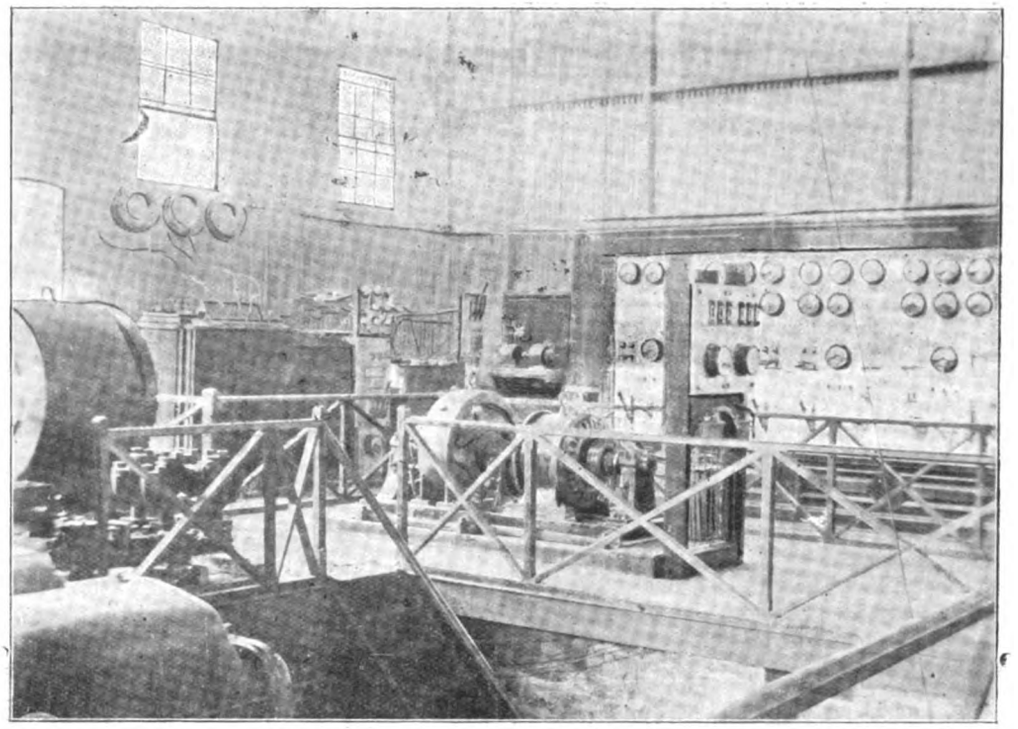

FIG. 3.—North-East Corner of Engine Room, Witwatersrand Deep.

At Knight Central there is installed a 150-h.p., three-phase, 50-cycle motor wound for 1,100 volts, driving by flexible coupling a 100-kw., 30-cycle, three-phase, 950-volt induction type generator, the speed being 400 r.p.m. to 500 r.p.m. The power is used chiefly for mine dralnage, one 25-h.p. motor being also employed in the workshops.

But to return to Witwatersrand Deep, it should be mentioned that the main switchboard (Figs. 3 and 4) is of white Italian marble mounted in a frame of polished teak, and consists of four generator panels, six circuit panels, and a voltage regulator panel. It remains to enumerate the different uses to which electric power is put on this property. For mine drainage there are installed in the

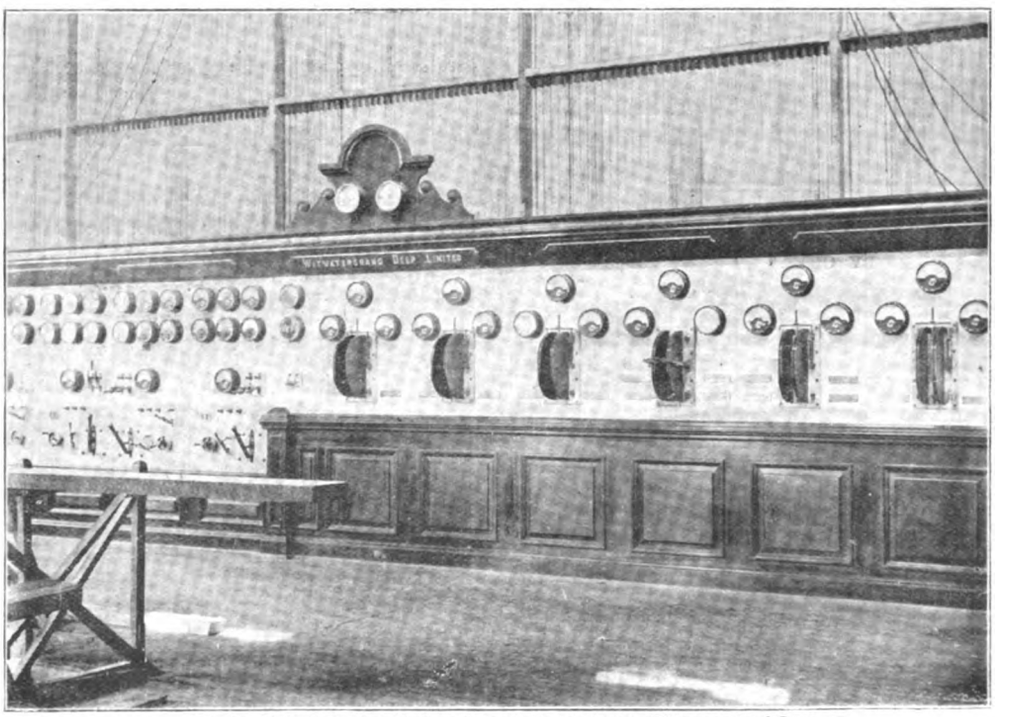

FIG. 4.—Main Switchboard, East Side of Engine Room, Witwatersrand Deep.

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west shaft three 4½in. by 8in. three-throw pumps, connected by Hans Renolds chain gear to a corresponding number of 25-h.p., three-phase, 50-cycle, 120-volt motors, lifting from 1,520ft. to 1,050ft., and two 16in. by 16in. three-throw pumps geared to two 75-h.p, three-phase, 50-cycle, 110-volt motors for lifting from the 1,050ft. station to the surface level; in the east shaft a 6½in. by 8in. pump connected by Hans Renolds chain gear to a 35-h.p., three-phase, 50-cycle, 120-volt motor, and a 4½in. by 8in. pump driven in the same manner, both lifting to the surface a matter of some 420ft. Transformers wound for 1,100 to 110 volts are used in all the underground stations. Current also for mine lighting is taken from the mine pump-station transformers. The carpenters' shop equipment includes a 40-h.p., 50-cycle, three-phase motor wound for 1,100 volts, and used for driving a circular saw, and those of the fitters' and blacksmiths' shops a 20-h.p. motor and two 6½-h.p. motors respectively, the latter driving drill sharpeners, while the boilermakers' shop disposes of a 20-h.p. motor. In the boiler-house itself two 6½-h.p. motors are used to drive the scrapers of the Green's economisers installed; a 11-h.p. motor works the ash conveyor, and another of 6½ h.p. drives the feed pumps. The mill engine condensing plant is served by two motors of 20 h.p. each, and the condensing plant described in the foregoing by two of 20 h.p. and two of 6½ h.p. each. The ore crushing and sorting plant, including belt conveyors to the mill, accounts for five motors of 40 h.p. each, two of 20 h.p. each, and one of 5 h.p. The sands conveyor requires a motor of 40 h.p. to work it, and in the extractor house there are two 40-h.p., three 20-h.p., and three 11-h.p. motors, the list being completed by two machines employed in the assaying and sampling departments of 11 h.p. and 6½ h.p. respectively. Thus between 40 and 50 motors of various sizes are comprised in the equipment of this mine, while about 1,000 lamps are installed, the lighting supply being at a pressure of 120 volts and the power supply at 1,100 volts. The above list of motors may not make interesting reading, but it will serve to indicate some of the requirements of a Rand mine.

The chief electrical engineer on the Witwatersrand Deep property is Mr. Louis B. Wilmot, to whom we are indebted for the particulars here given, as also for the photographs from which our illustrations are reproduced. Mr. Wilmot recently spent some weeks in this country and is now in America, where it is his intention to remain for a short time before returning to South Africa. We trust, during his stay here, English firms were able to convince him of the superiority of their manufactures—certainly a desideratum in view of the important market which South Africa promises to become for electrical machinery and apparatus of all kinds.

NOTES ON AERIAL POWER LINES.—III.

BY CHE.

(Continued from page 227.)

In response to a request to give complete information *re* the electrical characteristics of power lines, it is proposed in this article to consider the two-phase system of transmission; it will add interest to the problem if we take the same data as were considered in the example of the three-phase system dealt with last week. Thus, let it be required to determine the size of wire and the drop in volts in the line for a two-phase system transmitting 1,000 h.p. a distance of 50 miles, given that the pressure at the receiving end is 20,000 volts, that the frequency of the supply current is 50 periods per second, and the permissible loss in the line 15 per cent. of the power delivered.

There are two cases to be considered, according as (α) the transmission is effected by means of four conductors, or (β) the transmission is effected by means of three conductors, one of which is $\sqrt{2}$ times the cross-sectional area of the phase wire and forms a common return wire to the two phases. To make the example more complete it will be well to consider two examples of each type—*i.e.*, (1) when the load is non-inductive or the power factor of the load is unity, and (2) when the power factor of the load is 0·8.

First Case. Power Factor Unity, System (α).—The proper disposition of the wires in the four-wire system is shown in Fig. 4, in which case the mutual induction between the wires will be zero, since they are symmetrically arranged at the corners of a square. It is clear that each phase

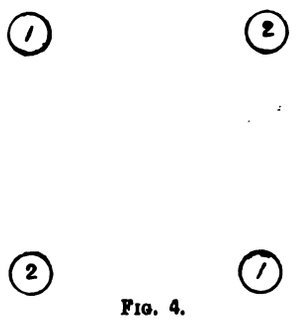

Fig. 4.

will transmit half the power, consequently the current per phase will be

$$I_1 = \frac{500 \times 746}{20{,}000} = 18{\cdot}65 \text{ amperes.}$$

If R_1 = resistance of 100 miles of wire, d_1 inch in diameter, forming one phase, we have

$$I_1^2 R_1 = \frac{15}{100} \times 500 \times 746 \text{ watts.}$$

But
$$R_1 = \frac{{\cdot}66}{10^6} \times \frac{100 \times 5{,}280 \times 12}{{\cdot}7854\, d_1^2}$$

$$\therefore d_1 = \sqrt{(18{\cdot}65)^2 \times \frac{{\cdot}66}{10^6} \times \frac{100 \times 5{,}280 \times 12}{{\cdot}7854 \times 75 \times 746}}$$

$$= 0{\cdot}1819 \text{in.}$$

which is approximately a No. 5 (B. & S.) wire. The area of this wire is approximately $A_1 = 0{\cdot}026$ square inch, and the resistance per phase

$$R_1 = \frac{{\cdot}66}{10^6} \times \frac{100 \times 5{,}280 \times 12}{0{\cdot}026}$$

$$= 160{\cdot}837 \text{ ohms.}$$

$\therefore$ resistance drop $R_1 I_1 = 160{\cdot}837 \times 18{\cdot}65 = 2{,}999{\cdot}6$ volts.

Since the pressure is high, it will be advisable to place the wires 54·6in. apart, in which case the reactance per phase will be $x_1 = 2\pi \sim L_1$, L_1 being the coefficient of self-induction per phase. By application of Maxwell's formula,

$$L_1 = 528 \left[15{\cdot}24 + 140{\cdot}366 \log \frac{54{\cdot}6}{{\cdot}091} \right] \times 10^{-6}$$

But
$$\log \frac{54{\cdot}6}{{\cdot}091} = 2{\cdot}778$$

$$\therefore L_1 = 0{\cdot}214 \text{ henry,}$$

and
$$x_1 = 2 \times 3{\cdot}1416 \times 50 \times {\cdot}214$$

$$= 67{\cdot}23 \text{ ohms,}$$

and the reactance drop $= 67{\cdot}23 \times 18{\cdot}65$

$$= 1{,}253{\cdot}8395 \text{ volts.}$$

The vector diagram for this case is given in Fig. 5, from which the generator pressure is found to be 23,033 volts;

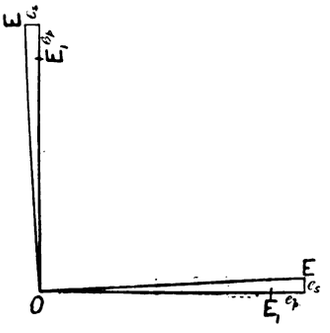

Fig. 5.

consequently the loss in volts in the line is 23,033 – 20,000 = 3,033 volts.

First Case. Unit Power Factor (β).—With three wires and a common return the current in each phase wire will

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be the same as before, but with the same percentage line loss the size of wire will be different. Thus

$$I_2 = 18{\cdot}65 \text{ amperes},$$

and the line loss

$$2\,I_2^2\,R_2 + (\sqrt{2}\,I_2)^2\,\frac{R_2}{\sqrt{2}} = \frac{15}{100} \times 1{,}000 \times 746,$$

in which R_2 is the resistance of each phase wire 50 miles in length, and $\frac{R_2}{\sqrt{2}}$ is the resistance of the common return (50 miles long), since it is $\sqrt{2}$ times the area of each phase wire.

But

$$R_2 = \frac{\cdot 66}{10^6} \times \frac{50 \times 5{,}280 \times 12}{\cdot 7854\,d_2^2},$$

where d_2 is the diameter of each phase wire,

whence

$$d_2 = 0{\cdot}168\text{in.},$$

which is slightly larger than a No. 6 wire. Taking a No. 6 wire of diameter 0·162in. and area 0 0206 square inch, the resistance of 50 miles of which is 101·5 ohms, the area of the common return wire should, therefore, be $\sqrt{2} \times 0{\cdot}0206$, or 0·029128 square inch, corresponding to a diameter of 0·192in., which is slightly less than a No. 4 wire. It will, therefore, be advisable to use a No. 4 wire for the common return, its diameter being 0·2043in., area 0·03278 square inch, and resistance for 50 miles 63·8 ohms.

The resistance drop per phase wire $= 18{\cdot}65 \times 101{\cdot}5$
$= 1{,}893$ volts,

and resistance drop in common return $= (\sqrt{2} \times 18{\cdot}65) \times 63\,8$
$= 1{,}682$ volts.

Keeping the wires still 54·6in. apart, the coefficient of self-induction for each of the phase wires will be

$$L_2 = 0{\cdot}1089 \text{ henry},$$

the reactance $x_2 = p\,L_2 = 34{\cdot}2$ ohms,

and reactance drop $= x_2\,I_2 = 637{\cdot}83$ volts.

Similarly, for the common return

$$L_{2m} = 0{\cdot}1026 \text{ henry},$$

$$x_{2m} = 32{\cdot}23 \text{ ohms},$$

and reactance drop $= 850$ volts.

The vector diagram is given in Fig. 6. It is assumed that the receiver pressures O E_1 and O E_1' are equal

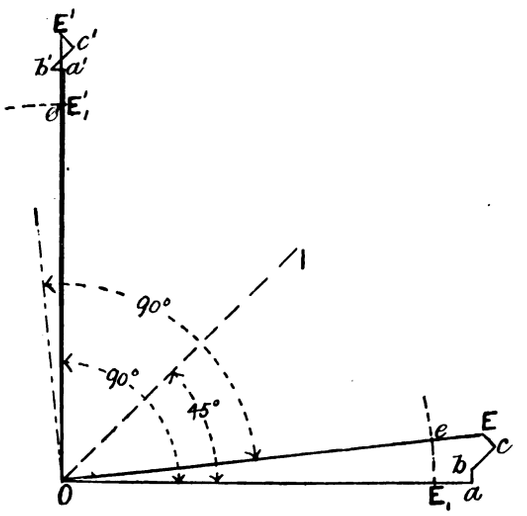

Fig. 6.

(20,000 volts) and are in quadrature (90deg.) with one another. $E_1\,a = E_1'\,a' = 1{,}893$ volts are in phase with O E_1 and O E_1', whilst the reactance volts $a\,b = a'\,b' = 637{\cdot}8$ volts; these refer to the phase wires. Since the current in the common return wire is the vector sum of the equal line currents, its direction will be O I, making 45deg. with O E_1 and O E_1'; consequently the vector representing the resistance drop for the common return will be parallel to O I, and $b\,c = b'\,c' = 1{,}682$ volts, whilst c E and c' E' (normal to O I and equal to 850 volts) represent the corresponding reactance drop in the common return. The generator pressures for the two phases are given by O E and O E' respectively, and it will be observed that they are not equal and are not in quadrature with each other. Thus, from the diagram O E = 22,625 volts and O E' = 23,625 volts, and the drop in volts in one phase is 2,625 volts and in the other 3,625 volts. Such conditions could scarcely be realised in practice, as the generator pressures O E and O E' would approximately be equal and in quadrature with each other. The assumption that the receiver pressures were equal and in quadrature, as made above, is wrong, and the more correct way is to begin with equal generator pressures in quadrature with one another, and making use of the data previously obtained, to work backwards, as it were, and determine the receiver pressures in the manner explained below in the second case with a common return. It is obvious that, although economy of copper is secured by adopting the two-phase three-wire system, the regulation of the line is defective.

Second Case. With Power Factor = 0·80 (α).—In this case the actual power received = ·80 × apparent power.

$$\therefore \text{ current in each phase} = I_3 = \frac{500 \times 746}{\cdot 8 \times 20{,}000}$$
$$= 23{\cdot}31 \text{ amperes}.$$

Also

$$I_3^2\,R_3 = \frac{15}{100} \times 500 \times 746,$$

and

$$R_3 = \frac{\cdot 66}{10^6} \times \frac{100 \times 5{,}280 \times 12}{\cdot 7{,}854\,d_3^2}.$$

$$\therefore d_3 = \cdot 2274\text{in.}$$

A No. 3 wire is ·2,294in. in diameter, so this size may be selected, its area being 0·04133 square inch, and the resistance for 100 miles is 128·8 ohms. Therefore, the resistance drop = 3002·3 volts, and placing the wires 54·6in. apart, the coefficient of self-induction per phase is

$$L_3 = 0{\cdot}2105 \text{ henry},$$

the reactance $x_3 = 66{\cdot}13$ ohms,

and reactance drop $= 1540{\cdot}9$ volts.

The vector diagram is given in Fig. 7, from which the generator E.M.F. per phase is found to be 23,375 volts, and the drop in volts in the line 3,375 volts.

Second Case. With Power Factor = 0·80 (β).—With three wires, one of which is a common return wire, the current in each phase wire will be the same as with four wires,

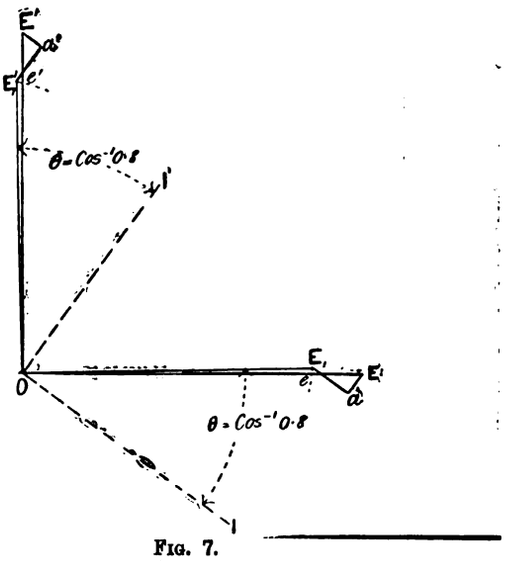

Fig. 7.

and $I_4 = 23{\cdot}31$ amperes, but with the same percentage line loss the size of the wire will be different. In this case

$$2\,I_4^2\,R_4 + (\sqrt{2}\,I_4)^2\,\frac{R_4}{\sqrt{2}} = \frac{15}{100} \times 1{,}000 \times 746,$$

in which R_4 is the resistance of each phase wire 50 miles in length; and since the common return wire must have an area of cross-section $\sqrt{2}$ times that of each phase wire, its resistance will be $\frac{R_4}{\sqrt{2}}$ for 50 miles. Let d_4 and d_{4m} be the diameters of these wires; then

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$$R_4 = \frac{\cdot 66}{10^6} \times \frac{50 \times 5{,}280 \times 12}{\cdot 7854\ d_4^2}.$$

But $$I_4^2\, R_4\, \{2 + \sqrt{2}\} = 150 \times 746,$$

and $$I_4 = 23{\cdot}31 \text{ amperes.}$$

$$\therefore\ d_4 = 0{\cdot}211\text{in.}$$

The nearest gauge wire is No. 4, which is 0·2043in. in diameter and 0·03278 square inch in area. The resistance for 50 miles is 63·78 ohms. To determine the size of the common return wire we have $\sqrt{2} \times \cdot 03278 = 0{\cdot}04635$ square inch, which corresponds to a diameter of 0·243in.; the nearest gauge wire to this is No. 2, which has a diameter of 0·2576in., an area of 0·0521 square inch, and a resistance of 40·13 ohms for 50 miles.

The resistance drop per phase wire is therefore

$$I_4\, R_4 = 23{\cdot}31 \times 63{\cdot}78 = 1{,}486{\cdot}7 \text{ volts,}$$

and the resistance drop in the common return is

$$\sqrt{2}\, I_4\, R_{4m} = \sqrt{2} \times 23{\cdot}31 \times 40{\cdot}13 = 1{,}322{\cdot}7 \text{ volts.}$$

The coefficient of self-induction per phase wire is

$$L_4 = \frac{50 \times 5{,}280}{1{,}000} \left\{ 15{\cdot}24 + 140{\cdot}366 \log \frac{54{\cdot}6}{\cdot 102} \right\} \times 10^{-6}$$

$$= 0{\cdot}1026 \text{ henry.}$$

The reactance $x_4 = 2\pi \sim L_4 = 32{\cdot}23$ ohms,

$\therefore$ reactance drop per phase wire is

$$x_4\, I_4 = 32{\cdot}23 \times 23{\cdot}31 = 751{\cdot}28 \text{ volts.}$$

Similarly for the common return wire we have

$$L_{4m} = \frac{50 \times 5{,}280}{1{,}000} \left\{ 15{\cdot}24 + 140{\cdot}366 \log \frac{54{\cdot}6}{\cdot 1288} \right\} \times 10^{-6}$$

$$= 0{\cdot}1012 \text{ henry.}$$

The reactance $x_{4m} = 31{\cdot}8$ ohms,

$\therefore$ reactance drop in common return wire is

$$x_{4m}\, I_{4m} = 31{\cdot}8 \times \sqrt{2} \times 23{\cdot}31 = 1{,}048 \text{ volts.}$$

If we assume that the receiver pressures are equal and in quadrature (90deg.) with one another, the vector diagram, given in Fig. 8, is readily constructed. Since the power

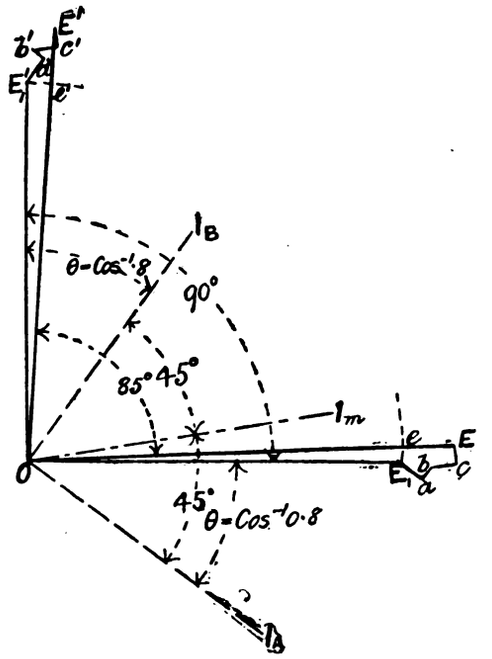

FIG. 8.

factor of the load is 0·8, the receiver pressures (20,000 volts), O E_1 and O E_1', make equal angles with O I_A and O I_B, the two phase currents, also assumed to be in quadrature with each other. $E_1\ a$ and $E_1'\ a'$ represent 1,486 volts, the resistance drop per phase wire, and are parallel to O I_A and O I_B respectively. The reactance drop per phase wire is represented by $a\ b = a'\ b' = 751{\cdot}2$ volts. The phase of the current in the common return is given by the vector O I_m; consequently the vector for the resistance drop in the common return is given by $b\ c = b'\ c' = 1{,}322{\cdot}7$ volts, parallel to O I_m, whilst the reactance drop for the common return is given by $c\ E = c'\ E' = 1{,}048$ volts. The generator pressure for the two phases are given by O E and O E^1 respectively, and it will be found that these are not equal and are not in quadrature. For instance, O E = 22,750 volts and O E' = 23,000 volts, and the phase relationship of the two generator pressures is 85deg. The drop in volts in the respective phase wires are 2,750 and 3,000 volts. These conditions do not correspond with those obtained in practice, and the method of working backwards to obtain the diagram for the working conditions is as follows. Let us assume that the generator pressure for each phase is 22,875 volts—*i e*, the mean of the pressures 22,750 and 23,000 volts as determined above. Now, the percentage drop in volts in one phase is

$$\frac{2{,}750}{22{,}750} \times 100 = \frac{1{,}100}{91} = 12{\cdot}1 \text{ per cent.}$$

and in the other phase is

$$\frac{3{,}000}{23{,}000} \times 100 = \frac{300}{23} = 13 \text{ per cent.}$$

Therefore, with the same percentage drop in the lines and a generator pressure of 22,875 volts, the drop in volts in the first phase will be

$$\epsilon_1 = \frac{11}{91} \times 22{,}875 = 2{,}765 \text{ volts,}$$

and the resulting receiver E.M.F. will be

$$22{,}875 - 2{,}765 = 20{,}110 \text{ volts.}$$

In the second phase we have

$$\epsilon_2 = \frac{3}{23} \times 22{,}875 = 2{,}984 \text{ volts,}$$

and the resulting receiver E.M.F. will be

$$22{,}875 - 2{,}994 = 19{,}891 \text{ volts.}$$

It will simplify matters if we assume that the currents in the two phase wires change proportionately with the receiver pressures, consequently the currents in the phase wires will be respectively

$$I_A' = 23{\cdot}31 \times \frac{20{,}110}{20{,}000} = 23{\cdot}438 \text{ amperes.}$$

$$I_B' = 23{\cdot}31 \times \frac{19{,}891}{20{,}000} = 23{\cdot}183 \text{ amperes.}$$

The resistances and reactances of the conductors are as before, therefore

Resistance drop in phase wire A = $23{\cdot}438 \times 63{\cdot}78$
$= 1{,}494{\cdot}876$ volts.

Resistance drop in phase wire B = $23{\cdot}183 \times 63{\cdot}78$
$= 1{,}478{\cdot}6$ volts.

Similarly the reactance drop in phase wire A = $23{\cdot}438 \times 32{\cdot}23$
$= 755{\cdot}4$ volts.

The reactance drop in phase wire B = $23{\cdot}183 \times 32{\cdot}23$
$= 747{\cdot}2$ volts.

As regards the new construction of the vector diagram (Fig. 9), the generator pressures are taken as being in quadrature, or, in other words, their phase relationship has been increased by 5deg., consequently the phase angle between the receiver pressures O E_1 and O E_1' and between the currents O I_A' and O I_B' must also be increased by 5deg.—*i e.*, have a phase angle of 95deg. Beginning with O I_A', representing 23·438 amperes, and O I_B', representing 23·183 amperes, making an angle of 95deg. with one another, the current in the common return wire is given by the diagonal, O I_M', of the parallelogram, and is thus found to be 31·6 amperes. Consequently

the resistance drop in the common return = $31{\cdot}6 \times 40{\cdot}13$
$= 1{,}268$ volts,

and the reactance drop in the common return = $31{\cdot}6 \times 31{\cdot}8$
$= 1{,}005$ volts

The receiver E.M.F.'s, O E_1 and O E_1', equal to 20,110 and 19,891 volts respectively, are next introduced, and making with O E_1 and O E_1' respectively an angle θ, such that $\cos\theta = 0{\cdot}8$. The diagram is completed by introducing the following vectors in the order given.

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$E_1 a$ parallel to $O I_A'$	and equal to	1,494·8	volts.
$a b$ normal to $E_1 a$	,,	,,	755·4	,,
$b c$ parallel to $O I_m'$	,,	,,	1,268	,,
$c E$ normal to $b c$	,,	,,	1,005	,,
$E_1' a'$ parallel to $O I_B'$	,,	,,	1,478·6	,,
$a' b'$ normal to $E_1' a'$	,,	,,	747·2	,,
$b' c'$ parallel to $O I_m'$	,,	,,	1,268	,,
$c' E'$ normal to $b' c'$	,,	,,	1,005	,,

O E and O E', the respective generator pressures, will then be found to be practically equal to one another (and = 22,875 volts) and to make an angle of 90deg. with each other. The bad regulating qualities of a three-wire two-phase transmission system are still obvious, and it will be

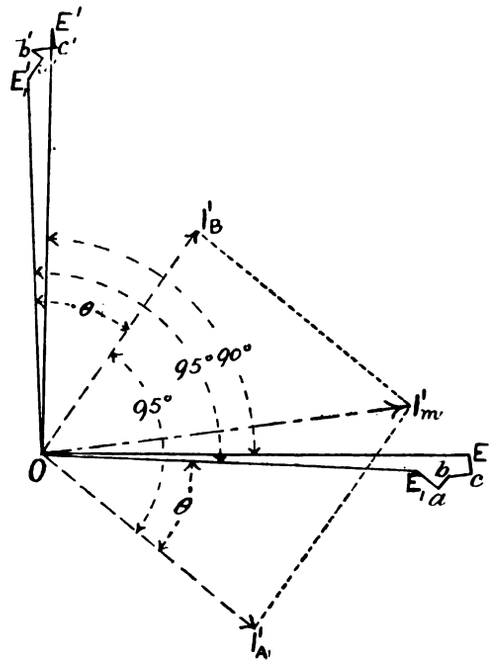

FIG. 9.

observed that the receiver pressures are unequal—*i.e.*, 20,110 and 19,891 volts—and it may be remarked that several engineers are now discarding this system of transmission.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LINE CALCULATION.

SIR,—I have been looking through answers to Question 795 in the issue of Aug. 4, and it seems to me that two of the answers printed are seriously incorrect.

1. *Answer by E. P. Hollis.*—In Table A the interest and depreciation is taken as 8 per cent. on the *total cost* of the 40 miles of line. This is, I think, incorrect, for according to Kelvin's law the 8 per cent. should only be taken "on that part of the capital outlay which is proportional to the area of the conductor"; in this particular case the copper conductors only. As the cost of poles, brackets, insulators, and erection will remain constant for at least six sizes of conductor nearest the one wanted, so that the 8 per cent. should be reckoned on the cost of the copper wires only. The cost of waste energy per year given in the table as $\frac{£12·3}{A}$ is not right, inasmuch as it takes no account of the load factor, which is the *sine qua non* of the whole business. The real cost of waste energy per annum would be $\frac{£12·3}{A} \times (\text{load factor})^2$. Curiously enough, the conclusion arrived at from Table A as to the size of wire to use is fairly correct, the two mistakes neutralising one another.

Fourth Answer by "Newcastle."—In working out the wasted units per annum, this writer assumes a 35 per cent. load factor and makes the units wasted 144,000. This, however, is incorrect, as the units wasted are *not* proportional to the load factor, but to the *square* of the load factor—a very different matter. So that the wasted units would really be about 36,700, and, therefore, the annual loss £115, instead of £450 given in the answer. Also from this it follows that the sectional area of No. 9's wire, instead of being too small as stated, is too large, and the curve of "cost of units wasted" in the diagram is quite out of place. In reckoning out the total loss in the line for 8 S.W.G. wire, the figure is given as 24·9 kw. This is wrong, for the resistance of 40 miles of 8's wire is 85·66 ohms, and not 59·5 ohms, the figure taken in the example; so that the total $C^2 R$ loss is 54 kw. instead of 24·9 kw. The lost volts are also obtained from a formula (which I think is incorrect) as 1,490. The lost volts—*i.e.*, loss between any two wires—are equal to $\frac{\text{total energy loss}}{1\frac{1}{2} C} = 2{,}490$ volts; or by Ohm's law $C = \frac{E}{R}$, where R is resistance of 80 miles of No. 8's wire and C is current per wire.—Yours, etc.,

Aug. 15, 1905. DUPLICATOR.

THE SWITCHMAN'S INVOCATION TO ELECTRA.

BY SIMPLEX.

Ho most divinest fair!
That makest hall thy slaves go through the 'oops
Like a performin' bear
Or other animals in circus troupes.
Bow down thy beaucheous hear!
List to the throbbin' sorrow of my song!
Tell me my rise is near,
Yea, gently whisper "Now we shan't be long."

Ah, what a weary while
I've punched the volts abart this bloomin' board!
Ho with what shockin' guile
The chief with promises my mind hath stored!
Too late I know the truth!
I shan't get any rise at all this year.
Mourn then my wasted youth,
And w'en I snuff it, drop a pitying tear!

Electra! 'Art of stone!
Wilt thou not melt in pity for thy slave?
Jest listen 'ow I groan!
Stretch forth thy 'ansum arms thy worm to save.
Hear then this shuddering sob—
Find me a screw, and let me have the tip.
Send me a better job.
This sort of thing gives me the 'orrid pip!

PERSONAL.

Mr. H. E. Osborne, engineer-in-charge to the Watford Urban District Council, has been appointed to a similar position by the Dover Corporation, and his place has been filled by Mr. C. S. Taylor, of Erith.

Mr. J. Mordy Lambe, formerly borough electrical engineer of Kimberley, has been appointed to a similar position in Johannesburg, owing to the retirement of Mr. C. W. Moore on account of his health, which we are glad to hear is now improving. With regard to this appointment 55 applications were received through London agents, and 21 from persons resident in South Africa. Mr. Lambe was one of a short leet of four. The others were E. B. Thornhill (Taunton), E. A. Browning, and W. J. Dale, the two latter giving addresses at Streatham. The Johannesburg Council have appointed Mr. J. A. McMullen station engineer.

The Acton District Council have appointed Mr. Harry A. Harding, of Leatherhead, assistant electrical engineer at a salary of £130 per annum.

The staff of the Aberdeen Corporation electricity department last week entertained Mr. J. Wilson and Mr. D. J. Hawkes at dinner on the occasion of their leaving Aberdeen, Mr. Wilson to fill an appointment with the Clyde Valley Electricity Supply Co., and Mr. Hawkes with Siemens Bros., London.

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A DOCTRINE OF NEGATION.

The British Association has in the past done good work, and may continue so to do in the future, but the good work consists only of a few grains of corn among the mountainous heap of chaff which has been turned out. The Rev. W. Cunningham, presiding over the economic section, has delivered an address entitled "Unconscious Assumptions in Economics," wherein, by quotations, he shows that the classic economists were very much at sea when touching upon the development of new countries or colonies. The reverend gentleman seems to us to have fallen somewhat into the error of his predecessors, and unconsciously assumes that the conditions which exist at the time he argues are the conditions that will continue to exist through all time. Now, if we only think for a moment of the conditions of the world's affairs which existed when some of the classic economists wrote, we find a set of conditions differing very considerably from those prevailing to-day. The great factor in the change has been the increased facilities for intercommunication. Says the presidential address: "The men of the classical period of economics who devoted themselves to the study of new countries were not in a position to deal with the subject properly, and their writings seem singularly lacking in grasp." Adam Smith did not realise, nor could he be expected to realise, that America would ever be brought within a week's journey, or that communication almost instantaneous would be held with that country. He had no idea of a system which would permit of Australasian mutton being sold in the markets of Britain. But we know this is a daily operation, and the market for Australasian mutton has been largely increased thereby. A demand usually increases but to be supplied, and a larger demand means development of the tract of the world's surface from which the demand is supplied. The classic economists did not assume too much—they argued from the facts they knew and from changes they deemed possible and probable. Take a couple of mineral operations and see the difference. New Zealand teems with coal, but its coal is not being rapidly developed, nor does this mineral wealth play a very great part in the development of the country. The Transvaal possesses great stores of gold and diamonds. Its development has been largely due to these mineral riches. In one case, that of coal in New Zealand, there is but a small market; in the other, that of gold and diamonds, the market is as extensive as the world, and the demand enormous. Thus we see differing conditions lead to development in different ways. The facilitating of intercommunication increases the market which demands a certain product, and production increases accordingly. The ruling factor is demand, and this the classic economists knew. What they did not know was that telegraphy and the steam-engine would play so large a part in increasing the demand by increasing the area over which the product could be supplied. Our author pertinently says, "Economic experts are not even yet acquainted with philosophical principles as to the manner in which communities ought to develop, and, therefore, we are not justified in pretending to train up a young country in the economic way it should go." This is but another way of saying we do not know and we cannot foretell the conditions which will exist, hence no hard-and-fast lines of development can in the abstract be indicated. It must not be assumed that discussions into the domain of economics are uninteresting to the engineer. This is certainly not the case, and especially in an old-established community like our own. The development of the younger communities can be and must be assisted from the older community, hence a large part of our trade.

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Ships, engines, railways, machinery are required for the supply of mutton or gold. The suppliers of these products look elsewhere than to themselves for these things, and naturally obtain them from the older and more greatly developed countries.

WIRELESS TELEGRAPHY MEASUREMENTS.*

BY W DUDDELL, MEMBER, AND J. E. TAYLOR, ASSOCIATE MEMBER.

(Concluded from page 240.)

Adjustments of Transmitting Apparatus.—To successfully carry out measurements of the strength of oscillations set up in a receiver antenna under the various conditions set out in this paper necessitates very great care in the working of the transmitter to avoid irregularities of action. In spite of all precautions some variations were unavoidable, but they were not of such a nature as would invalidate results obtained if other conditions remained constant. To produce the most regular and uniform strength of oscillations in the transmitter wire, it was necessary to give attention to the following points: (1) To use an interrupter which is capable of uniform and consistent operation. (2) To use a definite adjustment of the spark or discharge gap in relation to the power applied. This gap must not be too short, or erratic multiple sparking is obtained, nor must it be too long, or frequent "misfires" or spark failures then result. (3) To use sparking knobs of a size suited to the capacity and length of spark adopted. (4) To keep the insulation of all parts of the high-tension system as nearly perfect as possible, and minimise all brush discharges. (5) To use Leyden jars with good metallic coatings. The nitrous fumes developed during use cause rapid deterioration of unprotected tinfoil coatings. The jars used were completely varnished over the inside coatings with shellac varnish, except where connections were made. (6) To keep the height and relative positions of the antenna wires, earth leads, and earth netting constant.

The most difficult points to negotiate were those connected with the adjustment of the spark-gap, as, having taken all precautions, sparks would occasionally misfire or vary in intensity. Owing, however, to the method adopted in observing and recording the deflections obtained on the receiving instrument, occasional "misfires" did not necessarily affect the readings, because for each reading a continuous series of sparks, lasting half a minute, was used, and any erratic momentary deviations in the deflections were not considered in recording the mean deflection, the steady value only being taken into account. Apart from this effect, mysterious changes in the spark were often observed. When the transmitter oscillations, as indicated on the thermal ammeter, were below par, it would often be possible to resuscitate the sparks by slightly moistening the discharge knobs. It was also found that for relatively large capacities, such as that used for wave No. 3, it was impossible to get uniform results with 1in. diameter brass knobs on the discharger when using a short gap. If, however, the 1in. knobs were replaced by ¼in. brass rods with rounded ends, a much more uniform effect was obtained for short sparks of, say, ⅛in. to ¼in., but for longer sparks the knobs were preferable. On the other hand, with the smaller capacities used, the knobs were found suitable under all conditions of spark-lengths adopted in the experiments, whilst the rods gave poor results.

As regards the form of interrupter, the most consistent results were undoubtedly given by the mercury turbine if run at speeds less than about 1,500 r.p.m. At higher speeds there is a tendency to churn up the alcohol and mercury, forming a mercury emulsion, which seriously interferes with the action of the interrupter. It is also very important to keep the resistance of the primary circuit through the spark coil as low as possible, and adjust the current strength by regulating the voltage applied rather than by inserting resistance. The Grisson interrupter gives a much more rapid series of sparks, however, and, therefore produces a larger deflection on the receiver. The relative positions of the antenna wire and earth netting is very important. The strongest oscillations were obtained when the antenna was immediately over the middle of the earth netting. In experiments with a transmitter antenna of an inverted L-shape, the reading on the thermal ammeter in the transmitter wire increased from a mean of 0·464 ampere, with the earth netting displaced about five yards from its symmetrical position under the antenna, to a mean of 0·496 ampere with the netting immediately under, an increase of about 7 per cent. in current strength.

Tuning.—The tuning between the exciting circuit and the transmitter antenna, although well defined, was not of the sharpness which can be developed by improved methods of coupling. It was such that the number of turns in the auxiliary inductance used for tuning the antenna might be varied to the extent of about 15 or 20 per cent. without greatly affecting the strength of oscillations. The tuning of the receiver antenna was rather more definite than this. For the different waves used the adjustment of tuning inductances with full height of antennæ was as follows:

	Turns of Inductance in Antennæ.	
	Transmitter.	Receiver.
Wave No. 1	12	8
,, ,, 2	18	12
,, ,, 3	40	32

The total lengths of wire from the top of the antennæ to the earth netting in each case were:

	Transmitter wire.	Receiver wire.
Wave No. 1	96ft.	92ft.
,, ,, 2	102ft.	96ft.
,, ,, 3	124ft.	116ft.

It was from these figures that the wave-lengths were deduced on the assumption that the wave was about four times the length of the wire used in the radiating system. For wave No. 3 it might be thought that a length of 480ft. would be more consistent with the lengths of wire than the 500ft. assumed, but in this case considerable amounts of inductance were inserted in the antennæ, and it appeared reasonable to assume that in such a case the inductance would be increased in a greater ratio than the number of turns of wire on the drum. The reason for the receiver wire being shorter than the transmitter is not very clear, but the difference is within the limits of experimental error. It is, however, possible that the oscillating current in the antenna flowed to earth *viâ* the spark gap and the Leyden jars, rather than *viâ* the Leyden jar inductance spiral. If this was the case, it would be necessary to add more inductance in series with the antenna to tune it to the same period as the oscillatory exciting circuit, hence the longer length of wire. This method of computing the wave-length in terms of the length of wire used is open to error where large aerial capacities are concerned, but in the present instance, where the antennæ were formed of single wires, it may be taken as sufficiently accurate for a rough approximation. As an aid to tuning and for indicating the strength of oscillations in the transmitting system, the pivoted thermo-ammeters proved very satisfactory, and they have the great advantage, as compared with hot-wire ammeters of the usual description, that the resistance and inductance which they introduce into the system is practically negligible. As regards the sensibility of the suspended form of instrument used at the receiver, it may be taken that good readable deflections could always be obtained so long as the strength of signals was sufficient to act upon the coherer receiver with the slow-sparking interrupter at the transmitter. To increase the range of sensibility beyond this point merely requires an increase of the rate of sparking. In connection with the question of tuning, a brief series of tests were made at the transmitter to determine whether the Duddell thermo-ammeter used was inserted in the best position in the radiating system. Accordingly one ammeter was fixed permanently in position A, as shown in the diagram (Fig. 1), whilst another was inserted in successive positions *a*, *b*, *c*, *d*, and *e*. The results obtained were as follows:

Position.	Current, amps.
a	0·300
b	0·337
c	0·344
d	0·355
e	0·338

* Paper read before the Institution of Electrical Engineers.

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It will thus be seen that whilst the ammeter was normally connected up in the correct position the actual antinode of current was not on the wire netting. From this point of view the netting appears to act as a capacity rather than an actual earth connection.

In conclusion, the authors wish it to be understood that the general scheme of operations and many valuable practical details of the experiments were directly due to Mr. Gavey, through whose good offices the necessary official permission has been obtained to publish these results, which they trust may be of some use in advancing the cause of wireless telegraphy.

THE MAINTENANCE OF COMMUTATORS AND BRUSHES.

BY S. LEES.

The subject of the following article may appear, perhaps, to some readers to be rather simple and uninteresting, but it is, nevertheless, a most important one to which too much attention cannot be given if the maximum efficiency and economy in the running of direct-current machinery is to be obtained with the minimum of expense. Even in these enlightened days, there are many central stations of large size (the writer speaks from actual experience) where, while money is literally thrown away on expensive test-room equipments—potentiometers, with their numerous adjuncts, photometers, balances, etc., in fact, no end of standard instruments of various kinds—it is considered quite

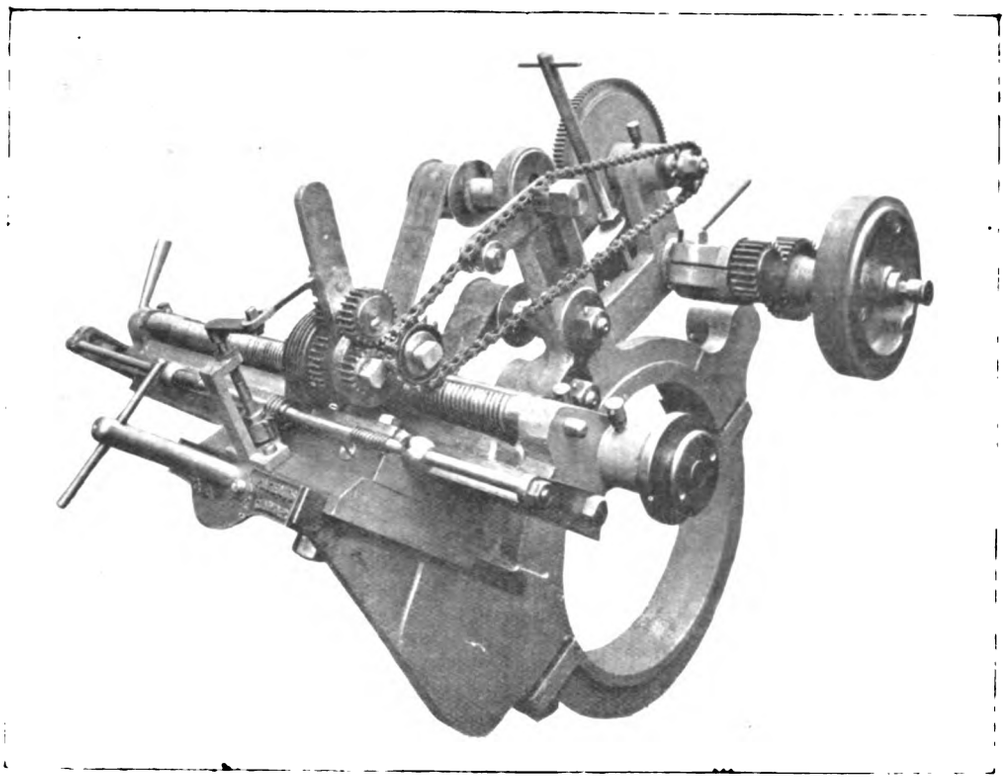
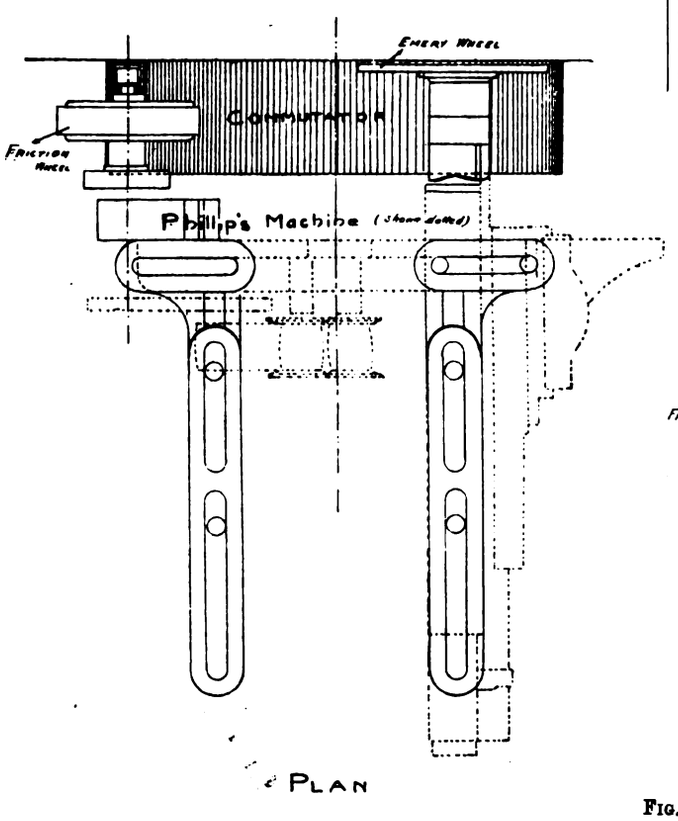


FIG. 1.



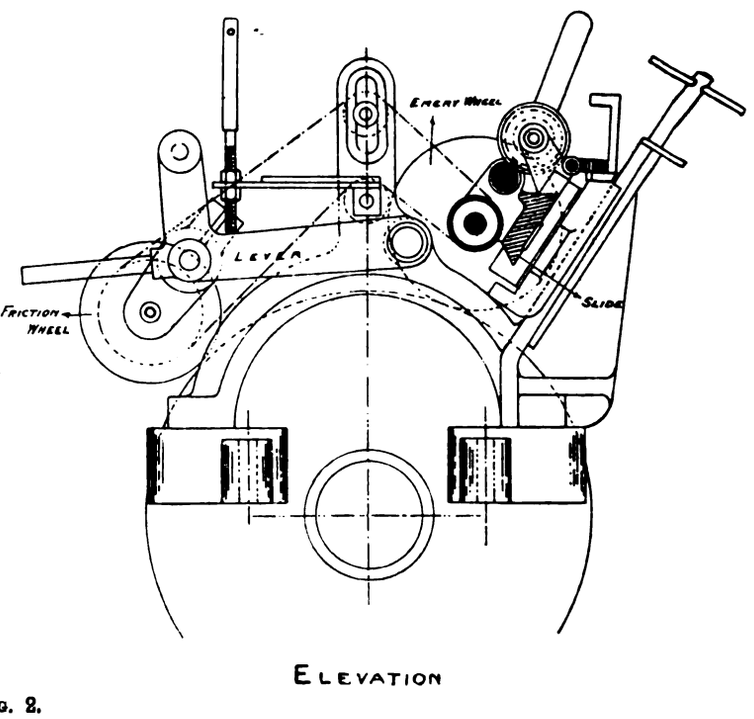


FIG. 2.

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unnecessary to provide anything in the way of tools for the cleaning and truing up of the commutators.

Formerly, it was usual when a commutator had been allowed to get into such a bad state that running was impossible unless accompanied by a fine display of pyrotechnics, to tide matters over by putting a file on the commutator; as, with many of the older types of machines it was an impossibility to rig up a slide rest and skim up

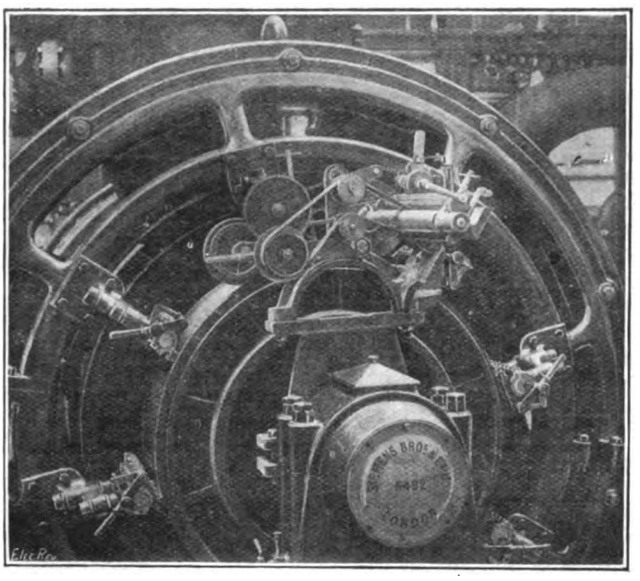


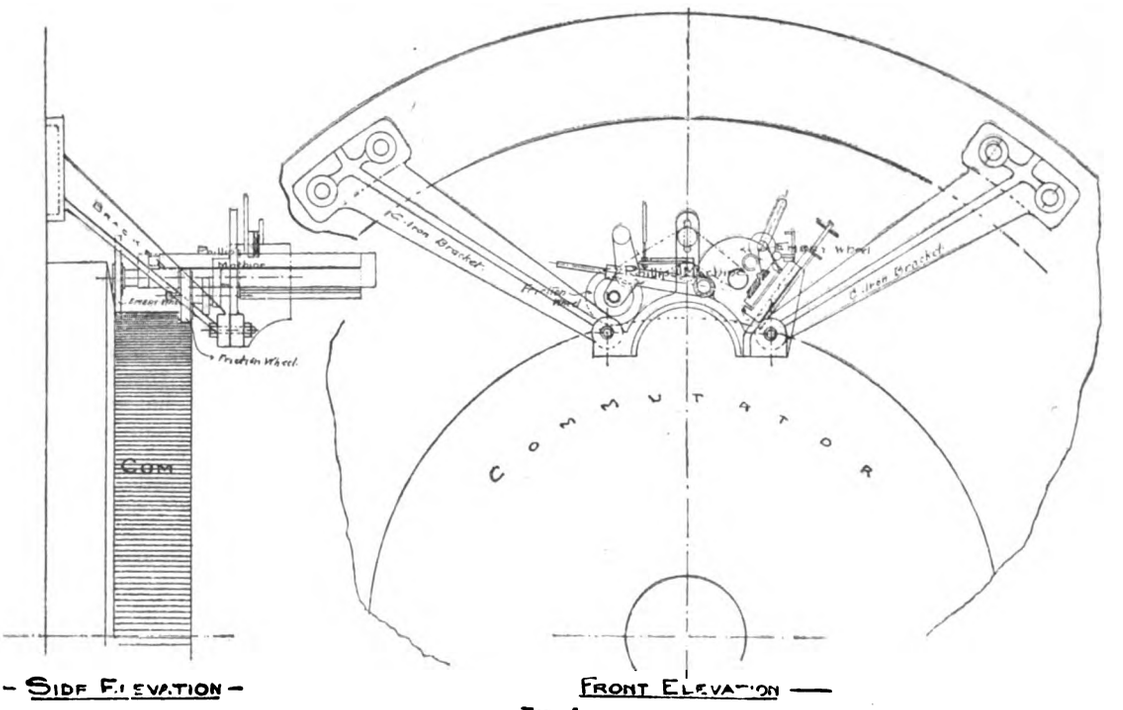
FIG. 3.

the commutator in position, and to take out an armature of four or five tons weight was often no easy matter—the lay-out of the plant in some of the older stations left much to be desired, these things being understood better at the present day—to say nothing of the inconvenience caused through the armature having to be sent away to some shop to be turned up, as very few of the stations of 10 or 15 years ago enjoyed the luxury of a lathe.

mutator very uneven, aggravating sparking by causing the brushes to jump, and resulting in increased wear of both the commutator and brushes.

The writer recalls an experience he encountered about eight years ago at a large electricity works in Yorkshire. The commutators of nearly all the generators (some 17 in number, varying in size from 150 kw. to 600 kw.) were in a very bad state, and one of the writer's first jobs on first taking up duties was the truing up (by file) of the commutators of two of the 150-kw. sets. The machines were of the bipolar type, having three copper gauze brushes to each holder. The brushes of dissimilar polarity had been placed exactly in a line with each other, owing to which the commutator had become worn down in the form of three grooves, the flanges thereto standing up about $\frac{1}{4}$in. all round from the rest of the commutator. The sets were direct-coupled, and, viewed from the machine end, ran counter-clockwise, rendering the filing nearly all left-hand work. The works did not boast a lathe, and the machines could not be spared out of service long enough to allow of the armatures being sent away.

Of the two methods of truing up commutators—viz, turning and grinding—the writer is of opinion that, taken all round, grinding makes the most satisfactory job. In order to get the best results by turning, the operator requires to have a thorough working knowledge of turning, and the writer's experience has taught him that a really good mechanic is the exception rather than the rule in most installations, not excepting even central stations. Where possible, it is preferable to true up the commutator in position. Hard-drawn copper as used for commutator bars is queer stuff to work, and as the bars have a tendency to spring when passing under the tool the cutting speed should not exceed about 90ft. per minute. With high-speed direct-coupled sets having engines of the two-crank type—particularly single-acting engines—it is sometimes a rather difficult matter to get even turning at these low rates of speed. A tool-holder to take tool steel of V section is very suitable for commutator work, as, in case of breakage, grinding only is required. Light cuts should be taken as the tool is liable to *dig in*. After the finishing cut is taken the speed may be increased slightly, and a file run over the commutator. Before finally polishing with emery cloth the



— SIDE ELEVATION —

FRONT ELEVATION

FIG. 4.

Nowadays there is no excuse for treating commutators in this barbarous manner, although some engineers still stick to the idea that the presence of slight flats does not necessitate the truing up of the whole commutator. That this idea is quite erroneous may be easily proved by carefully calipering the commutator after the flats have been *filed out*. The small flats have been removed only to give way to larger ones, thus leaving the whole surface of the commutator should be carefully examined all over and any metal which may be found bridging across the mica insulation between the segments carefully removed. The final polishing is best done with a special tool as described later on.

There are two types of commutator grinding machines—viz, (1) driven direct from the commutator to be trued up, (2) driven by belt from separate source, usually a small

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motor. Figs. 1, 2, 3, and 4, illustrative of type 1, represent the grinding machine of the Phillips Commutator Grinder Company, Limited, of London. Fig. 1 is a general view of an automatic machine having a clamp arrangement for fixing round the brush-rocker journal. Where no rockers are used the same machine can be fixed round the nose of the outer bearing. Distance rings of different sizes are used when necessary to fit various sizes of rockers. When inconvenient the bottom half-ring is dispensed with, and the machine is bolted to arms supported from the cover bolts (Fig. 2), and when the diameter of the commutator is extra large the arms are raised by means of distance pieces, or they are bolted to the platform of a casting clamped round the nose of the bearing, as illustrated in Fig. 3. Fig. 4 shows the machine as sometimes supported by means of two cast-iron arms fixed to magnet ring, and in some cases to the brush ring (when sufficiently strong). Here the machine is shown mounted on the top of a commutator 8ft. in diameter. The Phillips light hand-feed machine, which is used chiefly for small dynamos (exciters, boosters, etc.), is made to *true-up* commutators from 3in. to 9in. diameter and 6in. wide (across face). The heavier hand-feed machine is made stronger to carry longer slides to true-up commutators from 6in. to 12in. diameter to 10in. wide. This type of machine is specially suitable for dynamos on board ship (but they can be used otherwise), which, as a rule, are erected close to the bulkheads, allowing but little room for working. In working the grinding spindle is driven direct by means of a specially prepared rubber friction wheel running on the commutator. The grinding wheel moves to and fro across the face of the commutator, and in all except the hand-feed machines is automatically reversed at each end, being so constructed that stops can be set as in a planing machine, grinding the surface right up to the connecting wires and back to the edge. The grinding wheel should, of course, run in the opposite direction to the commutator.

A commutator truing machine possessing some novel features has recently been placed on the market by Jordan Bros., of New York, U.S.A. It is of the direct-driven type, the grinding wheel spindle being driven by means of a round belt passing round the commutator or armature shaft. The grinding wheel spindle is slotted to allow of lateral movement of the wheel across the face of the commutator. The feed is controlled by hand, the depth of cut being set by means of an eccentric gear. The grinding wheel is specially made for commutator work, as it is claimed that no substance which would be injurious to commutators enters into its composition. The machine is provided with suitable clamps for affixing to the rocker journal or framework of the generator or motor. An illustrated detailed description of the machine appeared in the June number of the *American Electrician*.

(To be continued.)

APPOINTMENTS VACANT.

Assistant Engineer, Handsworth Urban District Council. Salary £100 per annum. Applications by 30th inst.

Junior Demonstrator in Physics and Electrical Engineering to the L.C.C. School of Marine Engineering, Poplar. Salary at the rate of 10s. 6d. an evening. Applications by 10 a.m. on Sept. 18. See advertisement.

Head of the Department of Physics and Electrical Engineering, Portsmouth Education Committee. Salary, £175 per annum. Application by Sept. 4. See advertisement.

Draughtsman for switchboards. Apply to Box H 91, *Electrical Engineer* office. See advertisement.

Draughtsman for transformers. Apply to Box Y 2, *Electrical Engineer* office.

Electrical Units and Standards.—It is reported that the Elektrotechnische Reichsanstalt has called a conference, preparatory to the meeting of the International Commission of Electrical Units and Standards. This course is to be highly commended, and is in accord with the recommendations of the St. Louis International Electrical Congress, which advocated that the differences in the laws of various countries in reference to electrical units should be considered by an international commission. This conference is expected to be held at the end of next month, and invitations have been sent to the Governments of Great Britain, the United States, France, Austro-Hungary, and Belgium.

PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

The following is the report of the committee of the British Association, recently presented in South Africa, on experiments for improving the construction of practical standards for electrical measurements. Lord Rayleigh is chairman of the committee, and Dr. R. T. Glazebrook secretary.

The committee are glad to report that satisfactory progress has been made during the year with the ampere balance. The weighing mechanism was taken over from the maker shortly after the last meeting of the association, and the work on the coils completed at the National Physical Laboratory. The labour involved in insulating the two wires on the large cylinders was very great. Each wire consists of about 90 turns of about 105cm. circumference. Thus each wire is about 95m. in length, and the two are along their whole length about $\frac{1}{10}$mm. apart. In the coils as finally set up the insulation resistance between these two wires is measured in thousands of megohms, and is thus amply sufficient. The cost of the balance has amounted to £302. 6s., the excess over the £300 granted for the purpose being met out of the general fund at the disposal of the committee. Calculations of the force to be expected between the coils when carrying one ampere have been made by Mr. Mather and Mr. F. E. Smith, of the National Physical Laboratory, and are in close agreement.

The designs from which the balance has been made are the work of Mr. Mather, and originally it was contemplated that the balance would be set up at the City and Guilds Central Institute in Exhibition-road. At a meeting of the committee held on March 31, 1905, however, this decision was modified, and the following minute agreed to: "That the ampere balance remains for the present at the National Physical Laboratory, and that a determination of the ampere be made with it there under the supervision of Prof. Ayrton and Mr. Mather, steps being taken to connect closely with the determination and with any notification of the results the names of the late Prof. J. V. Jones, Prof. Ayrton, and Mr. Mather, to whom the design of the instrument is entirely due." Accordingly, the balance has been set up at the National Physical Laboratory, and a number of preliminary tests have been made. Particulars of some of these follow.

Ampere Balance.—The weighing mechanism of the balance was erected by Mr. L. Oertling at the National Physical Laboratory in March of the present year, and the electrical equipment was completed immediately afterwards. The four coils of bare copper wire wound on marble cylinders have given complete satisfaction, the ellipticity and conicality of each being very small. The average ellipticity is such that the diameters of the ellipse differ in length by about 10 micron, while the average conicality is approximately represented by a difference between the mean diameters of two sections 13cm. apart (the axial length of one coil) of about 12 micron. The contour of the cylinders is very well known, and the mean diameter has been measured with a probable error not greater than 0·001 per cent. This knowledge enables the calculation of the mutual induction between two coils to be made with great accuracy. Preliminary observations with a current of nominal value, one ampere, were made at various times during April and May, the first set of such observations determining the temperature to which the coils are raised by a continuous steady current, the magnitude of the disturbances arising from convection currents, the influence of the silver strips, and the nature of other disturbances. The convection currents give some trouble, but the experiments already carried out indicate that a change of 0·001 per cent. in a current of nominal value one ampere will be detectable. The balance acts conveniently as an indicator of the magnetic permeability of the marble and metal parts of which it is constructed, and it is satisfactory to know that the permeability of these parts does not differ from unity by a measurable amount, and cannot therefore influence the final results. Early observations showed that the concentric cable employed in the leads to the balance

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was faulty, some of the internal strands being broken, and the variable contacts thus resulting prevented a steady current from being obtained. Fresh concentric cable is being inserted, which should enable the final observations to be speedily made.

Apparatus for the Determination of "g."—The three half-second pendulums (the property of the Board of Education, and which were used in the last Antarctic expedition) have been swung at Kew and at the National Physical Laboratory in the room where the balance is erected. The observations are being continued. When all the constants have been determined and the observations with the balance are complete, it will be necessary to consider the means by which the result is to be given to the world. The current may be reproduced either by means of the silver voltameter or by means of a standard cell and a standard resistance. The silver voltameter is being investigated at the National Physical Laboratory, and a comparison of the accuracies of reproduction would perhaps influence the choice. The committee were represented at the International Electrical Congress at St. Louis last year by Prof. Perry and the secretary. The resolutions passed at the Cambridge meeting of the committee (see report for 1904) as to certain questions proposed for discussion were laid before the congress, and after discussion the following reports were unanimously accepted:

Committee of the Chamber of Delegates on International Electromagnetic Units.

The sub-committee appointed Sept. 13, 1904, beg leave to suggest that the Chamber of Delegates should adopt the following report: It appears from papers laid before the International Electrical Congress and from the discussion that there are considerable discrepancies between the laws relating to electrical units, or their interpretations, in the various countries represented, which, in the opinion of the Chamber, require consideration with a view to securing practical uniformity. Other questions bearing on nomenclature and the determination of units and standards have also been raised, on which, in the opinion of the Chamber, it is desirable to have international agreement. The Chamber of Delegates considers that these and similar questions could best be dealt with by an international commission representing the Governments concerned. Such a commission might, in the first instance, be appointed by those countries in which legislation on electric units has been adopted, and consist of, say, two members from each country. Provision should be made for securing the adhesion of other countries prepared to adopt the conclusions of the commission. The Chamber of Delegates approves such a plan, and requests its members to bring this report before their respective Governments. It is hoped that if the recommendation of the Chamber of Delegates be adopted by the Governments represented the commission may eventually become a permanent one.

Committee of the Chamber of Delegates on International Standardisation.

The committee of the Chamber of Delegates on the standardisation of machinery begs to report as follows: That steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of the nomenclature and ratings of electrical apparatus and machinery. If the above recommendation meets the approval of the Chamber of Delegates it is suggested by your committee that much of the work could be accomplished by correspondence in the first instance, and by the appointment of a general secretary to preserve the records and crystallise the points of disagreement, if any, which may arise between the methods in vogue in the different countries interested. It is hoped that if the recommendation of the Chamber of Delegates be adopted the commission may eventually become a permanent one.

The first of these reports, relating to the summoning of an international congress on electrical units, is now under the consideration of his Majesty's Government. Meanwhile a preliminary conference of representatives of standardising laboratories and others interested in the determination of electrical units has been summoned by the president of the Reichsanstalt to meet in Berlin in the autumn. Lord Rayleigh and the secretary have received invitations to be present. The object of this conference is stated to be that the institutions which are concerned in maintaining the accuracy of electrical measurements in conjunction with those scientists who have devoted especial attention to this field of work should exchange opinions, and, if possible, come to an agreement as to the measures which must be taken in order to obtain the international uniformity in electrical units and measurements which is desired. It is thus preliminary to the more formal consideration of the subject which would be the work of the international congress. One of the important questions which will be discussed will be the specification of some form of standard cell. Work on this matter has gone on in America and at the National Physical Laboratory, and an appendix to the report by Mr. Smith contains a provisional specification. It is suggested that persons interested in the matter might help by setting up cells in accordance with this specification and submitting them for test at the laboratory. Of the grant made to the committee in 1904 a balance of £3. 4s. 10d. remains. The work which remains to be done on the standard cell and with the ampere balance will all involve considerable expense, and to meet this the committee ask for reappointment, with a grant of £25 in addition to the balance now in their hands.

Appendix I.

On the Preparation of a Cadmium Cell.

BY F. E. SMITH.

(From the National Physical Laboratory.)

The research on standard cells has been continued at the National Physical Laboratory on the lines indicated in the last report to the association. Taken as a whole, the results are very satisfactory, but it is thought desirable to still continue the observations on some of the older cells before publishing the results in detail. Mr. G. A. Hulett, of Michigan, has completed a chemical research on mercurous sulphate, which throws considerable light on the anomalies reported to the association last year. Very slight changes can still, however, be traced to this salt, but fortunately they are of no commercial significance. The 12½ per cent. amalgam also produces slight variations in the E.M.F. of the cell. These, again, are commercially unimportant, and a manner of overcoming them in cells employed at a standards laboratory is indicated in this paper. The latter cells are set up with an amalgam entirely liquid at 0deg. C. At this stage of the research it is thought desirable to describe the methods by which the materials of the cell can be best prepared in the light of present information, and an appeal is made to those interested in the subject to set up one or more cells by these methods and submit them for comparison with the standards of the National Physical Laboratory. More light will thus be thrown on the slight discrepancies already referred to, and the degree of accuracy with which the cell can be constructed will be established. In this way it is hoped to specify a cell for commercial purposes accurate at all ordinary English working temperatures to 1 part in 2,000, applying no temperature correction, or to 1 part in 10,000 if the temperature correction be applied. In the specification which follows there are four methods of preparing the mercurous sulphate. The first of these is due to Prof. H. S. Carhart, Mr. G. A. Hulett, and Dr. Wolff, jun.; the main features of the second method were suggested by Mr. Swinburne to Dr. Glazebrook, while the third and fourth methods have resulted from some experiments at the National Physical Laboratory. It is suggested that one only of these methods be eventually employed; the observations on submitted cells will largely determine the choice.

Preparation of Materials for a Standard Cadmium Cell.

1. *Mercury.*—The commercial mercury should be squeezed through wash leather and passed in the finely divided condition in which it emerges, first through dilute nitric acid (1 to 6 of water) and mercurous nitrate solution, and afterwards through distilled water, both liquids being conveniently contained in long glass tubes. The mercury is then to be twice distilled *in vacuo*. Mercury suspected of abnormal contamination should not be employed.

2. *Amalgam.* Type A.—This is a 12½ per cent. amalgam, and is intended for all commercial cells. The method of preparation is practically identical with that used by Prof. Carhart. A current is passed from a thick rod of pure commercial cadmium to distilled mercury, the intervening liquid being cadmium sulphate solution rendered slightly acid with a few drops of H_2SO_4. The cathode is weighed

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before deposition takes place, and again afterwards, the percentage of cadmium in the amalgam being thus calculable. More than the requisite amount should always be deposited, and the percentage reduced to 12½ by the addition of more mercury. The fall of potential from anode to cathode should not exceed 0·3 volt. To prevent the anode slime having access to the cathode it is desirable to surround the anode with a small porous pot, as in the Richards silver voltameter, or to place a small crystallising dish beneath it for the anode powder to settle in. Contact with the cathode is made with a platinum wire sealed into a glass tube so as to protect it from direct contact with the cadmium sulphate solution, and a rough estimate of the quantity of cadmium deposited is obtained from the readings of an ammeter placed in the circuit. The amalgam so prepared, together with the mercury added to reduce the percentage of cadmium to 12½, is now heated on a water bath and stirred so as to ensure homogeneity, some cadmium sulphate solution still flooding the surface. It is then cooled, and the acid sulphate removed, neutral cadmium sulphate solution taking the place of the latter, and consisting of saturated solution plus an equal volume of distilled water. This 12½ per cent. amalgam is then ready for use and is entirely liquid at a temperature approximating to 60deg. C.

Type B.—This amalgam is liquid at the temperature of melting ice, and is intended for cells of a slightly better type than those made with the 12½ per cent. amalgam. The cells may be used at a higher temperature than 0deg C., but they are not intended to be so used, as their temperature coefficient is about 0·043 per cent. per rise in temperature of 1deg. C. The cells are primarily intended for standardising laboratories, and their E.M.F. at 0deg. C. is equal to the E M F. of the cells prepared with the A amalgam if this latter E M.F. is corrected to 0deg. C. with the temperature coefficient formula of the cell. This is equivalent to saying that if an A cell was in a steady condition at 0deg. C., and nothing abnormal occurred, its E M F. would be identical with that of a B cell at 0deg. C. It is not wise, however, to use a 12½ per cent. amalgam cell at low temperatures. An 8 per cent. amalgam may be so used, but its upward range (with a small temperature coefficient) is lower than that of the 12½ per cent. amalgam cell. For commercial purposes probably the 12½ per cent. amalgam will be of most service. To prepare the type B amalgam, take some of that previously prepared and add sufficient mercury to reduce the percentage of cadmium to 3. The amalgam will now be entirely liquid at ordinary working temperatures. On cooling, a crystalline amalgam separates from the liquid, and will continue to do so as the temperature is lowered. Cool the amalgam to the temperature of melting ice and remove the mother liquid; this is the amalgam desired. It is important that the temperature be truly that of melting ice, and that no solid is removed. For convenience the 3 per cent. amalgam may be placed in a tubular vessel well surrounded with ice shavings; a long very fine capillary tube reaches to the base of this vessel, and through it the liquid at 0deg. C. is removed by suction. Some solid must be left behind, or otherwise there is no certainty of saturation. Throughout all the operations neutral cadmium sulphate solution must cover the surface of the amalgam and wet all vessels, tubes, etc, through which the amalgam passes. Otherwise the amalgam will leave a "tail," and its composition may possibly be thereby changed.

3. *Cadmium Sulphate Crystals and Solution.* — Procure commercially pure cadmium sulphate ($CdSO_48/3H_2O$). Dissolve in about 1¼ times its weight of distilled water, agitating either continuously for about six hours or occasionally for two or three days. Filter through a fine-grained filter paper so as to ensure a clear solution, which should then be placed in a number of crystallising dishes and evaporation allowed to take place slowly at a temperature not exceeding 35deg. C., when, provided that dust be excluded, many transparent crystals of $CdSo_48/3H_2O$ will result. These should be prevented as much as possible from adhering to one another by removing the liquid to other dishes as soon as the crystals are of such a size that most of them are in contact. In this way about five-sixths of the liquid may be evaporated, the mother liquid being employed for a preliminary washing of the mercurous sulphate, the manufacture of which is afterwards described. The crystals of cadmium sulphate so obtained should be washed with successive small quantities of distilled water until after standing for five minutes no trace of acidity can be detected with congo red. The crystals, still moist, may then be transferred to a stock bottle. To prepare the final solution agitation with distilled water is recommended as before, the temperature being preferably 5 deg. or 10deg. higher than the normal temperature, so as to ensure saturation. On no account should cadmium hydroxide be employed to neutralise the first solution, which is invariably acid; nor, indeed, should any attempt be made to neutralise the solution except by crystallisation.

4 *Mercurous Sulphate.*—The preparation in each case is to be conducted in a darkened room.

(*a*) *Electrolytic Method.*—Pure distilled mercury forms the anode and platinum foil the cathode, the electrolyte being dilute sulphuric acid (one part by volume of concentrated acid to five parts of distilled water). The mercury is preferably placed in the base of a large flat-bottomed beaker, and about 20 times its volume of the dilute acid added. Contact with the mercury is effected by means of a platinum wire passing through a glass tube, while the cathode is suspended in the upper portion of the liquid. During the electrolysis the electrolyte must be continually stirred, an L-shaped glass stirrer being most efficient, the L portion being placed near the surface of the mercury. A current density of about 0·01 ampere may be employed. The salt so prepared is treated as per Note A.

(*b*) Precipitation method, mercurous nitrate and sulphuric acid being employed. Add strong nitric acid to a little pure mercury contained in a crystallising dish, and place in a draught chamber until the action is over. If any mercury remains, adds more acid and continue to do so until the mercury has completely disappeared and a strongly acid solution assured. Prepare dilute H_2SO_4 (1 to 4 by volume), allow to cool, and then add the acid nitrate solution drop by drop, keeping the mixture violently agitated. Mercurous sulphate is precipitated, which should be filtered and treated as per Note A. No more nitrate solution must be added to the dilute H_2SO_4 than will suffice to neutralise 30 per cent. of the H_2SO_4 present. The maximum amount it is permissible to add may be estimated by taking a small portion of the dilute H_2SO_4 and adding the nitrate solution until no further precipitation results. The proportion of nitrate solution to dilute H_2SO_4 in such circumstances must be reduced to one-third its value for the preparation of mercurous sulphate by method *b*.

(*c*) Precipitation method, strong and dilute sulphuric acid being employed. Purchased mercurous sulphate is warmed with pure strong H_2SO_4 and a little mercury to a temperature of about 150deg. C. for about 10 minutes, the operation being conducted in an evaporating dish covered with a clock glass and the mixture kept well stirred. The suspended matter is then allowed to settle, the hot liquid cooling sufficiently meanwhile for the vessel to be handled with comfort. The clear acid is then poured into dilute H_2SO_4 (1 to 6), when crystalline mercurous sulphate separates out. About 10 times the bulk of dilute acid should be employed, and to avoid spitting the hot liquid should be poured through a funnel, having its stem immersed in the dilute acid. The mixture is well stirred, cooled, and filtered, and the salt treated as per Note A. As the operation yields but a small quantity of the salt it is advisable to repeat several times

(*d*) By means of Nordhausen sulphuric acid. Place distilled mercury in the bottom of a beaker or bottle to the depth of about 3mm. Add about four times its volume of Nordhausen sulphuric acid and stir well, keeping the mouth of the bottle closed as much as possible, as the acid fumes are very unpleasant. Mercurous sulphate is formed in the cold and appears in the crystalline form after a few minutes. Allow the operation to continue until the acid strength has been considerably diminished; then pour into dilute H_2SO_4 (1 to 6). Considerable spitting always occurs, so that caution is necessary. Proceed with the product as per Note A.

Note A.—The mercurous sulphate obtained by the foregoing methods is first agitated with dilute H_2SO_4 (1 to 6)

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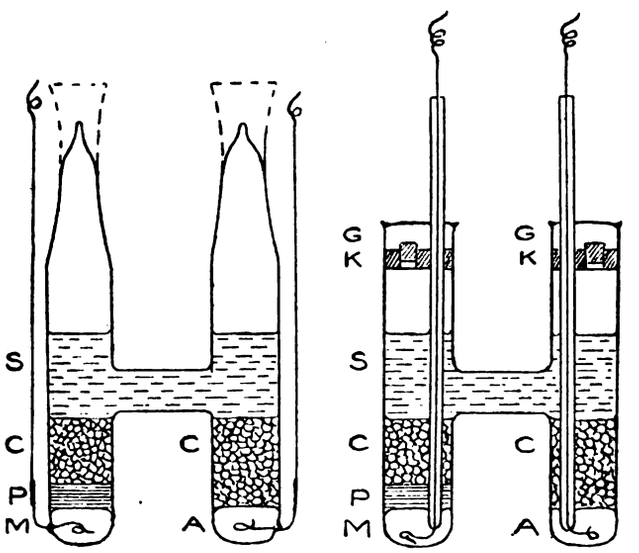
and distilled mercury. It is then filtered (a small Gooch crucible and filter flask are convenient), and the greater part of the mercury removed, as it interferes with the filtering. The salt is next washed with small quantities of saturated cadmium sulphate solution until free from acid. For the first few washings some of the first acid solution may be employed, but the final washings must be made with a little of the neutral solution. Trouble is often experienced in ridding the salt prepared with Nordhausen sulphuric acid from all trace of acidity, and it is preferable to wash five or six times with the cadmium sulphate solution, and then place in a bottle together with a little of the solution, shaking from time to time and filtering again in a few days. The acidity of the washing liquid should be tested with congo red. Instead of washing with cadmium sulphate solution, sulphuric ether (water free) may be employed.

The Mercurous Sulphate Paste.—Some cadmium sulphate crystals are ground in an agate mortar with a little cadmium sulphate solution; about one-quarter their bulk of pure mercury is then added and two volumes of the acid-free mercurous sulphate, the whole being well mixed with cadmium sulphate solution so as to form a thin paste.

The Form of Cell.—The H form of cell due to Lord Rayleigh is the most convenient, and is in general use. Two patterns have been adopted. In Fig. 1 a form is



FIGS 1 AND 2.—M, Mercury; A, Amalgam; P, Paste; C, Cadmium Sulphate Crystals; S, Saturated Solution of Cadmium Sulphate; K, Cork; G, Marine Glue.

shown in which the electrodes are sealed into the lower ends of the two vertical limbs, while in the form shown in Fig. 2 the electrodes pass through glass tubes, into the lower ends of which they are sealed. Form 1 can be hermetically sealed, and is intended to be immersed in an insulating liquid. Form 2 is sealed with marine glue, and may be immersed in ice or water. The hermetical sealing of form 1 was suggested by Lord Rayleigh and by Prof. Carhart. The glass tubes through which the electrodes are introduced in form 2 pass through corks which have been previously boiled in water and soaked in cadmium sulphate solution; in addition to the hole allowing of the passage of the electrodes, a second hole is bored through these corks for the passage of small glass pipettes. After the cell is filled these additional holes are fitted with small corks, and the cell is finally sealed with marine glue. The position of the various parts is shown in the figure. (Both forms of glass vessels are stocked by Mr. A. C. Cossor, of 54, Farringdon-road, E.C.) In filling the vessels it is convenient to use small pipettes made of two glass tubes, the one about 3in. long and $\frac{1}{2}$in. in diameter, and the other about 2in. long and $\frac{1}{3}$in. in diameter. If the larger tube has one end drawn out in the form of a cone, a junction is easily made. The amalgam of type A is melted over a water bath (its surface being flooded with dilute cadmium sulphate solution), and is introduced by means of a previously warmed pipette into one of the limbs. After the amalgam has solidified this limb should be washed out with a little fresh cadmium sulphate solution. If the amalgam of type B is used this washing is unnecessary. The mercury is next introduced into the other limb, then the paste, using if necessary a tiny glass rod as a piston through the pipette, and afterwards a thick layer of finely-pounded crystals is introduced into each limb. Saturated cadmium sulphate solution is finally added. The cells are then to be exposed in a warm room for a week or more to allow some of the liquid to evaporate, and so loosely cement together the fine crystals. This crystalline plug keeps the contents in their proper places, and enables the cell to be transmitted through the post. The sealing of the cells is next completed, care being taken not to abnormally heat the contents.

Cells which are submitted for comparison with the standards of the National Physical Laboratory should be accompanied with the following particulars: (1) maker's name and address; (2) name of the firms from whom the chemicals used in the manufacture of the materials were purchased (this information is only required so that the number of different sources of the materials can be estimated); (3) number of the method employed in the manufacture of the mercurous sulphate; (4) type of cadmium amalgam used; (5) notes on any peculiarities observed in the preparations.

REDUCTION OF BEARING FRICTION.

Since the electric motor has come into general use, the question of the economical transmission of power has come more prominently before manufacturers, and the more up-to-date concerns have been quick to appreciate the possibility of effecting large economies by eliminating the large amount of frictional load which always exists with long heavy lines of shafting.

The electric motor does away with the necessity of a great deal of shafting, especially the heavy main lines. At the same time, there are many cases where it is more economical to employ various lines of shafting, each separately driven by an electric motor, than to have each and every machine especially equipped with a motor of its own. When a manufacturer can stand in front of an electrical instrument and observe as easily as he tells the time of day from his watch just exactly how much power he is wasting and absolutely throwing away on the friction on his line shafting, he is very apt to welcome any suggestion which will tend to materially reduce this friction. There are, of course, anti-friction bearings of various makes on the market, all possessing more or less merit and demerit. Ball bearings for shafting have not been successful for two reasons, principally owing to the cost of the same and the difficulty of applying them, since balls must have hard steel races to run in in order that the bearing may have any durability. The second reason is that the balls are not so reliable as they might be, since one is likely to split at any time and ruin the entire bearing. Solid rollers have been used for many years off and on, but these bearings, like the ball bearings, in order to be thoroughly durable, must be very nicely made, hardened, and ground throughout, which, of course, means expense, and they also require sleeves on the shaft, which means a lot of labour and trouble in the fixing. Expense again stands in the way of the general adoption of these bearings for general line shafting transmission. There are, of course, cheaper grades of solid roller bearings manufactured, but those who have experimented with them have found that running solid rollers directly on soft-steel shafting is not a practicable or desirable thing to do.

For the past 10 years we learn that the Hyatt flexible roller bearing has been used with a marked degree of success for a multitude of purpose, chiefly among them for line shafting. These rollers, as shown in the accompanying illustration (Fig. 1), are practically helical springs, being wound from a ribbon of steel into spiral form. Their diameter and the size of the steel from which they are made are varied according to the speed and load under which the rollers are to operate. They are not put through a hardening process, but are constructed of a grade of steel especially made for the purpose, which is hard and very tough. The rollers are wound in a special machine constructed for the purpose and within very fine limits of absolute size. The fact that they are flexible and elastic makes it possible to operate them on the ordinary soft-steel shafting which is in general use, without wearing either the shafting or the rollers to any appreciable degree. The rollers are held in position round the shaft in a brass or steel cage (Fig. 2), with bars at proper intervals to keep the roller practically parallel with the shaft. If, however, a roller is permitted to get very slightly out of line it does not do any damage, either to itself or the shafting, due to the fact that it is flexible; whereas in the case of a solid roller, if it becomes the least bit out of parallel

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with the shaft, it immediately begins to wear heavily on the ends and is very likely to slip. This kind of thing very soon renders a solid roller bearing useless.

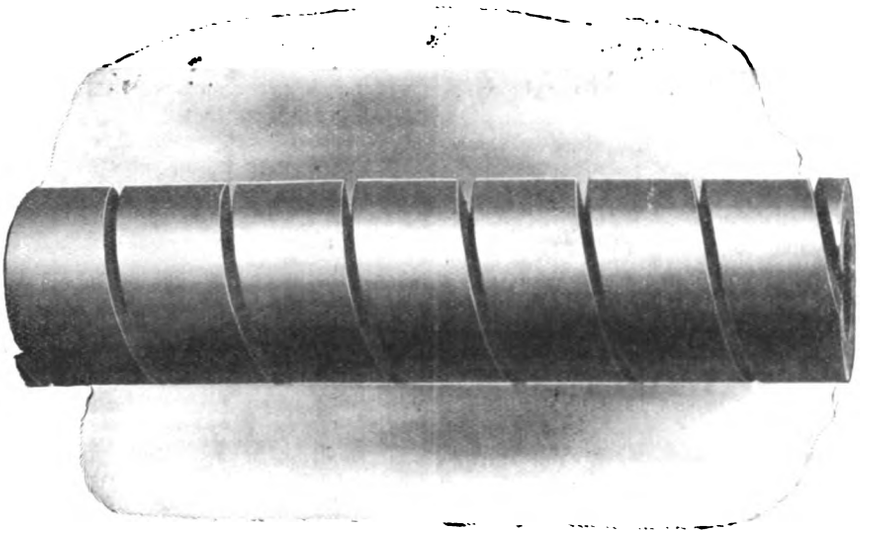

FIG. 1.

Regarding the efficiency of roller bearings in general, it has been found by very careful tests that the Hyatt flexible roller is 50 per cent. higher in efficiency than the ordinary solid roller

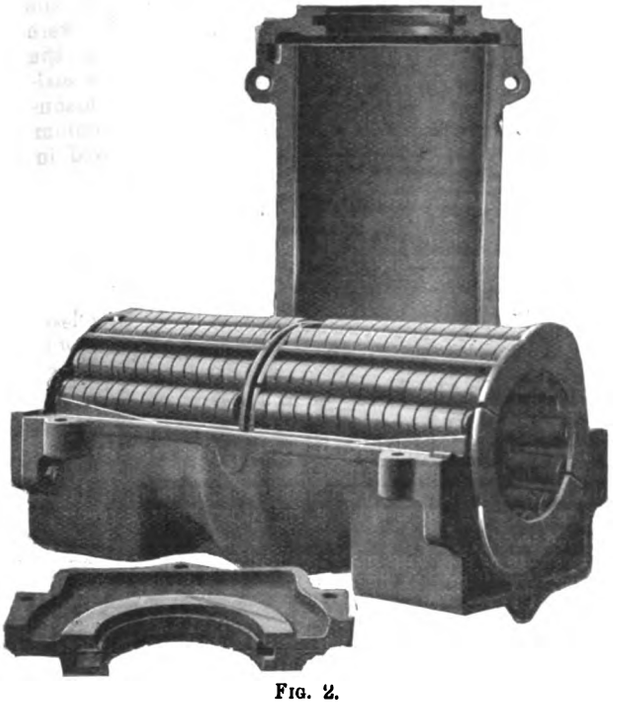

FIG. 2.

made of the same grade of steel when both are subjected to exactly the same conditions. In actual service on line shafting it has been proved by careful experiment that the flexible roller

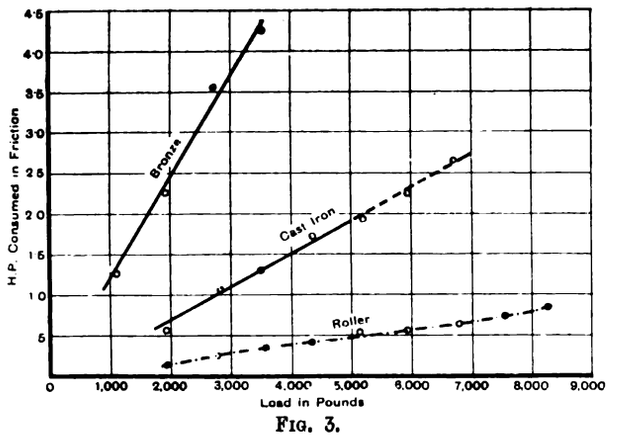

FIG. 3.

bearing will save from 50 to 75 per cent. of the frictional load found to exist with ordinary brass or white metal bearings. The heavier the shafting the greater the saving is in proportion.

We reproduce herewith two charts (Figs. 3 and 4) which embody the results obtained in a very careful test recently made by a prominent engineer to determine the relative merits of the Hyatt flexible roller bearing, bronze, babbitt, and cast-iron bearings. It will be seen from these charts that the results are uniformly in favour of the flexible roller, and very much so.

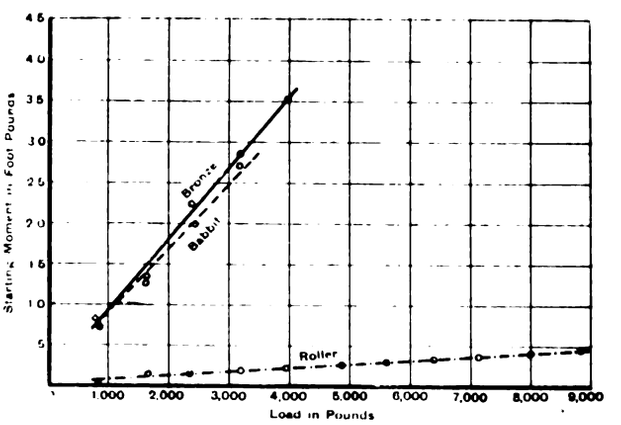

FIG. 4.

The first of these shows the horse-power consumed when running with varied loads on the different bearings. The second (Fig. 4) indicates the force required when starting, and it is remarkable how much the rollers reduce the starting effort. Many of the leading manufacturing concerns in England have already availed themselves of the opportunity of economising power by the use of these bearings, which in every instance appear to be giving excellent results.

Detailed information and particulars regarding the same may be had from the Hyatt Roller Bearing Company, 47, Victoria-street, London, S.W.

TRADE NOTICES AND NOVELTIES.

Machine versus Hand Firing.

From Messrs. E. Bennis and Co., Limited, 28, Victoria-street, S.W., we have received a copy of a little booklet they have had prepared, showing comparative tests between hand firing and machine firing with "Bennis" stokers. The results are highly favourable to the latter. Thus the figures in one case show a saving of 44·1d., or 57½ per cent., per 1,000 gallons of water evaporated in favour of machine firing. For the hand-firing test Holroyd engine coal at 10s. 4½d. per ton was used, and for the stoker test Haigh Moor pea slack and smudge mixed, of lower calorific value, at 7s. per ton. The record sheet further shows that there was a total absence of black smoke during the stoker test—not so, however, during hand firing. In another example it is shown that the extra evaporation obtained per pound of coal by the Bennis stoker over hand firing amounted to 18·9 per cent., Haunchwood D.S. nuts being used for both tests. The gain varies, of course, with the class of fuel employed. This point is emphasised by another set of figures, whence it appears that with black shale smudge the extra evaporation obtained per pound used by Bennis stoker and furnace was 70·9 per

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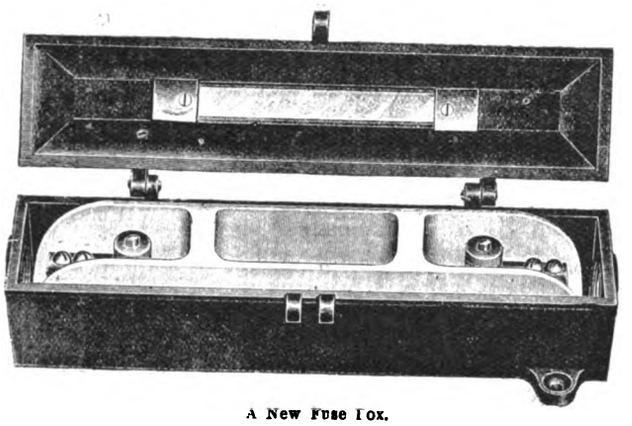
cent., and with low main peas 34·8 per cent. In order to estimate these results at their true value it is necessary to know all the conditions of the tests. These are given in the booklet in question, but we must leave the reader to weigh them in detail.

A New Fuse Box.

The fuse box illustrated herewith represents a type which the Metallic Seamless Tube Company, Limited, Wiggin-street, Birmingham, are putting on the market. These boxes have been designed to meet the requirements of the various supply stations, insurance rules, etc., for 250 and 500 volts, and have a clear break of 3in. for 250 volts and 6in. for 500 volts between the terminals. The boxes are suitable either for screwing



A New Fuse Box.

direct, or can be fitted with insulating nipples as may be required. They are designed so that the same form of terminal can be used either for connecting the cables by pinching screws, soldering, or both. In the 250-volt boxes one china bridge, and in the 500-volt boxes two china bridges, with slot for the fuses, are placed between the terminals. These bridges serve to prevent arching over, and also strengthen the porcelain channel.

A Useful Combination Instrument.

The accompanying diagram shows the connections of a Ferranti combined indicating and discriminating wattmeter and idle-current ammeter for a three-phase circuit. This instrument is constructed on the same principle as the firm's induction type indicating wattmeter. In addition, however, to indicating the total power flowing in the circuit, it serves as a discriminating device to give warning should the generator commence motoring. A centre zero is provided, the indications of the pointer to the right of this measuring the power being generated. Should, however, the pointer move to the left of zero, the switchboard attendant knows at once that something is causing the generator to motor, and he takes steps accordingly. Besides the above, the instrument will also indicate the idle or wattless current flowing in

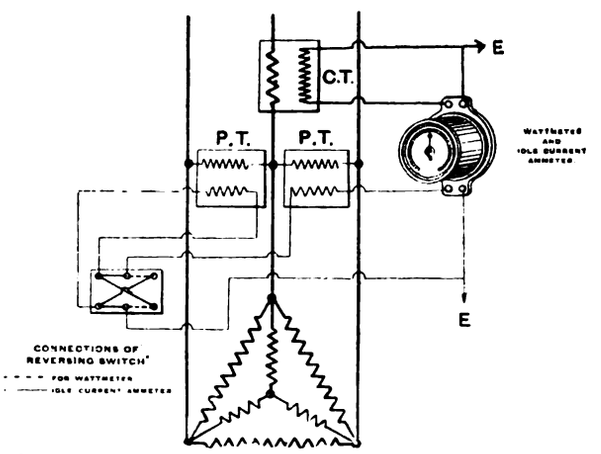


Diagram of Connections to Ferranti Wattmeter and Idle-Current Ammeter.

the circuit. The meter has two scales. The upper one, printed in black ink, is the watt scale, and the lower one, printed in red ink, is the scale of wattless amperes, to the left of the zero indicating a leading current, and to the right of the zero a lagging current. The change over from one scale to the other is effected by pressing the knob of a small reversing switch connected in the low-tension leads of the potential transformer. This switch is so arranged that when pressure is removed from the knob it automatically flies back to the position in which the instrument reads watts. Thus from time to time the switchboard attendant presses the knob and observes the value of the idle current in the circuit, and alters the excitation, etc., accordingly. The necessity of a separate power-factor indicator or idle-current ammeter is hereby avoided, with consequent lowering of cost. Reverting to the diagram, it will be noticed that two potential transformers are necessary.

Catalogues, etc., Received.

Single-Phase Motors.—From Mr. E. Brook, Threadneedle-street, Huddersfield, we have an illustrated list of single-phase motors ranging in output from 10 h.p. to ⅓ h.p.

Testing Machinery.—Some interesting testing machines for a variety of purposes are described in the latest catalogue from Messrs. W. and T. Avery, Limited, Soho Foundry, Birmingham.

Steam Fittings.—"Steam dryers" and "exhaust valves" are dealt with respectively in two lists recently issued by Messrs. J. Hopkinson and Co., Limited, Britannia Works, Huddersfield, and not previously acknowledged in these columns. The high reputation which Messrs. Hopkinson have won for steam fittings of all kinds is a guarantee of the excellence of those immediately in question, both as regards design and construction.

"Metallic" Steel Conduits.—The 1905 revised price-list of "metallic" steel conduits and accessories recently issued by the Metallic Seamless Tube Company, Limited, Wiggin-street, Birmingham, is a handy little volume for the pocket, and includes numerous illustrations. Particular attention is called to the company's "Grip" fittings, for which, we understand, there is a large and increasing demand. By the use of these fittings the danger of turning the tubes in screwing the nuts home, and possible damage to the insulation of the cables in consequence, is entirely avoided.

Wires and Cables, etc.—From the General Electric Company, Limited, Queen Victoria-street, E.C., we have a copy of the twelfth edition of their catalogue of wires and cables, etc. This catalogue is so well known to the trade that a detailed description of its contents would be superfluous here. Suffice it to say it includes a wide range of wires and cables for electric light, bell, and telephone work; also a large variety of brownware and porcelain insulators, of which latter the types for high-tension work are especially noteworthy; leading-in tubes and insulators, conduits, insulator ironwork, jointing materials, cleats, wiremen's tools, etc. It may be added that the general get-up of this catalogue reflects great credit on those concerned.

Fans.—Some popular types of electric fans are dealt with in a list recently issued by Messrs. Baxendale and Co., Miller-street Works, Manchester.

ST. ANNES ELECTRICITY ACCOUNTS.

The accounts of the St. Annes-on-Sea electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £38,605. Abstracts of the revenue account, balance-sheet, etc., are appended.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	2,273	1	3
Distribution of electricity	139	12	10
Attending and repairs to public lamps	509	6	2
Rents, rates, and taxes	305	7	8
Management expenses, salaries, etc.	556	18	3
Special charges, insurance, etc.	21	12	6
	3,806	5	8
Amount carried to net revenue account	3,516	0	3
	£7,322	5	11

Cr. Income.	£	s.	d.
Sale of current to private consumers by meter	2,637	2	9
Sale under contract for traction	3,115	7	8
Ditto for arc lighting	95	0	0
Ditto for public lighting	1,266	13	8
Rental of meters and tramway feeders	225	2	0
Sales and repairs	76	0	2
Discounts allowed by tradesmen	47	19	11
	7,463	6	2
Less discounts allowed and bad debts	141	0	3
	£7,322	5	11

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	35,888	1	9
Sundry creditors	569	16	3
Depreciation fund account	1,876	12	10
Depositors	402	0	0
Surplus account—loans repaid	3,216	18	3
	£41,953	9	1

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	38 605	14	1
Stores on hand	318	15	0
Sundry debtors for current supplied	1 634	9	8
Cash with treasurer and in hand	1,394	10	4
	£41,953	9	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			668,990
Quantity sold: By contract	373,846		
Quantity sold: Private consumers by meter	137.295		589,500
Quantity sold: Public lamps	78,359		
Quantity used on works			33 619
Total quantity accounted for			623,119
Quantity not accounted for			45 871

Total maximum supply demanded: traction, 400 kw.; lighting, 179 kw.

Number of public lamps: 34 arcs, 58 32-c.p., 9 ½-ampere, 99 ½-ampere, five 1-ampere, 1,275 equivalent 8 c.p. lamps connected.

KIRKCALDY ELECTRICITY ACCOUNTS.

Below we give abstracts of the electricity and tramway accounts of the burgh of Kirkcaldy for the year ended May 15, 1905. The total expenditure on capital account for lighting is £57,094, and for tramways £88,715.

ELECTRIC SUPPLY UNDERTAKING.

Dr. *Revenue Account.*	£	s.	d.
To generation of electricity	2,589	1	6
Distribution of electricity	100	16	7
Repairs and attending to public lamps	273	8	8
Rents, rates, and taxes	180	19	7
Management expenses, salaries, etc.	700	10	3
	3,844	16	7
Amount carried to net revenue account	3 091	9	5
	£6 936	6	0

Cr.	£	s.	d.
By sale of current to tramways	3,580	18	1
Ditto for private lighting	1,633	0	2
Ditto for motors	428	2	3
Ditto for public lighting	1,248	0	0
Other receipts	17	6	5
Property and income tax retained—less repaid	28	19	1
	£6,936	6	0

Dr. *Balance-Sheet.*	£	s.	d.
Capital account—amount received, less repaid	57,400	0	0
Sinking fund for loans repaid	2,076	11	6
Costs of order repaid	23	13	4
	£59,500	4	10

Cr.	£	s.	d.
Capital account—amount expended for works	57,094	16	4
Stores on hand	59	11	3
Sundry debtors for current supplied	717	9	1
Other debtors	1,017	15	0
Cash in bank	187	3	6
Revenue account—deficit	423	9	8
	£59,500	4	10

TRAMWAYS UNDERTAKING.

Dr. *Revenue Account.*	£	s.	d.
Traffic expenses, wages, tickets, etc.	4,072	0	3
Maintenance of buildings and track	792	16	2
Rents, rates, taxes, and insurance	553	1	1
Current for tramways	3,580	18	1
Management expenses, salaries, etc.	659	6	10
Depreciation	409	0	0
	10,067	2	5
Amount carried to net revenue account	2,137	8	4
	£12,204	10	9

Cr.	£	s.	d.
By traffic receipts	11,752	19	9
Receipts for advertisements	439	16	1
Other receipts	8	18	6
Property and income tax retained, less repaid	2	16	5
	£12,204	10	9

Dr. *Balance-Sheet.*	£	s.	d.
Capital account—amount received, less repaid	87,640	0	0
Sinking fund for loans repaid	1,849	4	8
At credit of depreciation account	449	0	0
Sundry creditors	1,004	16	4
	£90,943	1	0

Cr.	£	s.	d.
Capital account—amount expended for works	88,715	16	4
Stores on hand	110	5	11
Sundry debtors	381	16	4
Cash with bank	210	12	8
Revenue account—deficit	1,524	9	9
	£90,943	1	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			967,577
Quantity sold: Public lamps	100 953		
Quantity sold: By contract for tramways	572 945		830,185
Quantity sold: Private consumers by meter	156,287		
Quantity used on works			13,008
Total quantity accounted for			843 193
Quantity not accounted for			124,384

Number of public lamps: 104 arcs, 212 incandescents.

Total maximum supply demanded: 19,328 8-c.p. lamps for private consumers; 104 10-ampere arc lamps with 212 16-c.p. lamps on arc lamp pole for all-night lighting; 22 cars taking a maximum load of 385 kw.

IPSWICH ELECTRICITY ACCOUNTS.

Below we give abstracts of the electricity and tramway accounts of the Ipswich electricity department for the year ended March 31, 1905. The total expenditure on capital account for lighting is £76,773, and for tramways £111,999.

ELECTRIC SUPPLY UNDERTAKING.

Dr. *Revenue Account.*	£	s.	d.
To generation of electricity	4,577	2	10
Distribution of electricity	302	3	9
Rents, rates, and taxes	370	12	9
Management expenses, salaries, etc.	964	14	11
Insurances	35	18	2
Special expenditure	82	8	9
	6,333	1	2
Amount carried to net revenue account	2,605	10	9
	£8,938	11	11

Cr.	£	s.	d.
By sale of current for lighting and power	3,793	5	7
Ditto for traction	4,983	11	3
Meter rents	57	15	3
Re-test fees	13	16	6
Charging accumulators	10	0	11
Work done	80	2	5
	£8,938	11	11

Dr. *Balance-Sheet.*	£	s.	d.
Mortgage debt, less repaid	69,900	0	0
Loan repayment account	494	11	5
Depositors	8	10	0
Sundry creditors	4,060	16	3
Cash owing to treasurer	8,806	15	8
	£83,270	12	4

Cr.	£	s.	d.
Capital account—amount expended for works	76 773	7	3
Stores on hand	962	6	1
Sundry debtors for current supplied, etc.	3,679	18	2
Net revenue appropriation account	1,070	2	9
Preliminary expenses (suspense account)	715	14	3
Cash in hand and on deposit	69	3	10
	£83,270	12	4

TRAMWAYS UNDERTAKING.

Dr. *Revenue Account.*	£	s.	d.
Traffic expenses, wages, tickets, etc.	10,196	14	3
Maintenance of buildings and track	1 883	3	0
Supply of current for power	4,983	11	3
Management expenses, salaries, etc.	1,805	3	5
	18 868	12	1
Amount carried to net revenue account	4,521	6	8
	£23,389	18	9

Cr.	£	s.	d.
By traffic receipts	23,247	19	2
Passengers' luggage traffic	73	8	9
Parcels traffic	6	0	9
Rent (electric supply department)	54	15	0
Sundries	7	15	1
	£23,389	18	9

Dr. *Balance-Sheet.*	£	s.	d.
Mortgage debt	108,745	15	11
Amount of loan repaid by annuity	1,254	4	1
Amount in hand for redemption of debt	553	19	9
Sundry creditors	6 018	8	9
Cash owing to treasurer	8,895	4	2
	£125,256	12	8

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Cr.	£	s.	d.
Capital account—amount expended for works	111,999	0	4
Stores on hand	4,540	7	0
Unexpired licenses	20	5	0
Sundry debtors	5,163	7	4
Net revenue appropriation account	2,741	18	11
Preliminary expenses (suspense account)	602	11	6
Cash in hand and on deposit	199	2	7
	£125,266	12	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,189,872
Quantity sold: By contract—lighting	1,048		
Quantity sold: For tramways	797,370		1,066,285
Quantity sold: Private consumers by meters	267,876		
Quantity used on works			76 039
Total quantity accounted for			1,142,324
Quantity not accounted for			47,548
Total maximum supply demanded (kilowatts)			811

EAST HAM ELECTRICITY ACCOUNTS.

From the accounts of the East Ham Corporation electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounts to £117,285. Appended are abstracts of the revenue account and general balance-sheet.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	7,522	18	10
Distribution of electricity	457	7	4
Attending and repairs to public lamps	789	3	4
Management expenses, salaries, etc.	650	18	5
Rents, rates, taxes, and insurance	414	3	10
Bad and doubtful debts	84	8	3
	9,919	0	0
Balance, being gross profit	9,972	12	2
	£19,891	12	2

Cr. Income.	£	s.	d.
By sale of current to tramways	7,106	16	3
Public lighting	3 785	15	2
Sale of current to private consumers	8,489	5	10
Ditto to artisans' dwellings	233	7	9
Sale of old metal, etc.	261	3	8
Sale of lamps, etc.	6	16	6
Court fees recovered, etc.	7	7	0
	£19,891	12	2

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages	96,459	13	2
Cash due to bankers	15 990	6	1
Extinguished debt and depreciation reserves	10,459	0	8
Sundry creditors on revenue account	1,423	13	3
Contractors' and consumers' deposits	163	6	0
Revenue account (balance)	2,830	17	8
Cash at bankers and in hand	3,250	1	4
	£130,576	18	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	117,285	17	11
Renewals fund investment	4,485	0	0
Sundry debtors for current supplied	5,508	19	8
Stores on hand	3,297	0	7
	£130,576	18	2

GLOUCESTER ELECTRICITY ACCOUNTS.

The accounts of the Gloucester electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £75,239. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	2,536	19	6
Maintenance of buildings and plant	401	5	11
Repairs of mains and meters	257	2	5
Attending and repairs to public lamps	502	8	4
Rents, rates, and taxes	346	13	8
Management expenses, salaries, etc.	774	9	10
Special charges, insurance, etc.	45	17	1
Free wiring rental	7	3	11
	4,872	0	8
Balance of revenue account	5,539	7	1
	£10,411	7	9

Cr. Income.	£	s.	d.
Sale of current to private consumers by meter	5 350	18	1
Ditto for public lighting	1,876	4	1
Rental of meters	194	4	2
Free wiring rental	7	3	11
Miscellaneous receipts	288	16	7
Light Railways Committee	2,694	0	11
	£10,411	7	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received less repaid	47.797	0	7
Transferred to general district fund	285	12	7
Sundry creditors	134	17	8
Due to treasurer on capital account	21.944	6	3
Surplus, being amount of loans repaid	5 077	19	5
Sundry creditors, interest, and deposits	2,183	2	2
Due to treasurer on revenue account	3,405	18	10
	£80,828	17	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	75,239	16	6
Stores on hand	1,362	2	3
Sundry debtors for current supplied, etc.	3,448	19	10
Cash in hands of engineer	10	0	0
Balance at debit of net revenue account	767	18	11
	£80 828	17	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,071,135
Quantity sold: Private consumers for lighting	371,641		
Quantity sold: Private consumers for power	14,201		1,049,936
Quantity sold: Public lamps	146,837		
Quantity used on works			21,199
Total quantity accounted for			1,071,135
Total maximum supply demanded (kilowatts)			721
Number of public lamps			191

LEGAL INTELLIGENCE.

THEFT OF ELECTRIC CURRENT.

At the Manchester County Police Court last week Frederick Stewart, an electrician in the employ of the Trafford Park Estates, was summoned for stealing electricity, the property of the company.

The case against the defendant was that he had tapped the electric current supplied to his house before it passed through the meter, and thus obtained his light free of cost. His defence was an absolute denial of having tampered with the wires.

He was fined £5 and costs, or one month's imprisonment.

SMOKE TROUBLES.

At the Jarrow Police Court the Durham County Electrical Power Co. were summoned at the instance of the Corporation of Jarrow for having failed to comply with an order of the court made on May 18 to abate a smoke nuisance at the power station within two months from that date.

It appeared that the nuisance was not discontinued immediately, owing, the company explained, to the time occupied in making the needful alterations.

The Bench accepted this explanation, and dismissed the summons.

SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING CO.

A compulsory winding up order was made against the Sir Hiram Maxim Electrical and Engineering Co., in November, 1904, and a statement of affairs has now been issued, showing total liabilities £55,481, of which £19,192 is expected to rank for dividend. The assets are valued at £49,009, and are subject to deductions of £1 057 in respect of preferential claims and £20,309 for debentures. There is consequently an estimated surplus of £8,449 in assets to meet the unsecured liabilities of the Company, but the account with the contributories disclose a deficiency of £161,949.

COMPANIES' MEETINGS AND REPORTS

FIFE ELECTRIC POWER CO.

The second annual meeting of this Company was held last week in the Townhill generating station, when occasion was taken to turn on the electric current. Originally it was intended that the first generating stations should be established at Comrie and Cowdenbeath, but in view of its nearness to a large centre of population, Townhill was chosen for the beginning of the Company's operations.

Mr. R. E. WALKER, the chairman, in moving that the directors report, balance-sheet, and auditors' report be adopted, said that while the capital expenditure had been considerable, they had a splendid asset, for they had acquired parliamentary powers to erect generating stations in different parts of Fife, so that they might be in a position to cover the whole of the county. The county was rich in minerals

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and in other respects, and he hoped and believed that the company would be able in some marked way to help in the fostering of the mining and other industries, and in the realisation of the hopes which were entertained regarding the resources that lay below the soil. Having referred to the favourable situation of the generating station, he expressed confidence that an outlet for their current would be obtained, but they would have to wait patiently before they realised the benefits to the full. Favourable terms had been offered to the Dunfermline Town Council, and the laying of tramways to be worked by electricity was in prospect. A meeting is to be held in a day or two relative to application for powers to lay a tramway by an independent company. Then there was to be a naval base established at Rosyth, which would probably require at any rate a temporary supply. In conclusion, he predicted that before the five years that were allowed the debentures would be paid off.

Mr. HENRY RUFFER seconded the motion, which was unanimously adopted.

BOLCKOW, VAUGHAN, AND CO.

The directors of Messrs. Bolckow, Vaughan, and Co. report that the total expenditure upon new collieries, new blast furnace plant, electric installations machinery, and extensions during the past year was £567,564. Dividends amounting to 5 per cent. are recommended on the ordinary shares, leaving £44,224 to be carried forward.

MATHER AND PLATT.

The annual meeting of Mather and Platt was held in Manchester on Saturday, Dr. Edward Hopkinson presiding. Dividends and bonus amounting to 10 per cent. were sanctioned on the ordinary shares, £30,000 was transferred to the reserve account, bringing it up to £230,000, and £31,238 carried forward.

The CHAIRMAN observed that the year just passed had not been marked by any unusual character. They had been affected by the war in the Far East, but with the exception of the year 1903 4 the profits of the past year had been greater than in any other period during their existence. He mentioned that Sir William Mather had gone to America to investigate new engineering developments, the acquisition of which in times past had contributed largely to the prosperity of the Company.

The report was adopted, and Messrs. J. L. Holden and J. Platt were re-elected directors.

NEW COMPANIES REGISTERED.

R. W. Vicarey.—Capital, £1,500. Object: to acquire the business carried on by R. W. Vicarey and Co. at Stafford, to adopt an agreement with the said company, and to carry on in the United Kingdom the business of consulting, experimental, and analytical experts of electric storage batteries, preparers and publishers of standard specifications of acids and waters for use as electrolytes, electricians, engineers, etc.

Liens Registered.

Electric Supply Co. of Victoria (Limited), Liverpool.—Trust deed registered July 25, for £160,000 5 per cent. first mortgage debenture stock. Trustees: Trustees, Executors, and Securities Insurance Corporation, Limited; charged on certain tramway and lighting orders, all the freehold and leasehold property in the State of Victoria, the undertakings, and all other assets, present and future, including the uncalled capital.

Blackheath and Greenwich District Electric Light Co., Limited.—Lien registered Aug. 11, for £11,708 4½ per cent. debentures, part of a series not to exceed the issued and paid-up share capital; amount previously issued, £188,292; charged on the undertaking and property, present and future, including the uncalled capital.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Turn-Severin (Roumania).—The Mayor invites tenders for the electric lighting of the town. Tenders by Sept. 10.

Plasencia (Spain).—The municipal authorities require tenders for an electric lighting installation. Tenders by Sept. 15.

Pontypridd.—The Urban District Council invite tenders for (Section A) permanent way. Tenders by 12 noon on Sept. 2.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct coupled steam set.

Limerick.—The Technical Education Committee invite tenders for electric lighting of the municipal technical schools. Tenders by Aug. 26.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Zaragoza. Tenders by Sept. 12.

Swansea.—The Corporation invite tenders for switchboard, transformer pillars, transformers, switchgear, etc. Tenders by noon on Aug. 26. See advertisement in last issue.

Taunton.—The Corporation invite tenders for a water-tube (straight) marine-type boiler, superheater, economiser, pipe extensions, etc. Tenders by Sept. 2. See advertisement in last issue.

Bishop's Stortford.—The Urban District Council invite tenders for lighting such of the public streets as are at present lighted, for two or three years from Sept. 30. Tenders by 4 p.m. on Sept. 25.

Edinburgh.—Tenders are invited for the electric lighting installation at the mortuary buildings, High School Yards, Edinburgh, for the Lord Provost, Magistrates, and Council. Tenders by Sept. 11.

Larne (Ireland).—Tenders are invited for lighting the public streets and roads of the urban district of Larne by means of coal gas or electricity for three years from Aug. 1, 1906. Tenders by 10 a.m. on Sept. 2.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10,000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Chelmsford.—The Town Council invite tenders for lighting the public streets and public clock within the borough with electricity, gas, or other illuminating power for three or five years from March 25, 1906. Tenders by Sept. 8.

Paris.—The Waterworks Department of the Municipality require tenders for supply and erection of motors, pumps, and generators for the proposed waterworks at Chantilly. For particulars apply to above authority. Tenders by Oct. 12.

Glasgow.—The Corporation invite tenders for the construction of new tramways. Specification, with form of tender, can be had on application to Mr. James Dalrymple, general manager, 46, Bath-street, Glasgow. Tenders by 5 p.m. on Aug. 28.

Pembroke (Ireland).—The U.D.C. invite tenders for electricity supply mains, arc lamps and pillars, house meters, and switchboard panels. Tenders to Mr. J. C. Manly, Town Hall, Ball's Bridge, Co. Dublin, by 10.30 a.m. on Sept. 22. See advertisement.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Ashton-under-Lyne.—The Electricity Committee invite tenders for (Section A) one 500-kw. direct-current generator; (B) one water-tube boiler with superheater, to be worked in conjunction with a refuse destructor; (C) two superheaters for Lancashire boilers. Tenders by 12 noon on Sept. 2. It will be seen by a note and from an advertisement appearing among "Contracts Open" in to-day's issue, that tenders should be sent in addressed to the borough comptroller, Mr. John Neal.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Morton Banks (near Keighley).—The Keighley and Bingley Joint Hospital Board invite tenders for the following works at the isolation hospital, etc.: (1) for keeping the private telephones, wires, and apparatus, and the electric bells, wires, and apparatus at the hospital (including the small-pox hospital) in good working order and repair and properly charged for one year from Sept. 8 next; also (2) for the supplying and fixing of a lightning conductor and telephone for new diphtheria pavilion. Tenders by Sept. 4.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23.

RESULTS OF TENDERS.

Barnstaple.—The Town Council have sealed an agreement with Ashmead, Benson, and Co. for the maintenance of the accumulators at Barnstaple electric light works, at £120 a year, for five years.

Watford.—The Electricity Committee recommend the acceptance of the estimates from W. Robey for hand railing and ladders for condenser pit, amounting to £68. 10s., and from the Brush Electrical Engineering Co. for a 12 months' supply of transformers.

Ipswich.—The following tenders have been received for electric lighting the Presbyterian Church, Ipswich:

J. Pratt, jun.	£160
Mann, Egerton, and Co.	123

Stock Exchange.—The committee has ordered the Havana Electric Railway Co.'s 6,957,000dol. consolidated mortgage 5 per cent. 50-year coupon bonds of 1952 for 1,000dol. each, Nos. 1 to 6,957, to be quoted in the official list.

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BUSINESS NOTES.

TRACTION.

Hastings.—The passengers for the week from Aug. 10 to 17 totalled 298,437.

Heywood.—The work of reconstruction was expected to be commenced this week.

Huddersfield.—The Corporation have adopted the proposal to pay the employés time and a quarter on Sundays.

Shildon.—The Urban District Council have been granted a year's extension of time for starting the construction of tramways.

City of Buenos Ayres Tramways.—The directors have declared an interim dividend of 2s. 6d. per share for the half-year ended June 30 last.

Geneva Tramways Co.—The traffic receipts for July amounted to £8,500. 15s., being an increase of nearly £400 over the corresponding period of last year.

Rotherham.—Through running between the Rotherham and Sheffield systems comes into force on the 1st prox., when there will probably be a 10-minute service.

Metropolitan Railway.—It is reported that on the Inner and Outer Circle the whole service of the Metropolitan Railway will be run electrically on and after Sept. 16.

Swindon.—The Town Council have informed the Rodbourne Parish Council that the electric trams cannot at present be run to the Telford-road boundary, because the Great Western Railway bridge needs altering.

Light Railways Act.—The Board of Trade have confirmed the East Sussex Light Railway (Amendment) Order, 1905, amending the East Sussex Light Railway Order, 1901, made by the Light Railway Commissioners.

Level Crossings.—At Butte, Montana, a goods train collided with a tram at a level crossing, the accident being due, it is reported, to the driver of the tram trying to cross first. There were 29 passengers killed and injured.

Wakefield.—The Corporation, in conjunction with other municipalities, have decided upon a test case in regard to the rating of light railways, and proceedings are to be instituted against the Wakefield and District Light Railway Co.

Proposed Light Railway.—A proposal to construct a light railway from Fraserburgh to Turriff meets with favour from the inhabitants. The Fraserburgh Town Council support the project, which is apparently a question of finance.

London United Tramways.—There have been complaints by residents in Kingston and the adjoining districts as to the rate of progress and the consequent increase of time for which the streets are "up," but good progress all round was reported last week.

Mirfield.—The Huddersfield Corporation were not prepared to extend their electric car service into Mirfield, and the terms they imposed upon the Woollen District Tramways Co. were considered prohibitive. It is reported that the Mirfield Engineering Co. will fill the breach with motor 'buses.

York.—The tramways company report that the receipts for the past six months amounted to £21,681, and the expenses to £21,533, leaving a balance of £148, £5 of which is to be carried to the suspense account for reconstruction of lines, and the remainder appropriated as interest on the 5 per cent. debenture stock.

Maidstone.—The reply of the Board of Trade to the application of the Maidstone Corporation to run tramways from Penenden Heath to the top of High-street, and from the top of High-street to Loose, reverses the order of the Light Railway Commissioners, but the Board are prepared to consider alternative routes.

Alpine Railways.—Two short railways for ascending the Alps are projected for the St. Moritz district. One is for a line up the comparatively easy eminence known as the Muottas Muragl, which commands a splendid view of the country. This line is expected to be ready for use next year. The second project is for a mountain railway on Mount Piz Julien.

Swansea.—Colonel Druitt, Board of Trade inspector, last week inspected the Port Tennant section of the Swansea tramway extensions. Accompanying him were the mayor (Major Sinclair), Mr. Prusmann (electrical engineer), Mr. David James (manager of the tramways company), and Mr. Schenk (harbour engineer). The trial was successful, and it was expected that the necessary permit would be forthcoming in a day or two.

Erith.—The Board of Trade inspection of the new municipal tramway system, described in this issue, was held on Monday, when the work was approved. On one section the speed has been restricted until the street at that point has been widened. Elsewhere on the system normal speeds, ranging up to 14 miles per hour, have been sanctioned. The tramways are expected to be opened to the public to-morrow, after the inaugural ceremony.

Electric Train Dangers.—Alderman Spencer, mayor of Tynemouth, speaking at a meeting of the Town Council the other day, referred to the Southport electrical railway disaster. He strongly urged an alteration in the electric trains running from North Shields to Newcastle. The present system of shutting carriage doors from the inside was a great danger to passengers in case of fire or collision. The North-Eastern Railway directors, at an interview, promised to mend it, and he hoped there would soon be a modification in this system.

Walsall.—The traffic for the four weeks ending July 30 worked out as follows: Four weeks ending July 30, 1904—number of passengers, 364,507; receipts, £2,005. 1s. 8d.; car miles run, 47,365·95; receipts per car mile run, 10·17d. Four weeks ending July 29, 1905—number of passengers, 414,357; receipts, £2,241. 8s.; car miles run, 49,661·47; receipts per car mile run, 10·83d. Arrangements have been made with the Staffordshire County Council and the Willenhall Urban District Council as to the laying of the short length of line at Willenhall, which was completed and opened for traffic in time for the Staffordshire Agricultural Show.

Leith.—The extended line between Hamilton and Larkhall was inspected last Friday by Colonel Yorke, R.E., on behalf of the Board of Trade, and found satisfactory. Councillor Lambie; Mr. G. F. Moller, general manager of tramways; Mr. John Clarke, county road surveyor; and Mr. W. H. Purdie, Hamilton burgh surveyor, accompanied the inspector. The line passes through a populous mining district, and the cars, which have been running for some time, are being well patronised. The Newhaven section has been opened to the public. There will be a limited system of ½d. fares. A further conference is to be held with the Edinburgh Tramways Company to settle through fares.

Tunstall.—At the meeting of the Urban District Council it was reported that the Board of Trade would appoint an arbitrator to determine the difference between the Potteries Electric Traction Co. and the Council regarding the proposed junction between the company's lines and the Chatterley-Whitfield Co.'s sidings. The difficulty referred to occurred through the Council consenting to the company making the junction to enable them to convey coal over their lines to their generating stations, but refusing to sanction their conveying coal for the supply of manufacturers and general customers. The clerk was instructed to take such steps as appeared necessary to oppose the tramway company's application.

Sheffield.—The report for the year ending March 25 shows that the passengers totalled 63,952,283, the large majority being 1d. fares. The receipts amounted to £240,565. The car mileage aggregated 6,049,890. The routes showing a loss are Petre-street, Pitsmoor, Springvale, Intake, Firth-park, Owlerton (both routes), Brightside, Shoreham-street, and Osgathorpe. The plough lifeguards on 88 cars have been replaced by guards of the hanging gate type. All the cars are now fitted with this type of lifeguard. The casualties totalled 1,764, including three fatalities. Claims were made in 209 cases, the compensation paid amounting to £2. 15s. 7d. per claim, from which it may be inferred that the accidents were not of a very serious character.

Portsmouth.—The Corporation tramways took only £23 less than £5,000 in 1d. fares for the week ending the 12th inst., and more good weeks are in prospect. The portion of line between Portsmouth and Cosham would probably be much more remunerative if a mutual understanding existed between the Tramway Committee and the light railway company, so that there could be a through fare to Horndean, which is a picturesque resort. At Brighton a system of conveying passengers to points of interest, with a guide to explain matters, has been introduced, 1s. being charged for a trip of over two hours, and a writer in the local Press suggests a 6d. tour of Portsmouth, comprising visits to the dockyard, Charles Dickens's birthplace, Southsea Pier, and East Southsea.

"Tube" Competition.—Lord Rathmore, presiding at the half-yearly meeting of the North London Railway Co., said there had been a decrease in the number of passengers by 1,039,941, which he attributed to the continued and strenuous competition of electric traction. Electric traction facilitated the migration from the company's districts into the country of people who found that by these means they could live further out. For the present, at all events, it was impossible for them to attempt to meet this competition by electrifying their lines, as, until electrification was instituted on the London and North-Western on the lines belonging to the company over which the North London trains ran, it would be impossible for them to electrify their lines.

Leicester.—An accident occurred on the Melbourne-road section last week. A car was being driven down Nedham-street towards the Humberstone-road, when it was met by another car which was being driven slowly in the opposite direction. The rails at this spot divide into a loop for passing purposes, but before the latter car could clear the points a collision occurred. The driver of the first car applied his brakes, but the car was descending a slope, and failed to stop in time to avoid the impact. No passengers were in either of the cars at the time, and neither of the drivers nor the conductors were hurt. The cars, however, were considerably damaged. Mr. T. R. Smith, the resident electrical engineer, states that the "down" car was examined after the collision and no defect was found in the brakes or the mechanism of the car.

Southend.—The traffic receipts from the light railway for the year ending March 31 amounted to £17,419. 4s., as compared with £15,688. 17s. last year. The working expenses were £15,098. 16s. 4d., against £13,447. 6s. 3d., and a gross profit of £2,785. 12s. 8d. was made, being an increase of £67. 6s. 11d. on last year's working. After meeting interest and instalments of loans, there was a net loss of £1,031. 18s. 10d. on the year. A letter was read from Messrs. Isaacs and Bellamy at the meeting of the Town Council asking if the Corporation would consider the question of the lease of the proposed tramways from Southend to Southminster, and a reply was sent that the Corporation had no power to allow the proposal. In connection with the proposed extension to Shoeburyness, negotiations are proceeding with Colonel Burgess as to the land along the foreshore.

The Underground.—Mr. Arthur L. Stride, managing director of the London, Tilbury, and Southend Railway, states, in a communication (dated the 21st inst.) to the *Times*: "Under the heading of 'The Electrification of the Underground Railway,' on p. 8 of your issue to-day, you announce that the East Ham branch of the District Railway was worked for the first time yesterday under the new electrification scheme. I shall be obliged if you will allow me to point out that the District Railway ends at Whitechapel Station, and that

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the service inaugurated yesterday is a joint train service in the interests of the Tilbury and District Companies, from stations on the District Railway, working over the Whitechapel and Bow, which is the joint property of the two companies and from Bow to East Ham over the Tilbury and Southend line. This service will be extended to Barking as a terminus so soon as the alteration at that station is completed. There is no such thing as an East Ham branch of the District Railway."

Dewsbury.—There has for some time been an agitation for an extension of the electric tramway system at Dewsbury. By the agreement between the Corporation and the British Electric Traction Co. the Corporation can at any time call upon the company to carry out extensions, and if they decline to do so the Corporation may construct the lines. Cars now run to every part of the borough with the exception of Dewsbury Moor. There are acres of land in this district, and it is believed a tramway would encourage building operations and benefit the town financially, inasmuch as an increase in the rateable value would follow. A month or two ago the question was referred to a special tramways sub-committee, a suggestion being made at the same time that a service of motor 'buses might be introduced. The sub-committee have since gone into the subject, and they now recommend that the British Electric Traction Co. be requested to make a branch line from the bottom of Halifax-road up Williams-road, Moorhead-road, Boothroyd-lane, and Staincliffe-road to the borough boundary. If the company refuse to accede to the request, it is stated that the Corporation will seriously consider whether or not to make the line themselves. It is understood that the matter will come up for discussion at the next meeting of the Council. The company have asked the Council to accept one-fourth of the full rating assessment pending a test case contending that their undertaking is a "railway" within the meaning of the Act. The Council replied that the full rate must be paid, and they will hold the difference pending a decision.

Ramsgate.—The Board of Trade enquiry into the tramway accident at Ramsgate on Aug. 3 was opened at the Town Hall, Ramsgate, on Tuesday before Colonel von Donop. Stanley Frank Jones stated that he was conductor on the car. All went well until they reached the gardens at the Plains of Waterloo, Ramsgate. They stopped at the corner of Waterloo-crescent for seven passengers to get down; they did not take any on board. The witness then signalled to go on. As soon as they got on the slant it gradually got up speed. As it appeared to be going faster than it should do, the witness applied the slipper brake. The car was then at the end of the lawn, a little way before reaching Albion House. He remembered nothing further until they went over the cliff. The car flew by the usual stopping place. Replying to the inspector, the witness stated that he had been employed as a conductor for about six weeks before the accident. He had had no previous experience of tramway work. He had five or six days' training before he took charge of a car. On the loop line it was the duty of the conductor to put the slipper brake on before the car was restarted down the hill, and afterwards to ring to the driver to proceed. On the occasion referred to, he applied the slipper brake before reaching the stopping place. The car had appeared to be under proper control previously. There were six passengers in the car at the time of the accident. The manager of the tramway company testified that the track had been approved by the Board of Trade. Mr. A. E. Rossignol, consulting engineer, stated that he examined the car and the scene of the accident two days after. In his opinion, Madeira-walk was a dangerous road for tramway traffic, on account of the steep gradient and numerous curves, and it would be very difficult to prevent accidents from happening there. Just above where the accident happened the gradient was 1 in 13, and it was 1 in 16 where the car went off. He objected to the arrangement for dividing responsibility by giving the control of the slipper brake to the conductor. In his opinion, the slipper brake should be applied before the present Board of Trade stop was reached, and kept on. The superelevation needed correction, and the Board of Trade stops should be indicated by a special sign, so that there should be no slackness. The flanges of the wheels were in a rather dangerous condition, and ought to have been renewed earlier. He had found that the use of steel wheels with properly adjusted brakes was a great preventive of derailment. He further recommended that a special inspector should be appointed to supervise the men at all dangerous points. It would have been much better if a different route had been followed. He feared that there would always be a certain amount of danger on the present one. Cross-examined, the witness admitted that there were many more dangerous gradients in England. It is expected that the driver will not be in a fit condition to give evidence for two or three weeks, in consequence of which the inquiry was adjourned.

LIGHTING AND GENERAL.

Armagh Lunatic Asylum.—An expert is to be called in to examine all the electric lighting installation.

Acton.—Application is to be made for sanction to the borrowing of £225,000 for laying mains, etc., and other purposes of electric lighting.

Kashmir.—*Indian Engineering* says the Kashmir Durbar have accepted a scheme for developing electric power in the valley, but want funds.

Cleveland and South Durham Electric Power Co.—The Eston Urban District Council have approved the plans for the company's works at Grangetown.

Frinton-on-Sea (Essex).—We understand that the electric light and power station was destroyed by fire on Saturday. The damage is estimated at £3,000.

Brynmawr.—A further canvass of the town is to be made with regard to the proposed electric lighting, the councillors to be responsible for the canvass of their respective wards.

Buxton.—The report of the electrical engineer (Mr. Leeming) recommending that £4,000 should be expended in the extension of the works, has been adopted by the Urban District Council.

St. Marylebone.—The Borough Council's generating station at Lisson-grove is now so far advanced that the Council will soon be entirely independent of the Metropolitan Company's supply.

Standish.—The Lancashire Electric Power Co.'s main extends to Westhoughton. Before going any further the District Council propose to ask the Wigan Corporation for a price for current in bulk.

Grimsby.—The Electric Lighting Committee have agreed to a recommendation of a special sub-committee involving the expenditure of £18,000. The extensions include engines, dynamos, and mains.

Wells.—Strong representations are being made to the Postmaster-General on the question of telephonic communication, urging him to do all in his power to complete the installation in the city without delay.

Yorkshire Electric Power Co.—The Thornhill station has been started to supply Ravensthorpe, Mirfield, Liversedge, Birstall, Gomersal, Drighlington, Pudsey, and other districts within a radius of 15 miles from Thornhill.

Annfield Plain.—The Council are about to consider the question of what an electric plant of their own would cost, and whether they should enter upon the work of providing their own electric light for the whole of the district.

Rushall.—The accounts for the year show that the receipts from the telegraph station have been sufficient to cover the requirements of the Post Office and that the Council will not be required to make any payment under the guarantee.

Lowestoft.—The resident engineer's last report states that during the month 12 new consumers were connected with the mains, representing 338 8 c.p. lamps. There are now 639 consumers connected to the mains, representing 32,119 8-c.p. lamps.

Brighton.—Application is to be made for sanction to borrow £38,500 for works in connection with the electricity undertaking. The new connections during the past four years were 333, 489, 327, and 225 respectively, or an average of 344 connections per annum.

Ossett.—At the last Town Council meeting a resolution to the effect that the Council should proceed no further with the electric lighting scheme, but should apply for a further extension of time for putting the electric lighting order into force, was discussed and lost.

Bridgwater.—The Property Committee reported at the last Town Council meeting that an installation of electric light had been made to the chancel of St. Mary's Church, and the town clerk was directed to write the vicar and churchwardens thereon, and to give notice to the insurance company.

New Branch.—We are informed that the Sloan Electrical Co., 15, Fore-street-avenue, E.C., have, in consequence of the increase in the sale of "Conradty" carbons, opened offices and a warehouse at Manchester in order to promptly supply customers in the Midlands and the North of England.

Tenders Open.—Referring to an advertisement of Ashton-under-Lyne appearing in issue of Aug. 18, an error occurred as to the name of the gentleman to whom tenders were to be sent in. Corrected advertisement appears in our issue of to-day, from which it will be seen that tenders are to be sent in to Mr. Jno. Neal, borough comptroller.

Watford.—The electrical engineer reported at the last Urban District Council meeting that the number of consumers connected to date was 414. The Market-place sub-station has now been equipped and put into service. The Whippendell-road sub-station is now in use for public as well as private lighting supply. The revenue account for the year ended March 31 last is stated to be satisfactory.

Dissolution of Partnership.—As our readers are probably aware, Wm. Aug's Gibson Limited, now in liquidation, was a consolidation of interests of A. and P. Steven, of Glasgow, who have been established in the lift trade for nearly 60 years, and Mr. Wm. Aug's Gibson. Owing to some differences in opinion, the company has gone into liquidation under a special resolution. We are informed that Messrs. A. and P. Steven, having decided to do their business direct in future, have opened offices at Thanet House, 231-2, Strand, London, W.C.

Macclesfield.—The Green-street site has been adopted for the new electricity works, and the engineer (Mr. Woodward) is about to prepare plans and specifications for machinery required, and to advertise for tenders. Messrs. Whitaker and Bradburn have been appointed architects for the erection of the electricity supply works at a commission of 2½ per cent. on the erection of the building and 2½ per cent. on the specifications. The engineer has been instructed to advise the architects to have the advice of a chimney expert for the erection of a chimney 140ft. high, and to superintend the erection. Application is to be made for a loan of £16,000.

Pudsey.—The electric lighting will be commenced this week. The *Yorkshire Post* says that Messrs. William Lupton and Co., of Cliffe Mills, Pudsey, have already begun to use the current for power purposes, and before the week is out it will be used by several tradesmen for lighting purposes. During the Feast, which commences on Saturday, two 2,000-c.p. arc lamps will be placed at the entrance to the grounds. The current is purchased in bulk by the Corporation from the Yorkshire Electric Power Co., and in a station which has been erected by the Corporation it is transformed by the company from an alternating current of 10,000 volts to a continuous current of 500 volts. The whole of the compulsory area covered by the provisional order has been wired by the Corporation, some 3½ miles of cables having been laid.

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Walsall.—The total number of consumers supplied on July 31 last was 423. During the past month the total units generated at the station were 114,709. The total output from the main generators was 110,793 units. The total units from the transformers were 85,214 (estimated). The total units registered on the meters were 82,635. The machinery was run for 702 hours. The wages paid amounted to £133.

Newport.—An inquiry has been held into an application of the Corporation for sanction to borrow £10,000 for the purposes of electric lighting and power—*i.e.*, £6,400 for mains and services for the supply of power, and £3,600 for meters. It is considered that this expenditure would cover the requirements for the next two years. It was stated that the demand was increasing. The total revenue last year was £24,149, and the gross profit £12,695.

North Wales Power Co.—The electric power station in course of erection in Cwm Dyli, at the head of Nant Gwynant, in which electrical current is to be generated by turbines driven with water from Llyn Llydaw, is nearly completed. The North Wales Power Co. are proceeding to erect overhead cables by way of Roman Bridge to Blaenau Festiniog, a distance of some eight miles, for the purpose of supplying current for power purposes to a number of quarries in the neighbourhood.

Handsworth.—The electricity supply mains have now all been laid and tested, and it is expected that the lighting will be commenced in about four weeks. The actual length of roads originally scheduled was 8,000 yards, but that figure has been doubled, and, in addition, the District Council have decided to lay a main to the boundary at Witton. There are 120 arc lamp standards, each of which carries also two incandescent lamps for use after midnight. The generating station is nearly finished. It is proposed to charge 1d. for each 8-c.p. lamp for about five hours' use. Churches and chapels will be supplied at a uniform rate of 4d. per unit. The total cost of the undertaking has been £45,000.

Wilmslow.—The Lord Mayor of Manchester last Monday opened an electrical exhibition, promoted by the Alderley and Wilmslow Electric Supply Co., in the Wilmslow Drill Hall. The exhibition was held to celebrate the inauguration of the supply of electricity in the urban district. The company's works were opened in October, 1899, and in the first month 372 8-c.p. lamps were connected in Alderley. At the beginning of the present year these had increased to 9 026, and a continued advance has been maintained. About 15 miles of distributors and feeders have been laid in Wilmslow, and all public lamps have been converted. The whole scheme has been carried out under the supervision of Mr. Cuthbert W. Bentley, the engineer and manager for the company. Part of the takings of the exhibition are to be handed over to the Wilmslow Charity and Sick Nursing Association.

London Gazette.—The partnership between John Joseph Jubb and George Kaye Spivey, carrying on business as electrical engineers at Batley Carr, Batley, has been dissolved by mutual consent. A receiving order has been made out on debtor's petition in the estate of Alfred John Earp, electrical and general engineer, 12, Palmerston-road, Boscombe, Bournemouth. The first meeting will be held at the Official Receiver's Office, Midland Bank-chambers, High-street, Southampton, on Aug. 30, at 3.15 p.m. A receiving order has been made out on creditors' petition in the estate of Albert John Harris, electrical engineer, and trading as A. J. Harris and Co. at Borough Mills, Bower-street, Bradford. The first meeting will be held at the Official Receiver's Chambers, 29, Tyrrel-street, Bradford. Nernst Electric Light Limited has been wound up voluntarily, and Mr. M. Levinger, manager and secretary of the company, appointed liquidator.

Greenock.—The engineer's report for June shows that the output for private supply and public lighting has increased 95 per cent. as compared with the corresponding month last year. For traction supply the increase was 26 per cent. The coal consumption has increased 60 per cent. because the condenser was not in use during the month on account of alterations. The output of electricity for the year ended June 30 last shows an increase of 60 per cent. for lighting and 14 per cent. for tramways. The income amounted to £16,336, of which £4,643 was received from the tramways. The expenditure totalled £8,204, leaving a gross surplus of £7,131, equal to about 7·5 per cent. on the capital prodided during the year. Allowing for the sinking fund at 3½ per cent. and 3 per cent. for interest, there remains a net surplus on the year's working of £1,593. The engineer estimates that the surplus next year will be £1,300. The sinking fund now stands at £13,000. Out of the extra 325,000 units sold last year, 106 000 (or 33 per cent.) have been used by installation fitted up by the Corporation owing to the popularity of the free wiring system. It is proposed to borrow £50,000 to cover the extensions required by the undertaking during the next five years. The cost of production is stated to be 1d. per unit.

Glasgow.—The Corporation have fixed the charges for the supply of electricity for the financial year June, 1905, to May, 1906, as follows: I. For lighting purposes (250-volt supply)—(1) Shops, warehouses, offices, theatres, halls and places of entertainment, and all other premises except those specified under heads 2 and 3, for any quantity of current equivalent to an average use of two hours per day (730 hours per annum) of the maximum demand as recorded upon the demand indicator, 3½d. per unit; for all current consumed over this quantity, 1d. per unit. (2) Domestic consumers, a uniform charge of 3½d. per unit. (3) Churches, a uniform charge of 3d. per unit. For stair-lighting purposes—for each 5 c.p. lamp lighted from sunset to sunrise, including cleaning, lighting, and extinguishing, 15s. per annum. II. For motive power purposes (250 and 500 volt supply)—(1) For any quantity of current up to an equivalent of 1,000 hours' use per annum of the maximum demand as recorded upon the demand indicator, 1½d. per unit; for all current consumed over this quantity, ¾d. per unit. (2) In cases where consumers can so arrange their demand that no current is taken during the hours between 5.30 and 6 p.m. in the months of November, December, and January, a uniform charge of 1d. per unit. The supply of current for motive power purposes is given subject to a minimum account of £2 per annum, payable in advance, but any account for current used by same consumer for lighting premises where power supply is given is to be set off against this minimum charge. The rates of charge for current for lighting shops, etc., and staircases, and the rates for motive power purposes, are substantial reductions on the rates charged last year, the maximum price for lighting being now 3½d. per unit as against 6d.

Pontardawe.—Mr. J. Morgan, consulting electrical engineer, has reported on a scheme for the electric lighting of the following parts of Pontardawe rural districts: Alltwen, Ynismeudwy, Trebanos, Clydach, Craigcefnparc, Ystalyfera, Brynamman, Gwauncaegurwen, Cwmgorse, Cwmllynfell, Rhos, Rhydyfro. The estimated aggregate requirement is 385 kw. It is suggested that a generating station be erected at Pontardawe, and Mr. Morgan considers that, owing to the large area that it is required to supply energy to, it will be necessary to generate at high tension. Except in the main streets, or where a large number of private consumers are close together, he advises overhead distribution, as being far cheaper in first cost, and because it can also be added to economically, besides saving the continual breaking of the streets. Two 16-c.p. incandescent lamps are to be fixed on the poles at distances varying from 60 to 100 yards. In Pontardawe underground cables are suggested for High and Herbert streets, where the old gas-lamp pillars can be utilised for the electric lamps. One hundred and sixty-four lamps will be required. Mr. Morgan recommends a surface condenser, if sufficient water can be obtained from the canal, as considerable steam consumption of engines will be reduced, as well as effecting a saving of 20 per cent. in fuel consumption. The total cost of the generating station is estimated at £9,260, the principal items being engines, generators, exciters, etc., amounting to £4,050; high-tension transmission lines, £7,200; low-tension distributors, £12,110; parliamentary expenses, £500; telephone system, £380; engineering expenses, £1 445; contingencies at £5 per cent., £1,545—a total of £32 440. Annual standing charges, £4,050; running expenses, etc., £1,829—total annual expenses, £5 880. The engineer suggests that a charge of £2. 10s. per lamp per annum be made; estimated revenue, £1,037. 10s.; from private consumers, £5,146. 17s. 6d. The total estimated revenue is £6,850, and the estimated expenditure £5,880.

Salford.—In his annual report Mr. C. D. Taite, electrical engineer, states that during last year there occurred no serious mishaps of any description, and that the economical results recorded in his last report have been more than maintained. The normal number of machines running on load in the winter evenings was five—three of these were used on the lighting and power supply up to 5.30 p.m., when one would usually be transferred to the tramway supply. The maximum load was 3,600 kw. Several small improvements in the boiler-house plant have reduced the cost of fuel per unit sold from ·22d. to ·19d., an improvement of nearly 14 per cent., but about 4 per cent. of this reduction is due to a more favourable coal contract. The coal consumption per unit sold has, however, been reduced from 5·26lb. in the previous year to 4·66lb. in the year under consideration. Mr. Taite says that the efforts of the staff in this direction have been greatly assisted by the diagrams obtained from the carbonic acid gas recorder, which indicate at once when the amount of air admitted to the furnaces is in excess of the requirements of the fuel; leakages of air through cracks in the brickwork are also shown up. In addition to fuel economies an arrangement has recently been introduced for cooling the coking bars of the mechanical stokers by means of a water service. These bars in the past have been the chief item of expenditure in connection with the upkeep of the stokers, and they have accounted for about half the total expense under this heading. The new arrangement is working most satisfactorily, and will be a notable economy. A further reduction in coal consumption may be expected during the current year, owing to improvements which are being carried out on the high-pressure valves. In consequence of the contract to supply the Manchester Ship Canal Company with electricity for use at the new No. 9 Dock it has been necessary to extend the lighting and power switchboard, and to instal a booster to furnish the necessary pressure. The switchboard has been built by the staff of the department, and is now ready for use; and a booster is being built by the British Westinghouse Company at Trafford Park. The batteries in the Frederick-road sub-station, after having been in use for about five years, are being renewed by the Tudor Accumulator Company. When completed, the available battery power will be equivalent to half the full-load power of one of the main engines. The report goes on as follows: During the year a considerable amount of work has been carried out at the old works to enable a portion of the buildings to be used as a central testing department for meters, motors, lamps, etc. The testing department was transferred from these premises to the new quarters at the end of last summer, and the additional space now provided enables the work of the department to be carried out in a more thorough and efficient manner than was possible previously. Incidentally, the room vacated at these offices by the removal of the department has permitted an important improvement to be effected here in the form of increased accommodation for the office staff. The mains department has been kept fairly busy throughout the year, owing largely to the work necessitated under the Prestwich provisional order. The length of the distributing mains has been increased by 6,918 yards. In addition to the above high-tension feeders have been laid up to a central point in Prestwich, where a sub-station is to be provided, and subsidiary feeders have been taken down several roads where the demand which is likely to arise does not warrant the laying of low-tension cables. A tramway feeder has also been laid for a distance of 2,400 yards from the borough boundary, and a further cable is to be installed for the tramway system in Bury Old-road, Prestwich. The whole of the feeder and distributing system throughout the borough and outlying districts has been kept in excellent order by means of

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systematic testing, and the low-tension system has been entirely free from serious faults; 183 new consumers have been obtained, and the new connections are equivalent to 16,112 8-c.p. lamps and 815 h.p. in motors. During the present year the supply to the Manchester Ship Canal will be inaugurated and that to the Broughton Copper Company largely increased, and as a result the motor connections will experience a very marked expansion. The motor hiring business has made steady progress, there being, at March 31, 165 motors on hire of an aggregate of 1,367 h.p., compared with 105 motors of 954 h.p. 12 months previously. As the price of current for power purposes is to be reduced from July 1 a still more rapid expansion of this department is not unlikely. The net profit for the past year amounted to the sum of £7,514, which has been allocated as follows: depreciation and reserve, £3,000; contribution in reduction of rates, £4,514. The amount set aside for depreciation and reserve represents only a fraction over half of 1 per cent. on the capital expenditure at the end of the year, and, having regard to the possibility of obsolescence and the high capital expenditure per kilowatt of plant installed, this sum cannot be considered an adequate provision for future contingencies; further, for the current year, out of an anticipated profit of £10,650, no less than £7,500 has to be contributed in aid of the rates, leaving only £3,150 for depreciation and reserve, a quite inadequate amount. The gross profit for the year was £40,696, equivalent to 7½ per cent. on the capital invested at the end of the year; this compares with a gross profit of £42,860 last year, equivalent to 8 per cent. on the then capital. The diminution in the gross and net profits is entirely due to the reduction made in the price of current, not only to the tramway department, but also to ordinary consumers; thus the price charged to the former was 1·5d. in place of 1·95d. per unit, while the average price to ordinary consumers came down from 2·56d. to 2·17d. per unit sold. The gross profit has been dealt with as follows: interest on loans, £16,455; sinking fund, £16,727; net profit, £7,514. The total sum which has been paid to the sinking fund since the commencement of the undertaking now amounts to £64,726. The depreciation and reserve fund stands at £11,000. Compared with the previous year there has been an increased sale of over 1½ million units, while the total cost of production has been reduced just over ½d. per unit sold. All the items of expenditure show a reduction per unit sold with the exception of management, under which heading are included several special items which will not occur again—*e.g.*, the cost of the Prestwich electric lighting provisional order. The works costs have been reduced below ½d. per unit, and the figure of ·19d. for coal is the lowest yet published by any municipal undertaking. The capital expenditure during the year has been less than for any year since 1898; a large proportion of the expenditure is due to the extension of mains, while motors on hire come next with an outlay of £2,170. The sum included under the heading of buildings is due to the payment of the balance of the architect's fees. During the present year the expenditure is again likely to be small. A comparison between the cost of the Salford undertaking and those of other towns shows that as a result of the improved figures obtained Salford now takes precedence over Bradford, and ties with Newcastle-on-Tyne Co. for third place amongst over 240 undertakings. As regards municipal undertakings, Rotherham is the only one which has obtained results better than Salford. In conclusion, Mr. Taite testifies to the splendid assistance given him by the staff of the department.

PROVISIONAL PATENTS, 1905.

AUG. 14.

16457. An improved bayonet socket-holder for incandescent electric lamps. James Cleary, 119, Waldegrave-road, Preston Park, Brighton.

16460. An automatic starter for electromotors. Johannes Jessen, Zürich-Langnau, Switzerland. (Complete specification.)

16471. Improvements in lamps for Nernst filaments. Leo Kamm, 27, Powell-street, Goswell-road, London.

16479. Improvements in and relating to telephone systems. Jacob William Lattig and Charles Lane Goodrum, 77, Chancery-lane, London. (Complete specification.)

16484. Improvements in call signal apparatus for group-calling in telephone installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

16491. Coiling apparatus for hollow or solid flexible conductors for gas, electricity, and the like with auxiliary support for the hollow conductors. Samuel Quincey and Charles Harrison, 136, Kentish Town-road, London.

16518. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

AUG. 15.

16545. Improvements in or relating to electric arc lamps. Adrian Denman Jones and the Jandus Arc Lamp and Electric Company, Limited, Hartham Works, Hartham-road, Holloway, London.

16546. Improvements in or relating to electric arc lamps. Adrian Denman Jones and the Jandus Arc Lamp and Electric Company, Limited, Hartham Works, Hartham-road, Holloway, London.

16547. Improvements in or relating to electric arc lamps. Bernard Mervyn Drake, Adrian Denman Jones, and the Jandus Arc Lamp and Electric Company, Limited, Hartham Works, Hartham-road, Holloway, London.

16570. Improvements in storage batteries. Gustave K. Hartung, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16571. An improved attachment device for the shades of inverted incandescent gas and electric fittings. Entwistle and Stephens, Limited, and Henry Edward Dane, 8, Quality-court, Chancery-lane, London.

16587. Improvements in lightning arresters or like protective devices. Isidore Bernard Birnbaum, 322, High Holborn, London. (Joseph Nübel, Germany.)

AUG. 16.

16621. Improvements in electric terminal fittings for making connection between the various main and branch cables in conduit junction boxes. Charles Edward Gunner, Embank, Kemble-road, Waldon, Surrey.

16631. Improvements in the manufacture of electrical resistances. Charles Rozicka, Clun House, Surrey-street, London.

16655. Improvements in or relating to wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

16656. Improvements in tremblers for electric sparking apparatus. Marconi's Wireless Telegraph Company, Limited, and Edward Priddle, 24, Southampton-buildings, Chancery-lane, London.

16657. Improvements in and relating to electric arc lamps. The British Thomson-Houston Company, Limited, and Edwin Joseph Murphy, 83, Cannon-street, London.

AUG. 17.

13964A. Improvements in and connected with electric lighting or other installations. Percy Fullerton Corkhill, 6, Lord-street, Liverpool. (Date applied for under Rule 5 of the Patents Rules 1905, July 6, 1905.) (Complete specification.)

16664. Electrical and automatic means for indicating the number of occupied seats on or in a tramcar, omnibus, or other vehicle, place of amusement, or the like, and means for indicating the position of such seats. Benjamin Lewin Moseley, 147, Mackenzie-road, Beckenham, Kent.

16671. Electric working of mine shafts. James Swinburne, 82, Victoria-street, Westminster, London.

AUG. 18.

16772. Improvements in and relating to connection boxes for electric cranes. Siemens Bros. and Co., Limited, and Johnson Snow Huddleston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16773. Improvements in revolving field magnets for electrical machines. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

16796. Improvements in devices for the electrographical long-distance transmission and reception of drawings photographs, and the like. Henri Carbonnelle, 322, High Holborn, London. (Complete specification.)

AUG. 19.

16821. Improvements in and connected with apparatus for cooling water for condensing and other purposes. James Henry Brown, 4, Corporation-street, Manchester. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 7.

1904.

18066. Electro-mechanical apparatus for automatically operating the rail and electrical conductor points on electric tramways and railways from the tram or train. Parr.

18199. Controllers or cut-outs for electric circuits. Garrard.

18255. Parallel running of dynamo machines. Parsons and Stoney.

18293. Controllers for electrically-operated capstans and the like. Scott.

19572. Means for controlling electric circuit breakers. British Thomson-Houston Company, Limited. (General Electric Company.)

20019. Electric arc lamps. Davy.

21143. Friction gearing. Carolan. (General Electric Company.)

21622. Electric ignition for internal-combustion engines and apparatus therefor. Kennedy.

22236. Electric lamp fittings. Bonnella.

22247. Means for supporting incandescent electric lamps. Baylor.

22290. Safety devices for the trolley poles of electric cars. James Hawley, Limited, and Hardman.

22838. Electric arc lamps. Jandus Arc Lamp and Electric Co., Limited, and Jones.

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27665. Electric system of driving vehicles in an arena or course. Lehwess.

29435. Electric alternating-current motors. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

29436. Electric alternating-current motors. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

1905.

171. Electromagnets and safety devices used with cranes for lifting rails, ingots, or the like. Steel, Peech, and Tozer, Limited, and Bowen.

1553. Method of drying hygroscopic insulation of electric conductors. Nisbett.

2014. Electric distribution systems. Boult. (Entz.)

3312. Electric self-acting apparatus for tightening ropes and the like. Adam. (Date applied for under International Convention, Feb. 18, 1904.)

5976. Means for regulating compensated series electric motors and generators. Elektrizitäts Act.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, April 5, 1904.)

6073. Electrical mercury switches operated by a vehicle passing along a railway. Siemens Bros. and Co., Limited. (Siemens und Halske Act.-Ges.)

9161. Electrical connections. Jones.

10695. Apparatus for neutralising static electricity. Chapman.

10696. Apparatus for neutralising static electricity. Chapman.

11745. Electric telegraphy. Kitsee.

12418. Distribution of energy to commutator electric motors from a three-phase alternating-current source. Lamme. (Date applied for under International Convention, June 30, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £		Last price £
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅛-¼ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5½-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2½-2⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1½-1⅝
—— 4½ per cent. 1st Debenture Stock	100	..	92-95
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	107-109
—— Ordinary	5	..	10-11
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	3	..	1½-2
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1½-1⅝
—— "A" Shares, 01-017,139	5	..	2-2½
—— 5 per cent. Debentures	100	..	89-94
—— 4 per cent. Deb. Stock, Red.	100	..	83-88
Electric Construction, Nos. 1 to 112,100	2	..	5 8-5/7
—— 7 per cent. Cumulative Pref.	2	..	1⅞-2¼
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-101
W. T. Henley's Telegraph Works, Ordinary	5	..	11½-12¼
—— 4½ per cent. Preference	5	..	5⅞-5⅞
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15-16
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	32-34
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	11½-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9⅞-10¼ xd
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red	100	..	105-107
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	10-10¼ xd
—— 7 per cent. Preference	5	..	9⅝-10¼ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9-9⅛
—— Nos. 60,001-80,000	5	..	8¾-9¼
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13¼
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	6¾-7¼ xd
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5¼-5⅜ xd
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	..	4 13/16-5 1/16
—— ditto (1903) 40,001-80,000	5	..	4¼-5⅛
Chelsea Electricity Supply	5	..	6¼ 6⅜
—— 4½ per cent. Debentures	100	..	108-110
City of London, Ordinary	10	..	10¼-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	103 105
County of London Electric Supply, Ordinary	10	..	8¼-9 xd
—— 6 per cent. Cum. Pref.	10	..	12-12¼ xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5	..	6 1/16-6 5/16
—— 4½ per cent. First Mort. Deb.	100	..	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5	..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90

Name.	Amount paid. £		Last price. £
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	99-102
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	7⅞-8¼
Isle of Wight Elec Lt. and Pwr., 4½ p c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	..	¾-⅞
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	11¾-12¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	3	..	2-2⅛
—— 6 per cent. Pref.	5	..	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	9¼-10⅜ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	99-101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	..	7⅜ 8¼
—— do., 57,0 0-75,000	5	..	7⅜-7½
—— 5 per cent. Pref., 1-57,000	5	..	6 6½
—— do., 57,0 0 75,0 0	5	..	6-6½
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6¼-7
—— 4 per cent. Debenture Stock	100	..	98-100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2⅜ 2½
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	106-109
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13¼-14⅛
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97 99
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅜-4⅞
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5⅛-5⅜
Westminster, Ordinary	5	..	12¼-13 xd
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5	..	6¼-6⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5	..	5⅞-6⅛
—— Ord.	5	..	8¼-9
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p c. 1st Mor. Deb. Stk., Red.	100	..	103-105
Barcelona Tramways, Ord., 1-20,000	10	..	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9,-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅞-13⅝
Brisbane Tramway Invest., Ord , 1-75,000	5	..	1-1½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4¼
—— 4½ per cent Deb. Stk , Red., Prov. Certs. all pd.	100	..	95-98
British Columbia Electric Railway Co., Ord. Def.	100	..	103-112
—— Ord. Pref.	100	..	99-102
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	102-105
—— 4, per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c
—— 4 per cent Vancouver Power Deb.	100	..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	8¼-8⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10⅞-11¼ xd
—— 5 per cent. Perpetual Debenture Stock	100	..	122-124
—— 4½ per cent. 2nd Deb. Stock	100	..	97-99
Buenos Ayres and Belgrano Trams.	5	..	3-3¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5 7/16-5 11/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5⅛-5⅜
—— 5 per cent. Deb. Stock, Red.	100	..	105-107
—— Prov. Cert., all paid	100	..	101-104
Buenos Ayres Electric Trams., 5 p c. Deb. Stk., Red.	100	..	96-98
Calcutta Tramways, 1-102,268	5	..	9¼-10
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1⅛-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	6⅛-6⅜
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13¼-14⅛
—— 6 per cent. Cum Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-50,000	10	..	15-16
—— 3 per cent. Mort. Debs , 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14¼
—— 4, per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9⅞-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	99-102
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk , Rd.	100	..	102-104
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	¼-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	106-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-1¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref	10	..	9⅞-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9-9¼ xd
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,1 2 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	..	89-90 xd
—— 4 per cent. Pref.	100	..	101-103 xd
—— " " deferred	100	..	77-80
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100 ..	37-39
—— 4 per cent. Debenture Stock	100 ..	107-110
—— 5 per cent. Pref. Stock '91	100 ..	118-121 xd
—— ,, ,, ,, '95	100 ..	117-120 xd
—— ,, ,, ,, '01	100 ..	115-116 xd
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	— ..	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	98-99
Waterloo and City, Ordinary	100 ..	89-91 xd

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100 ..	109¼-110¼
—— Deferred Stock	100 ..	107-109
—— 6 per cent. Cum. First Pref.	10 ..	13-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅝-5¾
—— 3½ per cent. Deb Stock, Red.	100 ..	99½-101¼
—— 4 per cent. Deb. Stock, Red.	100 ..	104-106
Oriental Telephone and Electric Company	1 ..	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1 ..	1¼-1½

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 19	1,625	1,848	- 222	- 943h	25½	20⅔	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 19	461	465	- 5	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 20	1,085	1,033	+ 52	- 524	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 21	323	742	- 19	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 19	1,135	861	+ 275	+ 705	24	24	,, 25	48,875	8,661,720	985,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 17	3,410	2,500	+ 910	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 19	2,342	1,606	+ 736	- 852	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 20	2,112	1,988	+ 124	—	40	38	March 31	95,765	20,205,196	2 161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 16	2,161	1,440	+ 721	—	16 82	16 82	,, 31	55,276	10,058,288	1 121,623	1 32	11 83	3,225	7·19
Bradford Corporation	,, 19	4,938†	4,951	- 13	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 20	1,409	1,386	+ 23	+ 773	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 18	5,124	5,029	+ 95	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 19	1,190	1,128	+ 62	—	10 60	10·60	March 3	—	—	—	—	—	—	
Burton Corporation	,, 20	537	374	+ 13	- 698	8¼	8¼	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,058	6·76
Cardiff Corporation	,, 12	2,707	2,172	+ 534	+ 605	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 19	223	201	+ 22	- 389	8·5	8·5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 19	5,202	5,420	- 218	- 917	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway.	,, 20	2,380	2,235	+ 145	- 127	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 10	341	358	- 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 17	572	541	+ 31	+ 763	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6 64	—	4·69
Darwen Corporation	,, 18	283	233	+ 47	+ 250	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 12	344	317	+ 27	—	4½	4½	,, 3	11,250	2,853,200	284,743	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 18	151	134	+ 20	— h	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·73	942	7·33
Dublin U. T., electric cars	,, 13	4,273	4,206	+ 67	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 18	1,287	1,170	+ 117											
Dundee City Tramways	,, 16	893	842	+ 51	—	22	22	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 19	898	748	+ 50	+ 1,870	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 19	15,013	14,110	+ 903	+ 8,908h	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 16	2,445	1,693	+ 752	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 19	1,727	1,470	+ 257	+ 517	35	35	,, 3.	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 19	2,213	2,186	+ 26	+ 616	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 16	114	145	- 31	- 501	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 16	223	297	- 73	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 19	5,954	5,983	- 19	—	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 13	12,226	10,907	+1,319	+ 7,616	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 20	1,705	1,641	+ 64	- 355h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 12	17,287	13,740	+3,547	+50,467	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 17	157	167	- 10	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 19	13,207	12,407	+ 810	—	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,293	6·99
Nelson Corporation	,, 19	153	134	+ 18	+ 284	—	2¾	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation.	,, 19	3,703	3,628	+ 75	+ 2,754	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 20	1 662	1,164	+ 497	+ 9,521	—	34	,, 25	65,553	13,466,245	1,501,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 19	3,150	2,506	- 644	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	336,547	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 3	440	645	- 205	—	9½	7⅔	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 21	4,419	3,926	+ 493	—	70⅔	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	July 22	343	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 20	4,847	4,579	+ 268	+ 4,769	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 16	1,161	1,086	+ 74	- 270	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	July 5	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	Aug. 18	1,129	697	+ 432	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 13	1,778	1,424	+ 304	+ 623	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 16	253	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D C.	,, 19	947	854	+ 93	+ 560	11·85	10·5	,, 31	38,768	7,412.881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	July 13	342	332	+ 10	+ 175	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	Aug. 17	2,250	1,152	+1,098	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 16	829	801	+ 27	—	—	7½	,, 31	—	—	—	—			

† And 98 mile of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Municipal Ownership.—Municipal enterprise has entered many fields of late years, but probably in no other place does it take a more diversified form than in Freiburg, Germany, which must rival Glasgow in this respect. Besides electric cars, lighting, and power, the local authorities deal in a theatre, restaurant, savings bank, pawnshop, farms, workmen's cottages, an undertaker's business, and sundry details. One is inclined to wonder what the inhabitants do.

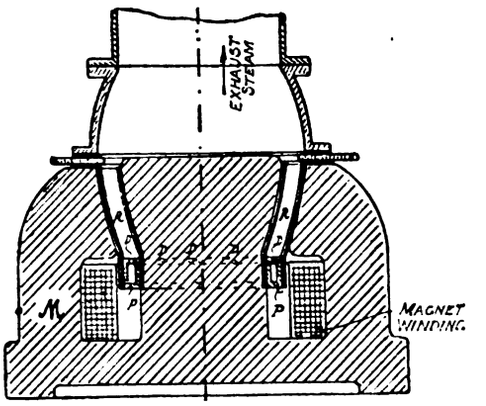
Telephony to the Continent.—Commencing to-day, the subscribers of the National Telephone Company will be enabled to use the Anglo-French and Anglo-Belgian telephone services on the same conditions as Post Office subscribers. It has been found necessary to limit the scope of operations in the first instance to the company's exchanges in London and the chief exchange in each provincial town where Post Office subscribers are at present admitted to the through service.

The South Wales Coalfield.—A detailed map on a large scale has been prepared by Mr. G. E. Gordon, mining engineer, of Swansea, showing the collieries, works, etc., in the South Wales coalfield. Besides giving full particulars under these heads, the map indicates the railways and stations, canals, and the class of coal obtained. There are also diagrams showing the average prices of the last decade and the annual output since 1860. The work, which is admirably executed, shows the various centres clearly, and should be of decided value to engineers for reference. Incidentally, the numerous dots illustrative of the mines and works exemplify what an extensive and, at the same time, compact area the South Wales Power Company have to work upon for the supply of energy for industrial purposes.

Trade Marks.—The new Trade Marks Act, which will come into operation on April 1, seems likely to place this branch of legislation on a more satisfactory footing. The following definition has been drafted with a view to giving a wider range in the selection of trade marks: "It shall mean a mark used or proposed to be used upon or in connection with goods for the purpose of indicating that they are the goods of the proprietor of such trade mark by virtue of manufacture, selection, certification, dealing with, or offering for sale." A company will now, for the first time, be allowed to register its name if represented in a special or particular manner, these words being substituted for "particular and distinctive manner" in the existing Act. An important provision is made in Section 62, which enables associations to register special trade marks to be used by the various members of such associations for the purpose of guaranteeing a standard or mode of manufacture of particular goods. The registration of associated trade marks is another useful provision, enabling an applicant to register the essential features of a label as separate trade marks. Section 41 enacts that registration shall after seven years be taken to be valid in all respects, unless obtained by fraud or calculated to deceive.

Electricity for Mining Marble.—One of the latest uses of electricity is for the mining of marble. This method has come much into favour in America, and it is estimated that in the State of Vermont alone the greater part of a million pounds has already been invested in electrical machinery and equipment for the quarries. While the marble industry was of moderate extent, steam derricks, drills, and locomotives answered the purpose, but the business rapidly assumed such dimensions as to render a change of method necessary, and electric power was introduced. This was found to be particularly valuable for operating large cranes, greater efficiency and economy resulting. It has only been within the last year or two that electric channelling machines have been used, but they have given so much satisfaction that their use is steadily increasing. The electrically-operated machine cuts on either side of it a channel from 4ft. to 10ft. deep and less than 2in. wide, whereas the steam type of channelling machine cut but one channel at a time. A single electric motor mounted on the machine and travelling with it operates the cutting implements, and also drives the traction gear of the machine. In addition, electrically-operated chisels, sand saws, buffers, and other devices are employed.

A New Unipolar Dynamo.—A German patent (No. 156,029) has been issued to Mr. A. Beringer for a unipolar dynamo of the type indicated in the accompanying diagram. An annular channel, R, with insulation



sides and situated between the circular poles of a magnet, M, contains a conducting fluid which is set in rapid motion by the direct impact of steam through a set of nozzles. In contact with the top and bottom of this rotating fluid are two electrodes, which serve to deliver the current generated into the outer circuit.

Submarine Signalling.—A further trial of submarine signalling by the Trinity House was made last week between the Trinity yacht "Irene" and the North Goodwin lightship. A reference to the previous trial appeared in our issue of Aug. 18. The "Irene" steamed out to the lightship so that the signal bell might be heard at close quarters and then retired, manœuvring at the same time in order to bring the lightship first on the one side and then on the other to test the hearing of the signal at various distances and positions. The bell could be distinctly heard over a distance of more than four miles. A notable phenomenon was observed on this occasion. At a distance of over two miles the submarine bell could be distinctly heard without the aid of the transmitters and the telephone by merely placing the ear against the wood casing at the side of the ship below or to one of the stanchions on deck. Altogether, the proceedings were regarded as having fully maintained the claim of the system to be a practical aid to navigation, and the representatives of various cross-Channel services expressed a favourable opinion of its possibilities. Arrangements have just been made by the managers of the White Star Line to have the apparatus fitted in the "Oceanic" and "Baltic," and the Holland-America Line have also announced their intention of adopting it.

Electrical Units and Standards.—As stated last week, the Elektrotechnische Reichsanstalt has called a conference, preparatory to the meeting of the International Commission of Electrical Units and Standards. This course is to be highly commended, and is in accord with the recommendations of the St. Louis International Electrical Congress, which advocated that the differences

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in the laws of various countries in reference to electrical units should be considered by an international commission. This conference is expected to be held at the end of next month, and invitations have been sent to the Governments of Great Britain, the United States, France, Austro-Hungary, and Belgium. The object to be aimed at by such a body is that the units of the different countries should harmonise within commercial limits rather than that ideal theoretical definitions should be laid down. The present United States volt, for example, is about ·1 per cent. less than that which is standard in some countries, and although this is a negligible quantity in many operations it becomes appreciable when dealing with, for instance, incandescent lamps. With the modern attainments of electrical science it should be possible to fix an international unit to within ·04 or even ·02 per cent. The movement is an eminently desirable one, and we trust that it will prove successful.

East London College.—We have received a copy of the prospectus of this foundation for the Michaelmas term, which commences on the 18th inst. for day pupils and the 25th inst. for evening students. In addition to affording a good general education there are courses in science and technical subjects, including electrical engineering. To these the governors have decided to add an arts section, so that the college may more completely fulfil its function as the University College for East London. In regard to the general scheme of education, a preparatory class, designed to meet the requirement of the London matriculation examination, has been formed to meet the needs of boys between the ages of 15 and 16 who have passed through a course of instruction in a secondary day school, but are not sufficiently advanced to take any of the prescribed college courses. Boys will not be retained in this class after 17 years of age. In July next the Drapers' Company will award four scholarships tenable at the college for boys belonging to certain foundation schools, nine scholarships (six for males and three for females between 16 and 19 years of age) to be judged on the result of the London inter-collegiate scholarship science examination on Oct. 1, 1906, and six scholarships (three for males and three for females) to be judged on the result of the corresponding art examination. The general technological scheme of the foundation shows an excellent standard, and promises to be of great assistance to students in the area covered by the college. The electrical engineering department comprises an excellent set of laboratories and workshops, and students are taken through a three-year course.

Colonisation.—The address of the Rev. W. Cunningham, president of the Economic Science and Statistics Section, to that branch of the British Association dealt with "Unconscious Assumptions in Economics." After a general survey of economic history and conditions, the president discussed the possibilities of mining in the development of countries, and gave some excellent reasons for dissenting from the view that mining could never form a stable foundation for the building up of a community, although this was the opinion of such eminent authorities as Bacon and Adam Smith. He remarked that it would be wise to discriminate a little before adopting this conclusion, and to examine the condition of, for example, different parts of Spanish America separately. The richest mines of all—those of Peru—were situated on the arid slopes of the Andes, where cultivation was impossible, and there were insuperable obstacles to the planting of well-ordered and prosperous communities; but very different results were achieved in Mexico. These workings occurred on a plateau where cultivation and settlement were possible, and the wealth which was obtained by mining reacted on the prosperity both of agriculture and manufactures. Extractive industry served to give a stimulus to that varied life, partly urban and partly rural, which is necessary for a community that hopes to take a real and independent place in the civilised activities of the world. It was foolish to jump to the conclusion either that mining gives a feverish and unhealthy stimulus, or that the Spanish system of regulation was incurably bad; we ought to distinguish carefully, and to try to learn from Spanish experience, both in South and in Central America, what were the conditions under which mining for the precious metals could be pursued so as to be not merely of temporary but of permanent advantage to the welfare of the community.

Electricity versus Steam.—In the course of his address to the Richmond (U.S.A.) Railroad Club, Mr. A. H. Armstrong, of the General Electric Company, gave some interesting figures relative to steam and electricity as the motive power for railroads. The electric locomotives which the General Electric Company are constructing for the New York Central line to Mothaven are not designed to effect any considerable increase in the present schedule for steam trains, except that acceleration to neutralise the stoppage for changing from steam to electricity at the section is to be provided for. It is found, however, that the electric locomotives will develop at the rim of the drivers some 3,000 h.p., or more than double the indicated horse-power of the largest steam locomotive on the line. It is also calculated that the weight of the electric locomotive would not exceed 200,000lb., against 250,000lb. for the typical steam locomotive. Mr. Armstrong gave a specific instance of the delusive tests sometimes advanced by steam railway engineers. On a railroad in a Western State there is a 20-mile section where the grade causes the cost of fuel to aggregate about 70 per cent. of the entire operating expenses, besides which the locomotive repairs represent over £1,000 a year, or a third of the cost of the locomotive. The figure for fuel given by the railroad engineer to an investigating electrical engineer was 10 per cent. only of the entire operating expenses, this amount representing not the cost on the actual section but the average cost on the whole system. After further investigation the electrical engineer found that, by utilising the available water power for electrification of the section, a saving could be effected sufficient to pay 15 per cent. on the investment, even with a service of only six trains a day. Further examples were given by Mr. Armstrong to show that, apart from water power, there were many lines where electricity could be used with advantage.

Patents.—We referred in our issue of March 31 to a memorial subscribed to by a number of eminent engineering and scientific signatories, and also by some 40 patent agents, urging a modification of No. 10 of the patent regulations which came into force on Jan. 1. The petitioners expressed the opinion that the Act of 1902 was designed to afford, both to the inventor and the public, the benefit of an official examination as to novelty without incurring the serious risk of inflicting injury upon the inventor by refusing a patent for alleged want of novelty, or by making public adverse official opinions. As framed, however, Rule 10 appears to be based upon the assumption that the Patent Office is charged with the function of publishing an official opinion to the world by placing an endorsement upon the specification whenever it appears to the examiner or controller that no patentable invention is disclosed, instead of merely requiring the applicant to mention any prior specification, a knowledge of which might be deemed necessary to enable the public to form an accurate opinion

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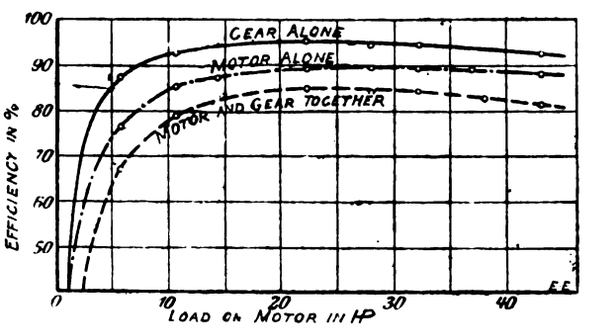
as to the validity of the patent. As we remarked in our previous reference to the subject, the oppressiveness of the regulation is accentuated by the fact that an examiner, or even the comptroller, while acting with the best possible intentions, might easily err in construing an invention as an anticipation when experts have disagreed upon similar points. It may be mentioned that a counter memorial was presented by 76 registered patent agents. The Board of Trade, in communicating their decision, intimate that, after consultation with the law officers, they see no occasion to alter the rule. The stringency of the regulation may conceivably be to the public interest in some cases, but its general tendency, we should say, is in the opposite direction. A well-established holder of a patent could hold it over the heads of others, and virtually coerce them into selling him their grants on terms favourable to him, with the alternative of paying him a royalty. Taken altogether, it is to be hoped that additional experience of the operation of this rule will induce the authorities to reconsider their decision.

Engineering in South Africa.—The address to the Engineering Section of the British Association by Sir Colin Scott Moncrieff, the president, dealt chiefly with the subject of irrigation. Tracing the methods from their primitive origin to modern practice, he dealt with pumps, windmills and artesian wells, but we are rather disappointed to find that he made no allusion to electricity, which has been employed for irrigation in certain parts of the world, including California, one of the places dealt with by Sir Colin. Pumps worked by steam power are extensively used by cotton growers on the banks of the Nile. Where wind can be relied on, the windmill is a very useful and cheap means of raising water. But everything depends on the force and reliability of the wind. In the dry Western States of America, wind power is largely used for pumping. Wind is of little use if its velocity is less than six miles an hour, but it can be utilised to a considerable extent in the regions just mentioned, where the average velocity is eight miles an hour. As, however, windmills should discharge their water into a tank, irrigation cannot go on without cessation day and night, and the mill may be pumping its best when irrigation is least needed. In America it is found that pumping by wind power costs about two-thirds that of steam power. With a reservoir, five to fifteen acres may be kept irrigated by a windmill; without a reservoir, three acres is as much as can be depended upon. Windmills attached to wells from 30ft. to 150ft. deep cost from £30 to £70. The windmill has done useful work in this field, but its area is limited, and much less than that promised by electricity, which may be expected to come in for more attention in the future. Speaking of artesian wells, Sir Colin said that so far they had not proved of great value for irrigation. In the State of California there are reported to be 8,097 artesian wells, of a mean depth of 210ft., discharge ·12 cubic feet per second, the cost on an average being £50. Thirteen acres per well is accounted a large output. The speaker remarked that where water had to be raised on to the field there was an outlay of human or mechanical power that might be saved if the water could be brought to flow over the fields by gravitation. Where this is not possible electrical transmission of energy for pumping purposes may reclaim many districts.

Worm-Geared Traction Motors.—The Maschinen Fabrik Oerlikon has recently repeated the experiment of employing worm gear with traction motors. Earlier experiments in this direction proved unsatisfactory, principally because the worm gearing available at that time was not sufficiently well made to give a high efficiency, and also because, with the rigid connection between motor and gear which was employed, the shocks and consequent wear proved excessive. These difficulties have been largely overcome in the recent construction, and an experimental car containing two 20-h.p., 1,200-revolution, worm-geared motors gave very satisfactory results. The motors only weighed 675lb., in place of 1,460lb. each, which would have been the case if ordinary single-reduction spur gear and 500-revolution motors had been used. The gear ratio was 12 : 1, the worm being of hard steel, with a triple thread having a pitch diameter of 3in. and a pitch of ·45in., whilst the worm wheel had a cast-iron hub with phosphor-bronze toothed rim attached, a pitch diameter of 18·3in. and 36 teeth. The motors were rigidly fixed to the car frame in accessible positions, and were connected to the worms through double flexible couplings, which allowed the necessary freedom of motion for the car springs. The worms and worm wheels are arranged on the outside of the car wheels, and run completely enclosed in oil baths. The end thrust is taken up on ball bearings. The gear was found to have an efficiency exceeding 90 per cent. for all loads between one-fifth load and full load, as is shown by the curves in the



accompanying diagram, which we reproduce from the *Elektrotechnische Zeitschrift*. The wear and the cost of upkeep proved to be less than with the ordinary spur gear, and the running was practically noiseless and free from shocks.

New Publications.—The *Proceedings* of the American Institute of Electrical Engineers, dated August, contain the discussions on "Measuring Instruments," "Time-Limit Relays," and "Duplication of Electrical Apparatus to Secure Reliability of Service." There is also a paper by Mr. C. E. Waddell, entitled "The Preservation of the Southern Appalachian Streams: A Forest Problem."—The *Bulletin* of the Imperial Institute contains reports upon a number of commercial matters, including rocks and minerals from the British Central Africa Protectorate, rubber in the East Africa Protectorate and Madras, the occurrences and uses of minerals containing thorium, and the utilisation of peat.—Messrs. P. S. King and Son have issued at the price of 1s. a report embodying "A Comparison of the Brassworkers of Berlin and of Birmingham,' compiled by Messrs. R. H. Best, W. J. Davis, and C. Perks. The object of the authors' investigations was to ascertain whether the brassworkers of Berlin "have succeeded in attaining a more desirable physical and industrial life than that led by the brassworkers of Birmingham." Their lengthy tour of inspection has highly impressed the authors with the sanitary condition of the German capital, and there are chapters dealing specifically with "The Education of the Child of the Brassworker"; "The Temperance Question"; "Trade Conditions"; "National Compulsory Insurance: Sickness, Old Age, and Infirmity"; and "Institutions." The authors, without pronouncing a positive decision, obviously consider that Berlin does not suffer by the comparison. The publication affords an interesting study of the sociological and

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economic conditions prevailing in one of the most important metal industries.—In response to numerous applications for copies of his paper on "Lightning Conductors," read before the Birmingham Electric Club and other institutions, Mr. W. H. Whitehouse, of 37A, Waterloo-street, Birmingham, has had an edition of the paper printed. It contains a highly interesting review of the evolution of the lightning conductor upon the usually accepted lines, leaving it for Sir Oliver Lodge and the Lightning Research Committee to introduce new phases.—We have received from Messrs. Archibald Constable and Co. volumes 2 and 3 (price 6s. each) of "National Engineering and Trade Lectures," edited by Mr. B. H. Morgan. In No. 2 Mr. P. R. Björling deals with "British Progress in Pumps and Pumping Engines," while in volume 3 Mr. C. E. Brackenbury treats of "British Progress in Gasworks' Plant and Machinery."

Iron and Steel Institute—The arrangements have been practically completed for the Sheffield meeting, which is to be held on the 26th, 27th, 28th, and 29th inst. The following is a revised list of the papers that have been offered: "The Wear of Steel Rails on Bridges," by Mr. T. Andrews, F.R.S.; "The Metallurgical Department of Sheffield University," by Prof. J. O. Arnold; "The Thermal Transformation of Carbon Steels," by Prof. J. O. Arnold and Mr. A. McWilliam: "The Nature of Troostite," by Dr. Carl Benedicks; "The Occurrence of Copper, Cobalt, and Nickel in American Pig Irons," by Prof. E. D. Campbell; "The Transformations of Nickel Steels," by M. L. Dumas; "Steel for Motorcar Construction, and on Vanadium Steels," by M. L. Guillet; "The Presence of Greenish-Coloured Markings in the Fractured Surface of Test-Pieces," by Capt. H. G. Howorth, R.A.; "Overheated Steel," by Messrs. A. W. Richards and J. E. Stead, F.R.S.; "Segregation in Steel Ingots," by Mr. B. Talbot; "A Manipulator for Steel Bars," by Mr. Douglas Upton; and "The Influence of Carbon on Nickel and Iron," by Mr. G. B. Waterhouse. Members who intend to take part in the discussion will, on notifying such intention to the secretary (Mr. Bennett H. Brough), have copies of the papers forwarded to them a week in advance, as far as that may be possible. The Housing Committee of the Sheffield Reception Committee are making arrangements for the accommodation of members, but it has been found necessary to limit the invitations to the fair sex, and hospitality cannot therefore be extended to more than one lady per member. The chairman of the executive committee is Colonel H. Hughes, C.M.G., and Mr. F. Huntsman is hon. treasurer; Mr. J. Rossiter Hoyle, vice-chairman; and Prof. J. O. Arnold, Mr. A. McWilliam, and Mr. John Wortley, hon. secretaries. The hon. secretaries' office for the registration of addresses, issue of badges of membership, programmes, invitation cards, etc., will be in the Cutlers' Hall, Sheffield, where arrangements will be made for the dispatch of letters and telegrams (telegraphic address: Irosamente, Sheffield), and for the use of the telephone. To the list of firms who will be pleased to receive members desiring to see their works the name of Messrs. Davy Bros., Limited, engineers, Sheffield, should be added. By the courtesy of the committees of the Sheffield Club, of the Sheffield Conservative and Unionist Club, and of the Sheffield Reform Club, the privileges of honorary membership will be extended to members during the meeting. Those desirous of availing themselves of this kindness are requested to intimate to the secretary of the institute to which of the clubs they would prefer to be elected. By the courtesy of the Great Western, the Midland, the Caledonian, the London and North-Western, the Great Northern, the Lancashire and Yorkshire, the Great Central, and other railway companies, return tickets to Sheffield at a single fare and a quarter, available from Sept. 23 to Sept. 30, will be issued from London and provincial towns on production of a voucher signed by the secretary, which will be forwarded on application.

Mathematics in Science. — The address delivered by Prof. A. R Forsyth, president of the section, to the mathematical and physical branch of the British Association comprised an extremely interesting review of the history of mathematics in relation to science. He alluded to the work of Bacon, Descartes, Copernicus, Galileo, Halley, Leibnitz, Kepler, Newton, Stokes, Maxwell, and others, and after tracing the development of astronomical science, he referred to the progress of physics, which, alike on the mathematical and the experimental side, had been no less remarkable or unrestricted. The elaborate and occasionally fantastic theories of the eighteenth century in such subjects as light, heat, even as to matter itself, were rejected in favour of simpler and more comprehensive theories. There was one stage when it seemed as if the mathematical physicists were gradually overtaking the experimental physicists; but the discoveries in electricity begun by Faraday left the mathematicians far behind. Much had been done towards the old duty, ever insistent, of explaining new phenomena, and the names of Maxwell, Weber, Neumann, and Hertz need only to be mentioned in order to suggest the progress that has been made in one subject alone. "We need not hesitate," he proceeded, "to let our thoughts couple, with the great physicists of the century, the leaders of that brilliant band of workers upon the properties of matter who carry us on from wonder to wonder with the passage of each successive year." Further, it had been an age when technical applications have marched at a marvellous pace. So great had been their growth that we were apt to forget their comparative youth; yet it was only the middle of the century which saw the awakening from what now might be regarded as the dark ages. Nor was the field of possible application nearing exhaustion: on the contrary, it seemed to be increasing by reason of new discoveries in pure science that yet will find some beneficent outcome in practice. Invisible rays and wireless telegraphy might be cited as instances that were occupying present activities, not to speak of radium, the unfolding of whose future was watched by eager minds. One gap in this subject struck the professor. There were great histories of mathematics and great histories of astronomy, but he could find no history of physics on the grand scale. Some serviceable manuals there are, as well as monographs on particular topics; what seemed to him to be lacking was some comprehensive and comparative survey of the whole range. The history of any of the natural sciences, like the history of human activity, is not merely an encyclopædic record of past facts; it reveals both the spirit and the wealth which the past has bequeathed to the present, and which, in due course, the present will influence before transmission to the future. Perhaps all our physicists were too busy to spare the labour needed for the production of a comprehensive history, yet he could not help thinking that such a contribution to the subject would be of great value, not to physicists alone. Dealing with the inter-relation between mathematical physics and pure mathematics, the professor stated that they had given much to each other in the past, and would do so in the future, in doing which they would take harmonised action in furthering the progress of knowledge.

Artom's Method of Wireless Signals.—Acting on a suggestion, made by Prof. Righi in the course of a

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mathematical investigation, that two rectangular sets of electrical waves of the same amplitude, frequency, and with a phase displacement of one-quarter wave-length, would set up circularly-polarised vibrations, Prof. Artom decided to attempt the practical application of such an arrangement to wireless telegraphy purposes. If the theoretical requirements are completely fulfilled, the circularly-polarised waves will be set up in a given direction, this direction being at right angles to the centre of the plane in which the oscillations occur. The method employed for producing the two fundamental sets of waves is the same as that commonly employed for producing rotating magnetic fields. Thus, in Fig. 1, by suitably proportioning the self-inductions, resistances, and capacity, the currents in the two branches, M N and

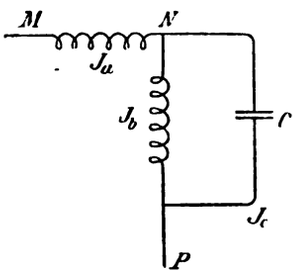

FIG. 1.

N P, can be made equal ($J_a = J_b$) but different in phase by $\frac{\pi}{2}$. If the voltage difference between N and P be V, and V is represented by the line O V in Fig. 2, the current J_c will be represented by the line O J_c at right angles to O V and equal to $2\pi n$ C V. If r_2 is the ohmic resistance and L_2 the self-induction of N P, the value of J_b is $\frac{V}{\sqrt{r_2^2 + 4\pi^2 n^2 L_2^2}}$. J_b will have a phase angle relatively to O V of such a value that the tangent of the angle $= \frac{2\pi n L_2}{r_2}$. When $2\pi n L_2$ is made equal to r_2 this angle is 45deg., and, as is seen in Fig. 2, the current J_a, which is the resultant of J_b and J_c, is equal to J_b, and is at an angle of 90deg. to the latter, provided that J_c is given the value $2 J_b \cos 45\text{deg}$. This value is attained when $4\pi^2 n^2 L_2 C = 1$—*i e*, when the circuits are in resonance. When these conditions are fulfilled, the currents J_a and J_b will produce a rotating field. Prof. Artom arranged the three ends,

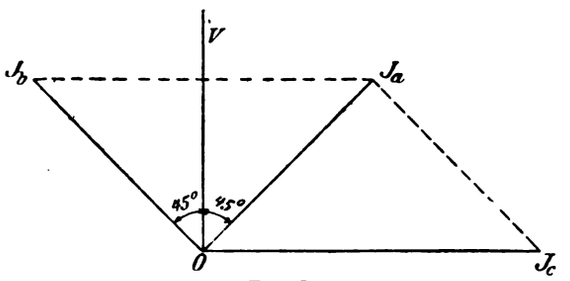

FIG. 2.

M, N, and P, of the circuit at the corner of a right-angle triangle with two equal sides (Fig. 3), and by selecting the proper values for the self-induction, S, and the capacity, C, obtained equal discharges between N and P and between N and M, with a phase difference of 90deg. The effect of the magnetic rotating field was practically dissipated by the excessive hysteresis losses which occurred at the high frequencies employed, but the electrical rotating field was readily observed. Thus, light glass shades supported on fine glass points were set in rotation when placed six or seven inches from the oscillator (supplied with 80 volts 5 amperes). When the connections were changed so that M N in place of P N formed part of the resonant circuit, the rotation of the glass shade was reversed. In order to avoid the disturbing effects of leakage at the spark gap, air wires were employed later. These air wires or antennæ consisted of single wires, but better still are systems of wires, of exactly equal length, connected direct to the spheres M and P, and set at right angles to one another, as in Fig. 4. In this way two equal sets of waves are sent out with a phase displacement of one-quarter wave-length, combining to produce circularly-polarised electromagnetic wires advancing along an axis set

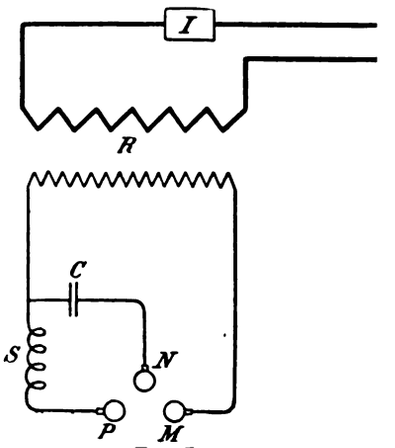

FIG. 3.

at the centre of the cross-point of the wires and at right angles to their plane. In place of a phase displacement of $\frac{\pi}{2}$, it is possible to obtain a rotating field and circularly-polarised waves with any other phase relation ϕ between two sets of waves of equal amplitude, provided that the antennæ are crossed at an angle of $(\pi - \phi)$. In conclusion, Prof. Artom gives particulars of some interesting practical tests carried out in the years 1903-4 in connection with the Italian navy. When signalling between S. Vito and S. Bartolomeo, in the Gulf of Spezzia, over a distance of 2½ miles, the stations at Varignano and Palmaria, lying a few miles out of the direct line, were quite unaffected. Signalling between Rome and Anzio (38 miles) clear records were obtained so

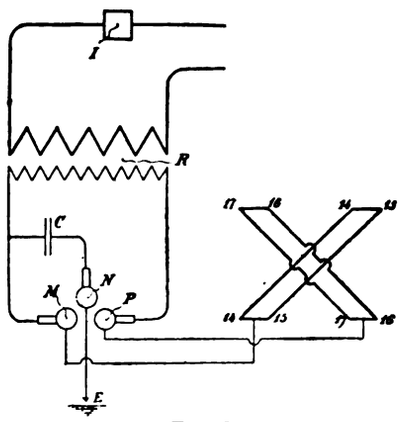

FIG. 4.

long as the axis was correctly directed, but ceased as soon as the radiator was directed on Sardinia. When signalling from Rome over 75 miles to the island of Ponza, the energy required to transmit readable signals could be trebled without making it possible to obtain records on the island of Maddalena (to the north of Sardinia), whilst when signalling between Rome and Maddalena (165 miles) no signals could be obtained at Ponza. When sufficient energy for 180 miles in the direction Rome-Maddalena was applied, signals could only be obtained for a distance of 60 miles in the direction Rome-Ponza. Shorter antennæ were also found sufficient in these tests. For the above 165-mile stretch, for instance, wires only 100ft. high were employed.

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THE FIFE ELECTRIC POWER COMPANY.

The pioneering station of the above company was formally opened on the 16th inst., and we gave a brief description of the ceremony in our issue for Aug. 18. Through the courtesy of the consulting engineers, Messrs. Bramwell and Harris, and the chief contractors, Messrs. Bruce Peebles and Co., we are now able to lay before our readers more particulars of the work which has been done towards the development of power supply in the county of Fife. It will be remembered that the Fife Power Company's Bill was passed during the parliamentary session of 1903, the company being authorised to supply power to individual consumers outside the area of supply of existing authorised distributors, and also to supply in bulk to authorised distributors within the power company's area. This area includes the whole of the county of Fife, certainly the most important industrial area in the East of Scotland, the 504 square miles being studded with collieries, textile mills brick and lime fields, quarries, and engineering and iron works. These industries are, moreover, so situated as to receive the utmost benefit from an electric supply company operating on modern principles, for they are for the most part scattered rather than grouped closely round any one centre, a condition pointing clearly to high-tension transmission. Another great outlet which the company will no doubt find, is supply to local authorities mainly for lighting purposes. A glance at a map will substantiate this, for it will be seen that in the whole area there are at present but two towns—viz., Kirkcaldy and St. Andrews—which have their own generating stations, the former having both lighting and tramways, and the latter lighting only. In view of the great number of towns of small medium size in the county, a large demand may certainly be looked for from this source.

In the scheme as presented to Parliament the sites of five generating stations were given. Up to the present, however, the work on these sites has not been commenced, and the station opened near Dumfermline is really a pioneer station to meet the demand in the surrounding neighbourhood. This is indicated by the block plan of the site (Fig. 1),

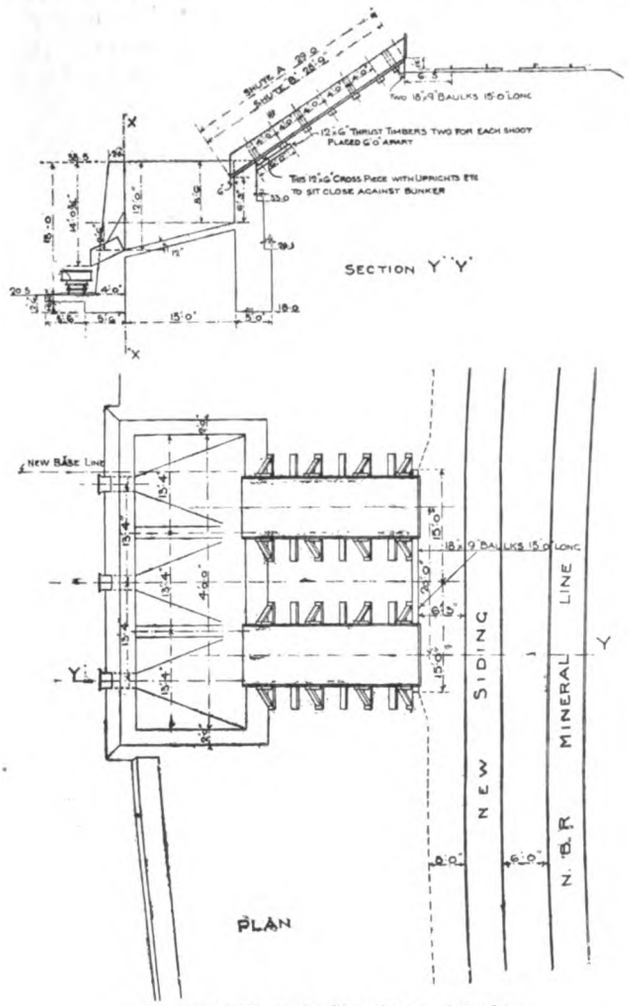

FIG. 2.—Details of the Coal Shoot and Bunkers.

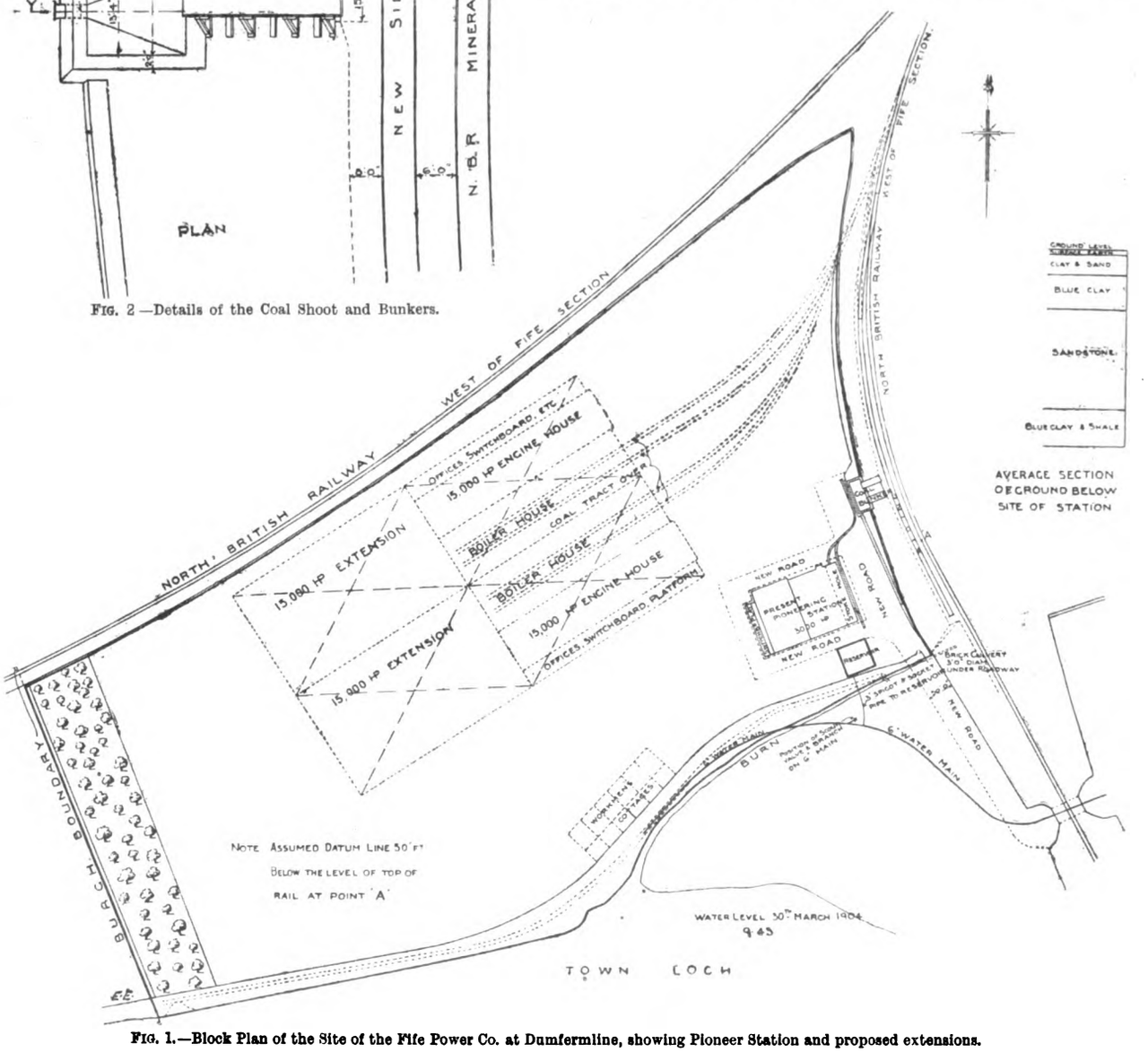

FIG. 1.—Block Plan of the Site of the Fife Power Co. at Dumfermline, showing Pioneer Station and proposed extensions.

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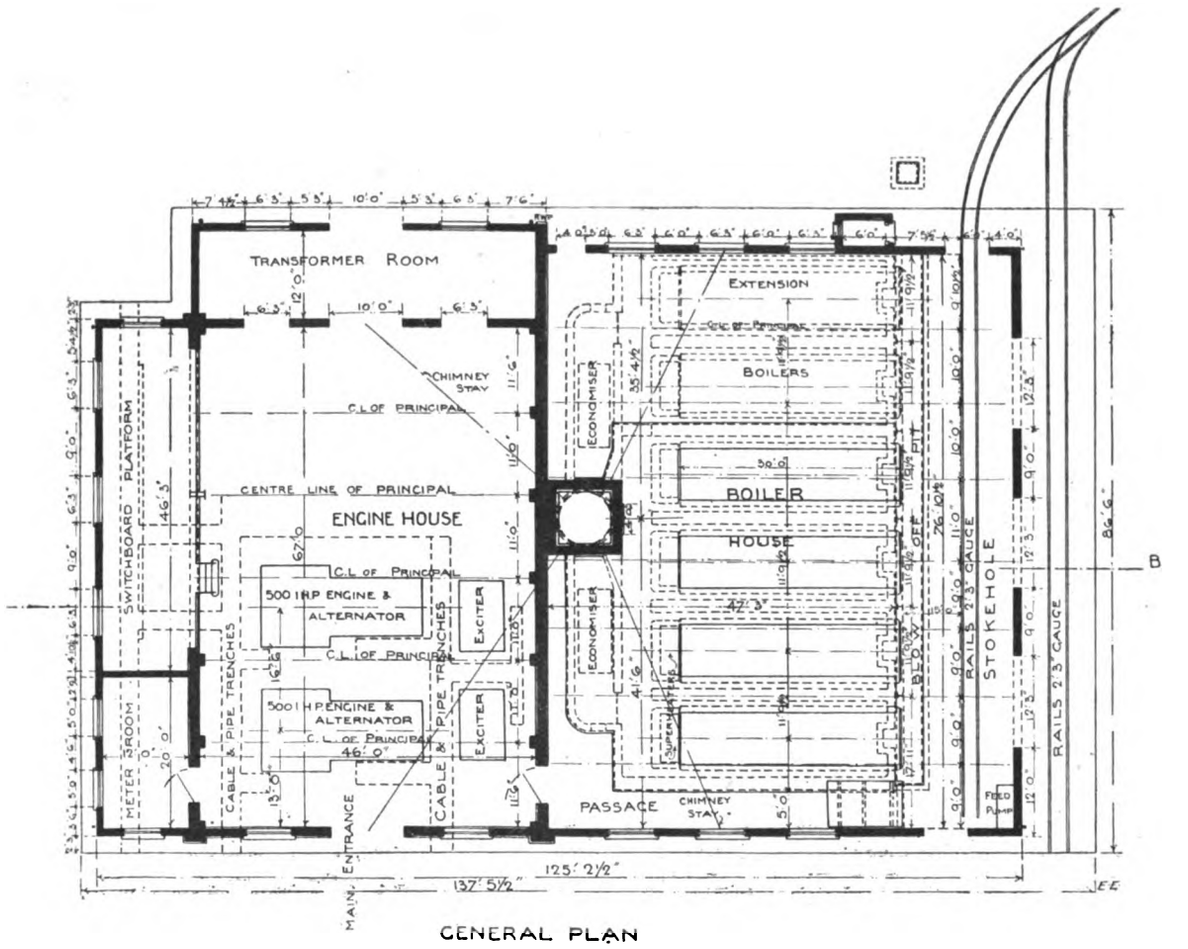
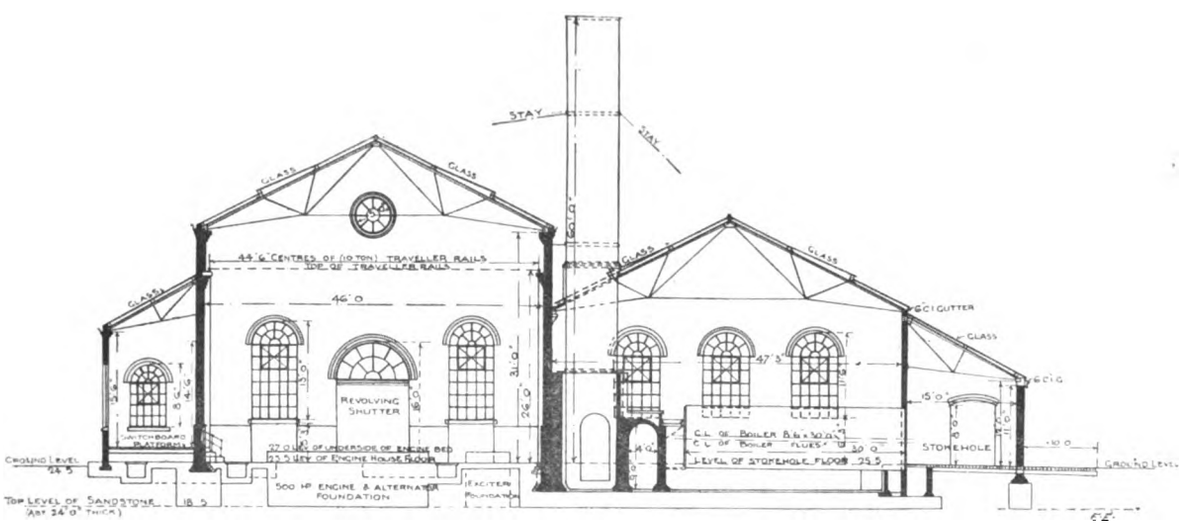
which shows that after the present buildings have been filled with machinery a 30,000-h.p. station will be equipped near by. The capacity of the site would not then be exhausted, as there is room for a plant of even double the above capacity. The large units which are now possible will enable an extremely economical station to be erected, as the coal and water facilities of the site are excellent. At present the coal is not taken directly into the boiler-room, but is delivered from the railway into a coal bunker, from which small trucks carry the coal into the stokehole. The details of this coal bunker can be seen in Fig. 2. The works adjoin a branch of the North British Railway, which runs along the high embankment seen to the right of the plan (Fig. 1). The town loch, which is close to the works, is looked upon as likely to afford a supply of condensing water for the large station when erected.

This power station erected at Townhill, near Dunfermline, has been built and equipped complete by Messrs. Bruce Peebles and Co, of Edinburgh, to the plans and under the supervision of Messrs. Bramwell and Harris, the consulting engineers of the company. The general arrangement of the same can be seen from Figs. 3, 4, and 5, which give respectively the plan of the station, a sectional elevation of the buildings, and a section to show the arrangement of the plant. The boiler-house is at present equipped with four large Lancashire boilers, each capable of evaporating 8,500lb. of water per hour, fitted with superheaters. Each boiler is 30ft. long over the end plates, and has an inside diameter of shell of 8ft. 6in. The working pressure is 160lb. per square inch. Two fire flues are fitted as usual, the vertical centre lines of these flues being placed 4ft. 1½in. apart, and the horizontal line being placed 5½in. below the centre of the boiler. The external diameter of the fire flue is 3ft. 7¼in. except for the two last rings at the back; the inner one of these rings is conical, diminishing from 3ft. 7¼in. at its front end to 3ft. 1¼in. at its back end, where it joins the last ring, which is also 3ft. 1¼in. diameter in each flue. Towards the back there are placed six



GENERAL PLAN



SECTION ON LINE A B

FIGS. 3 AND 4.—Plan and Sectional Elevation of the Fife Power Station.

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Galloway tubes at angles of 60deg. alternately on each side of the vertical centre line. Each boiler is provided with the customary valves, pressure and water gauges, blow-off cock, etc. The superheater is of sufficient capacity to impart 60deg. of superheat to the steam produced by the boiler when evaporating the full 8,500lb. weight of water per hour.

The pipework was sub-contracted by Messrs. Bruce Peebles to the Sir Hiram Maxim Engineering Company, and is of standard construction. The steam-main is on the ring principle, and is constructed of welded solid-drawn steel.

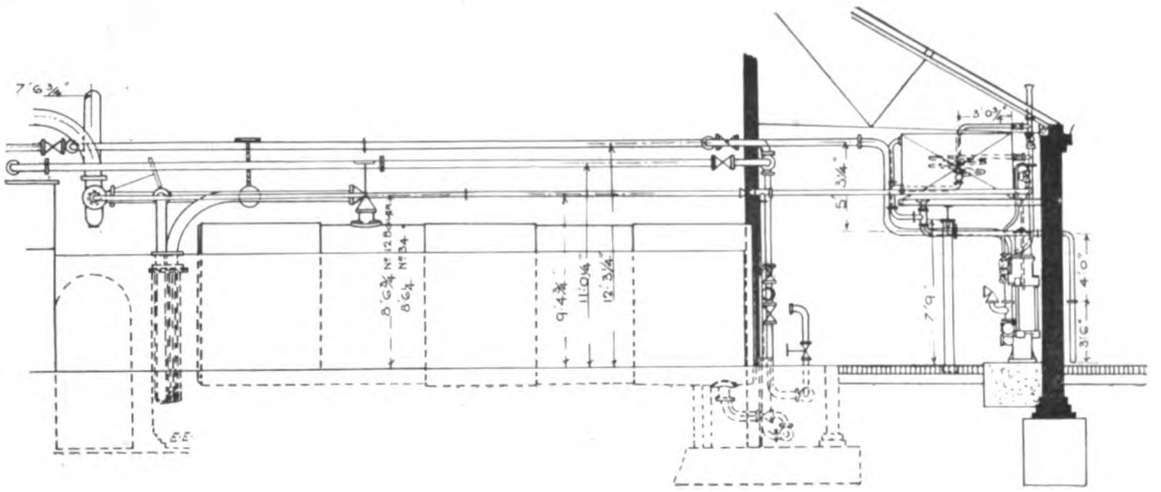

FIG. 5.—Section of the Boiler House, showing Pipe Connections.

A 7in. pipe is taken from each boiler stop valve to the superheater with a by-pass, and this is conducted into the main heater in the boiler-house. This heater has to cross over pipes to a smaller heater in the engine-house, steam separators being provided at the point where the cross-over points connect the engine-house main; the steam is taken from the upper side of this main direct to the separators on the engines. The exhaust of the four engines are connected to the main exhaust pipe of riveted steel 20in. in diameter, which is carried up outside the engine-house and terminates at the exhaust head. Condensing arrangements are not at present installed. The water supply is drawn from an overhead feed tank, which is fed by a Peebles motor-driven pump from a reservoir outside the station, shown in the exterior view. The water can be delivered from the overhead feed tank either direct to the boiler or through the economiser. The blow-off and feed pipes are carried along a trench in front of the boilers as usual. The boilers are also fitted with ejectors, which act as a stand-by feed. All high-pressure valves are of Messrs. Hopkinson's make.

As will be seen from the plans and from the photograph (Fig. 6), a tall chimney has not been built for the present station. Instead of this a low steel stack is used, and induced-draught apparatus is relied on to give the necessary draught. It is claimed that by this system the steaming capacity of the boilers is increased considerably above normal working capacity without damaging the boilers. Moreover, that the cheapest kind of fuel can be thoroughly burned, thus practically abolishing the smoke nuisance. The draught being mechanically produced is independent of any atmospheric conditions, and the system is more elastic in operation than natural chimney draught, which enables the fireman to regulate the supply of steam as desired.

The plant consists of Sturtevant steel plate exhausting fan, provided with patent water-jacketed bearings by means of which the fan is kept in perfect working order when handling gases at temperatures varying from 150deg. to 80deg. F. The fan is connected to the base of the iron stack by a mild-steel connection, and the outlet from the fan is connected to the stack, which is outside the roof of the boiler-house. Regulating dampers are fixed to these connections, so that, if desired, the boilers can also be worked with natural draught. The motor driving the fan is provided with patent controller fitted with automatic no-load and overload releases, and capable of regulating the speed of the fan from 350 r.p.m. to 420 r.p.m. as desired. The fan being connected to the extreme end of boiler flues, close to the base of chimney, when in operation creates a partial vacuum in the flues, and thus draws the air through the fires in the boilers, the desired vacuum being maintained according to the speed of the fan. The economiser, which, in connection with all the other auxiliary apparatus, is driven by a Peebles continuous-current motor driven from the exciter sets, is of standard construction, consisting of 144 tubes arranged in two groups of 72 tubes each, six tubes wide. The tubes are 9ft. long and 4in. internal diameter, being forced into the top and bottom

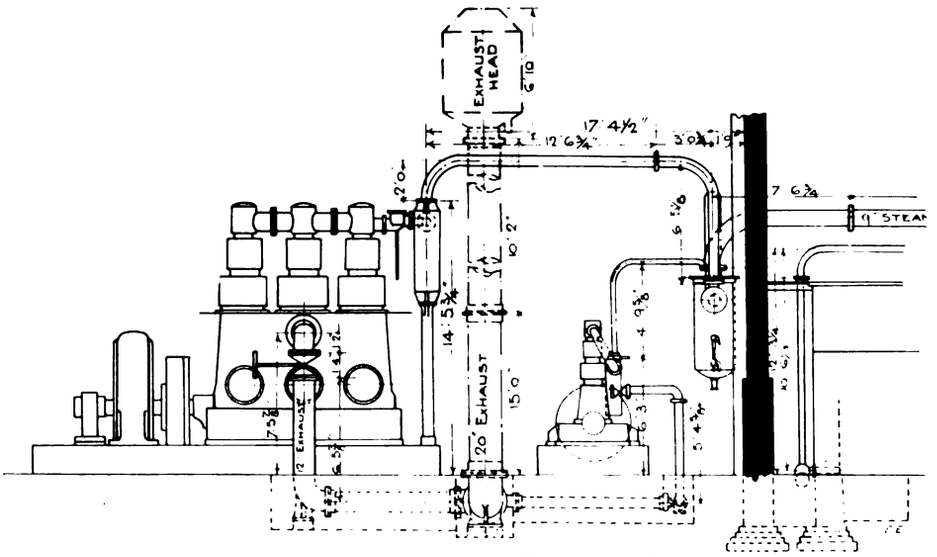

FIG 5A.—Section of the Engine Room, showing Pipework.

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boxes by hydraulic pressure, the joints being metal to metal. Self-acting scrapers with overlapping joints and chilled edges are provided. The economiser works at an ordinary pressure of 150lb. per square inch, and it is, moreover, so arranged as to deal in a satisfactory manner with cold feed water—*i.e.*, water at about 50deg. F., and when supplied with water at this temperature there is no sweating of the tubes.

The engine-room equipment is shown in Figs. 7 and 8. As will be seen from these that all the engines are of the Willans type, manufactured at Messrs. Willans and Robinson's Rugby works. The alternator engines (Fig. 7) are of the triple-expansion three-crank type, which give such excellent results as regards parallel running. The exciter engines (Fig. 8) are of the two-crank compound type. To each of the two main engines is coupled a 400-kw. Bruce Peebles two-phase alternator running at 50 periods and 3,000 volts. This output is given on a basis of the temperature rise after six hours' full-load run not exceeding 60deg. F. As regards regulation, the

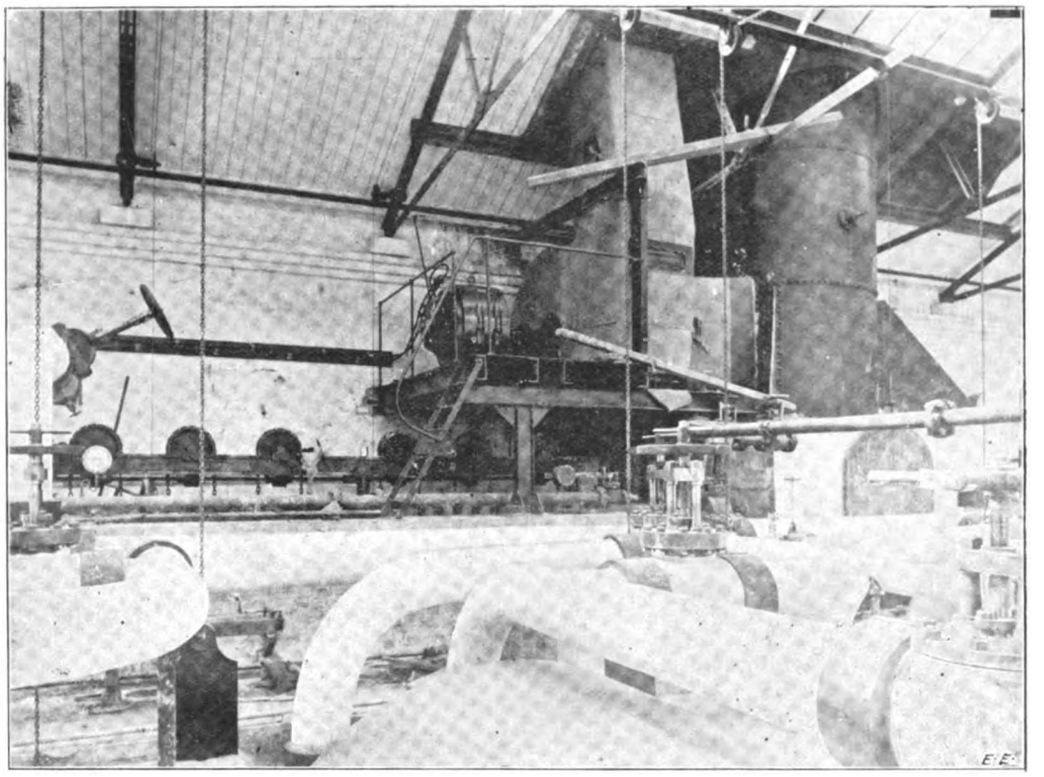

FIG. 6.—View of the Top of Boilers, showing Electrically-Driven Induced-Draught Fans.

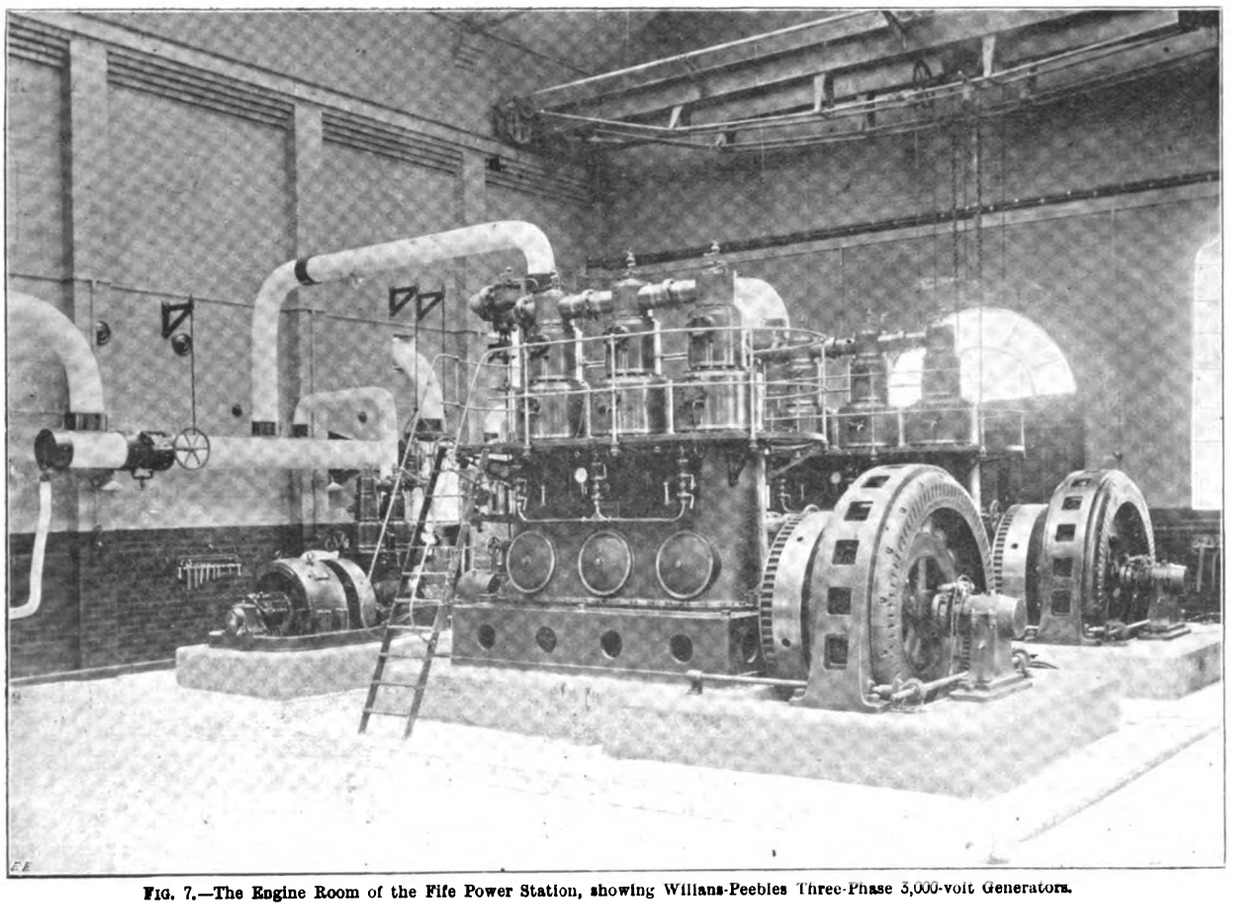

FIG. 7.—The Engine Room of the Fife Power Station, showing Willans-Peebles Three-Phase 3,000-volt Generators.

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engine governor is so efficient that the speed of the set will not rise above or fall below the normal by more than 5 per cent. momentarily or 2 per cent. permanently when full load of thrown off or on. The alternators are of the firm's standard construction with rotating fields. The field poles, which are bolted to the rim of the magnet wheel, are wound with bare copper strip on edge, adjacent layers being insulated by special paper. As the windings and field coils all round the magnet wheel are in series, and as there is a considerable number of turns on each pole, it will be seen that the voltage between turns of the winding is very small indeed, so that the special paper used provides ample insulation. This method of winding gives a very handsome mechanical job. The armatures are stationary, and are built up of stampings of soft iron, having nearly closed slots formed at the periphery. The windings are disposed in these slots and insulated with presspahn, mica, and special varnish. The winding is of the two-phase type. The two exciter sets consists each of a Peebles-Willans 45-kw., 110-volts, continuous-current combination, and these are used for excitation for the main alternators and also for driving the various subsidiary motors about the plant.

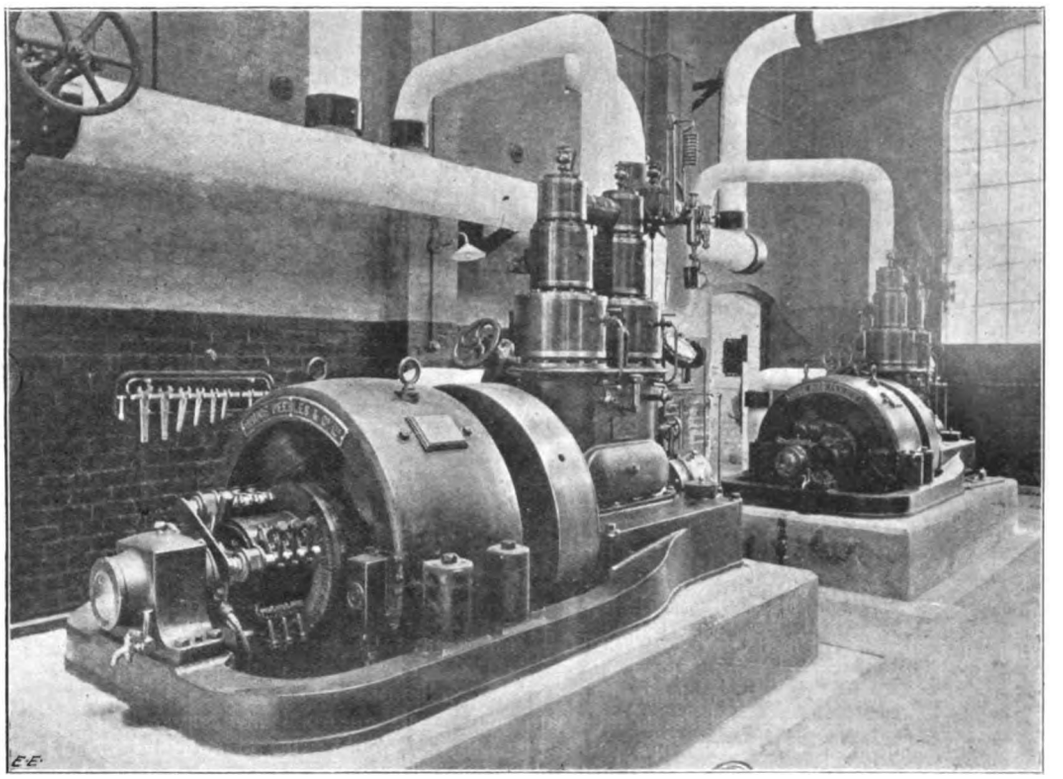

FIG. 8.—The Willans-Peebles Direct-Current Generators for Excitation and Auxiliary Motor Circuits.

The main switchboard (illustrated in Figs. 9 and 10) includes two alternator panels, each of which has an exciter panel beneath it, a synchronising panel, and three complete feeder panels. Two sets of 'bus bars are provided, lighting and power bars being normally separate. Either alternator can be plugged to either separate bar. As will be seen from the photograph of the back of the board, bars and connections of opposite polarity are separated by substantial slate partitions, and fireproof insulation is used on all insulator conductors. Each feeder panel consists of three sub-panels, two of which are normally in use, while the third is a spare. This third panel controls an additional lead, which may be plugged to the 'bus bars and

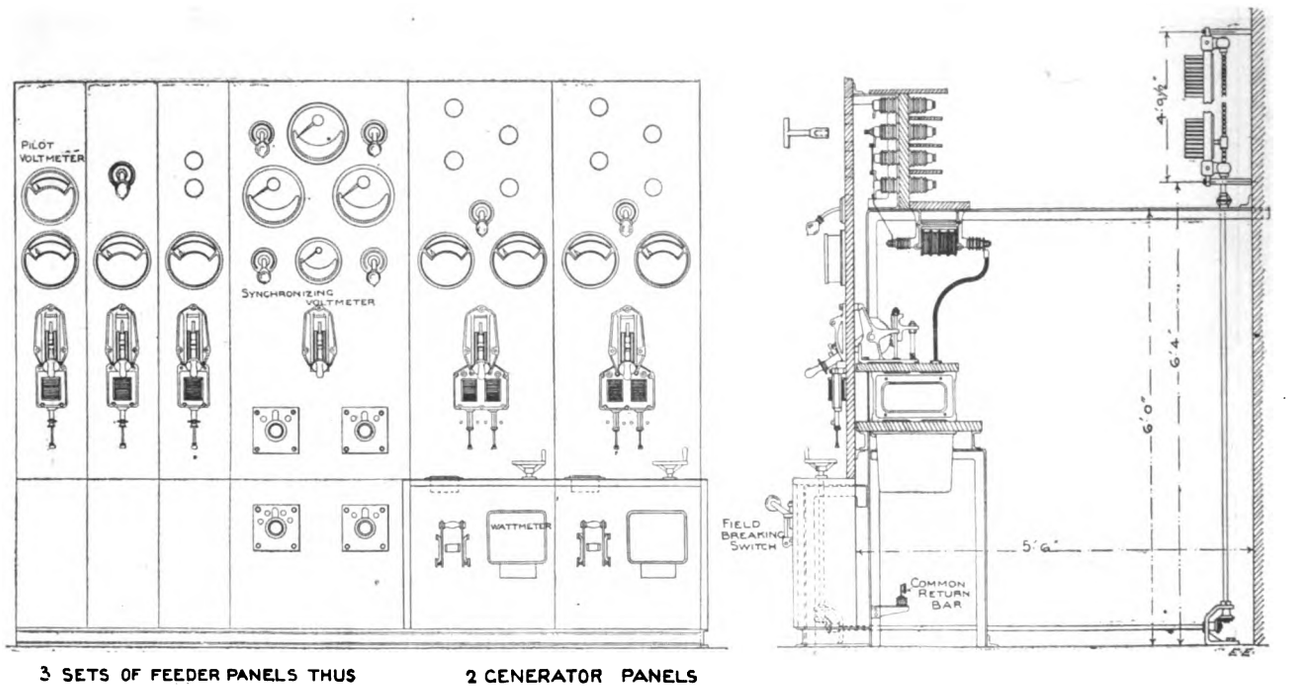

FIG. 9.—Front and Side Elevation of the Main Three-Phase Switchboard of the Fife Power Co.

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switched into service should one of the others break down. As usual, the alternating panels are arranged on the right-hand side facing the board, the synchronising panel in the middle, and the lighting and power feeders to the left. Each alternator panel is provided with four plugs, two ammeters, and circuit breaker, while the adjoining exciter panel is provided with a vertical ammeter, shunt-breaking switch, rheostat, and wattmeter. The synchronising panel is provided with voltmeters for the incoming alternator, and also one each for the lighting and power 'bus bars. In addition, synchronous voltmeter and lamps are provided, and an oil switch for coupling the incoming alternator to either set of bars. Each feeder panel is provided with an ammeter, pilot voltmeter for each phase, lamps and circuit breaker, also plugs for plugging in spare feeder. All circuit breakers are of the oil type. In addition to the main board, there is a small exciter board consisting of three panels. An interesting feature of the main board which

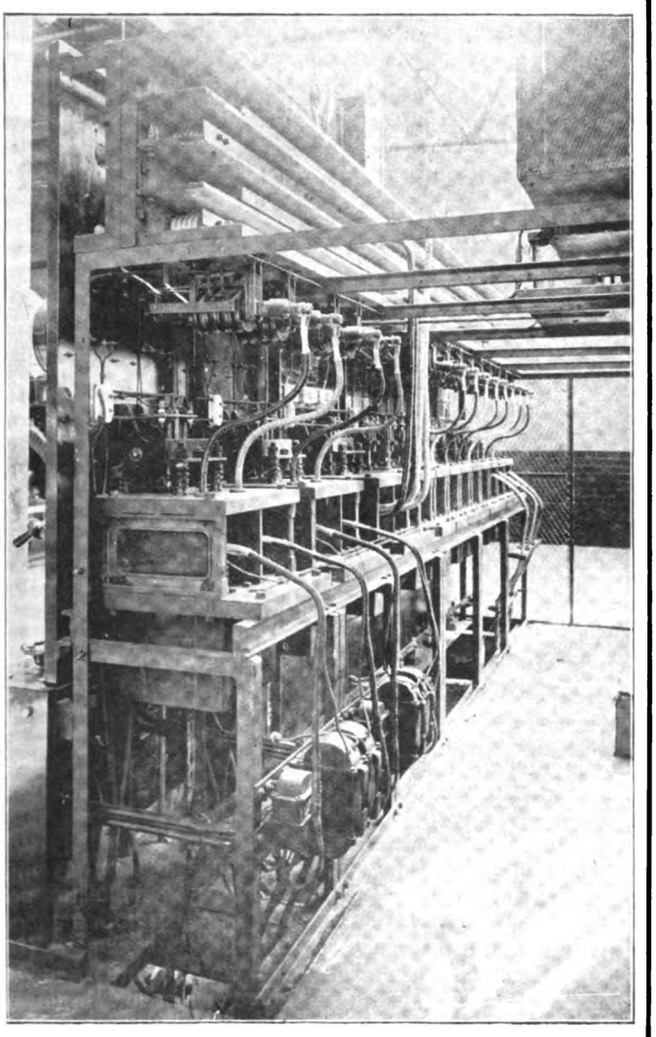


FIG. 10.—View of the Back of the Switchboard.

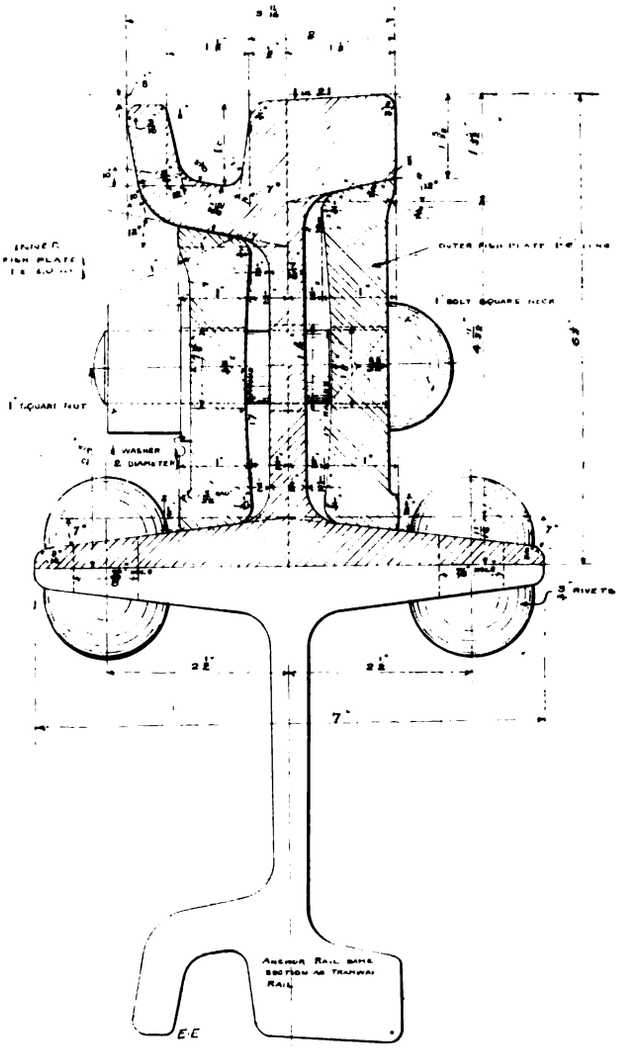
may here be mentioned, is that the lamps shown above the circuit breakers indicate from a distance whether the circuit breaker is closed or not. These lamps are operated by exciter current, and are switched on or off by auxiliary contacts on the circuit breaker itself.

The station is now completed, and a considerable number of mains have been laid to supply works in the Dunfermline neighbourhood. The whole of these mains have been supplied and laid by the Callender Cable and Construction Company, who have used for the purpose 0·1 square inch concentric, high-tension, fibre-insulated, lead-sheathed, steel-armoured cable. It has been laid direct in the ground, three being in one trench at a suitable distance apart, with marker board 3in. above.

The company are now supplying power to several works in the Dunfermline district. Further developments of the system, both as to supply in bulk for lighting and also to tramways, are likely to be arranged more promptly now that a supply is available.

ERITH ELECTRIC TRAMWAYS OPENING.

The opening ceremony of the Erith tramways on Saturday last was attended by a large company, including representatives from nearly all the London daily papers. This showed the interest taken in the system, which is a link in what will eventually be a large tramway network extending from London down through a large area in Kent. The company met at the car-sheds on the Walnut Tree-road, Erith, at 10.45 a.m., and had a good opportunity of inspecting the tramcars, the car-sheds, as well as the workshops and the offices from which the Erith tramways will be controlled. Before starting on the decorated cars to inspect the lines, an address of welcome was given by Mr. F. A. Stone, J.P., the chairman of the Erith Urban District Council, who afterwards declared the tramways open for public traffic. A procession of four decorated



The Anchor Rail Joint used on the Erith Tramways

cars then went along the three routes, which are shown in the map given on p. 258 of our last week's issue. The first route to be traversed was that along the Lower-road to Abbey Wood. On this is the bridge over the South-Eastern Railway and road diversion which replaces the previous level crossing. The construction of the bridge and the laying-out of the approaches form an engineering work which was greatly admired, and which will be of great value to the general users of the road quite apart from the tramway passengers. The view from the top of the bridge commanded nearly all the manufacturing works of Erith, and showed what great possibilities there are for development in this direction now that cheap power and a convenient tramway system are available. After going to the Abbey Wood terminus the car returned to the power station, and the guests inspected the same. We were particularly struck with the improvements which had been made by the extension of the engine-room. The front of the high-tension switchboard, on which the instruments and controlling

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handles are placed, has been moved back, and stands in openings in what was originally the outside wall of the station. The high-tension switch and fuse gear is now contained in an extension to the building. It is greatly to the credit of the electrical engineer, Mr. G. E. Heath, that the moving of the switchboard and changing over of all the high-tension gear and connections were made without the slightest interruption to the supply. After inspecting these works, the other two routes to the Northumberland Heath terminus and to the North End terminus respectively were traversed. The cars travelled smoothly over the lines, and there was no hitch whatever during the trial run.

At 1 p.m. the company adjourned to the Public Hall, where an inaugural lunch was held, to which ladies were invited. The chairman of the Council, Mr. F. A. Stone, J.P., presided, and proposed the usual loyal toasts. Eight other toasts were on the lists, and two more informal ones were added, so that the speechmaking was not lacking in quantity.

The Mayor of Woolwich proposed "Success to the Erith Tramways," and hoped that the London County Council would soon complete the tramways they had powers to construct in the south-eastern side of London, and that people would then be able to travel through to Gravesend without a change of car. He thought the work would be undertaken as soon as the Greenwich power station was completed. As regards power supply, he was not clear as to the advisability of the London County Council making themselves responsible for supply outside their area, but thought that one great station might be constructed by a combination of the Councils of Bexleyheath, Erith, Dartford, and Gravesend. The costs would be lowered by such a combined scheme, and transit would be cheapened. He hoped the profitable stage of tramway undertaking would soon be reached, and that on the completion of the connections to London produce as well as passengers would be carried.

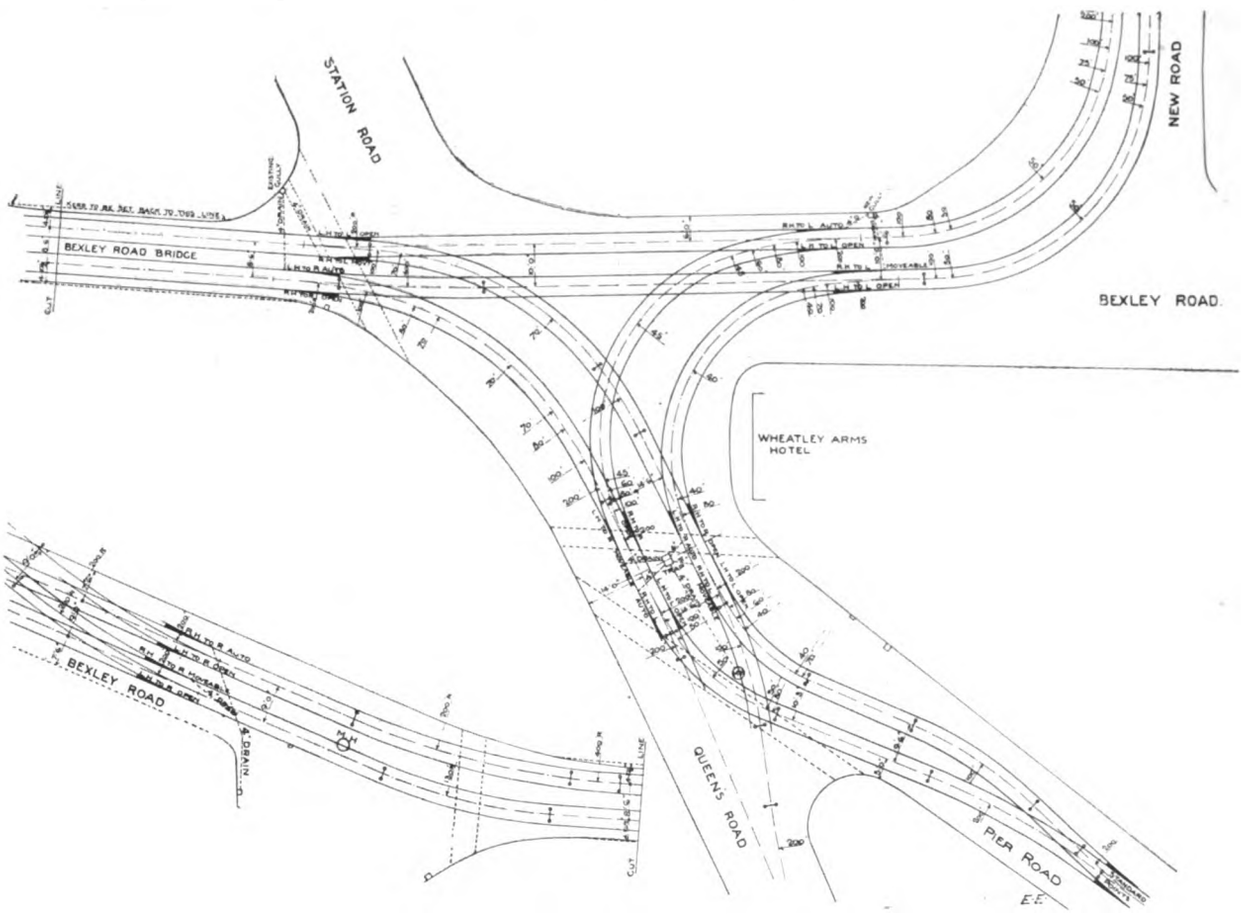
The Chairman, responding to the toast, said it had naturally been a great labour to bring the tramways to the state they were in that day. The Council had devoted a good deal of its time to the question for some three years. They felt, as the Mayor of Woolwich had pointed out, that the London County Council should link up their tramways with London, and when that day arrived their tramways would be a certain success. Until that time arrived they must trust to the loyalty of the citizens to make it pay. They were glad to be linked up at all events with Bexley, although they had not secured through running powers yet. They hoped to secure them, and when that day arrived it would be a benefit both to Bexley and to Erith.

Councillor H. Cannon complimented Messrs. Hawtayne and Zeden on the work they had done as consulting engineers to the Council. Neither time nor trouble had been spared to make the system a success.

Mr. W. C. Hawtayne responded on behalf of the firm, and gave credit to the individual members of his staff who had been responsible for the different sections of the work. He presented the chairman of the Urban District Council with a handsome silver bowl as a memento of the occasion.

The contractors, the Electric Lighting and Tramways Committee, the officers of the Council, the guests, the Press, and, finally, the chairman were all duly toasted.

Mr. Hawtayne was presented with a free pass over the Erith tramways by Councillor Grey, and in returning thanks expressed the hope that the pass would in time be available to Gravesend, if not to Maidstone and Dover.



Lay-out of Special Work at the Crossing near the Council's Office at Erith.

The company then adjourned to witness an interesting trial of the Westinghouse magnetic brake which was made on the heavy grade of Walnut Tree-road. A car was allowed to run down this grade with the trolley off the trolley wire and with the controller handle in such a position as to give the maximum braking effect. Starting from rest, the car reached such a speed that the motors began to generate, which applied first the slipper brake on the rail, and then by the dragging action of the slippers the wheel brakes were applied. These stopped the car, but the brakes were again released as soon as the current ceased. The whole cycle took place while the car was travelling down about 5ft. of the hill. This alternate starting, braking, stopping, and starting again clearly showed how sensitive the braking arrangement was. A speed of about one mile per hour was sufficient to make the motors act as generators and to apply the slipper brakes. A further trial was made in which the car was running down the grade at full speed in order to see how far it would run if the brakes had been applied, as would

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be the case for an emergency stop. In spite of a running speed of about 15 or 16 miles an hour, the car was pulled up in about one half of its length.

The guests coming from a distance then had an opportunity of comparing the comfort and speed of the tramcars with that provided by the South-Eastern and Chatham Railway Company's service, with which the tramways will compete. It is now, of course, possible to obtain communication with the London tramway system, with one or two changes, taking the car to Northumberland Heath, thence traversing the Bexley system to Woolwich and on, but it is the more direct routes, *vid* the Lower-road and Woolwich-road, yet to be constructed, that will be of the greatest benefit to the district. From the Bexley tramways a connection will also shortly be obtained with Dartford by means of the new light railways just commenced by the Dartford Urban District Council, which run as far as Horn's Cross. The connection between Horn's Cross and the Gravesend tramways has had to be abandoned through the opposition of the South-Eastern Railway, but a further application for the construction of this portion of the line will, no doubt, be successfully made after the authorised lines have been opened.

We are able this week to give an illustration of the special work supplied by the Hadfield Steelfoundry Company for the most important crossing on the system. This is at the top of the new Walnut Tree-road, where the lines to Bexleyheath and down Pier-road to North End branch off. The lay-out of this special work, which has been executed in manganese steel, is shown clearly in this illustration. The other drawing reproduced is of the joint employed between the rails.

Mr. J. W. B. Carruthers has acted as clerk of works throughout the construction of the permanent way and erection of the overhead equipment, and Mr. J. Pluck has filled a corresponding position during the construction of the bridge.

The Council have selected, from among a large number of candidates, Mr. A. Coveney to act as general manager of their tramways system. Mr. Coveney is a Kentish man, and received his early professional training in the county. He was at one time chief assistant engineer to the Isle of Thanet Light Railways, and subsequently became general manager of the Ashton-under-Lyne electric tramways, holding that position for 3½ years, during which time he acquired much popularity as a capable and urbane official. The general regret expressed by the Tramways Committee when Mr. Coveney resigned his appointment at Ashton to enter upon his duties at Erith augurs well for the success of his management of the new undertaking. We understand from him that the traffic on Saturday and Sunday last was exceptionally heavy, the takings being over £60 and £70 respectively. The steady returns since then show that the system is being well used by the inhabitants.

In conclusion, we have to thank Messrs. Hawtayne and Zeden for their assistance in the preparation of our descriptive article last week.

THE MAINTENANCE OF COMMUTATORS AND BRUSHES.

BY S. LEES.

(Concluded from page 274.)

Fig. 5 is illustrative of type 2. The emery wheel, A, is fixed on the shaft, B, which is carried by the bearings, C C, supported on the standards, D^1 D^2. The standard, D^1, is provided with a V slide on which it may be traversed across the bar, E, to suit different depths of cut. The base of the slide is carried by the sleeve, F, on which is formed a half nut, G, engaging the screwed end of the rod, H. A handle is fitted to rod H, by means of which the wheel, A, can be traversed along the commutator in either direction. The shaft, B, is slotted at M to enable it to travel through the bearing, C, and driving pulley, O; and the bearing standards, D^1 D^2, are telescopic, so as to admit of vertical adjustment for different heights of commutators. In the sketch the machine is shown fixed to the bedplate of the dynamo by an adjustable clamp, P.

The writer experienced some little trouble in getting a satisfactory belt drive with this type of grinder, but finally got over the difficulty by mounting the driving motor, starting switch, etc, on a portable stand, as illustrated in Fig. 6. The framework is built up of 3in. by 3in. well-seasoned pitch pine, all joints being mortised and bolted

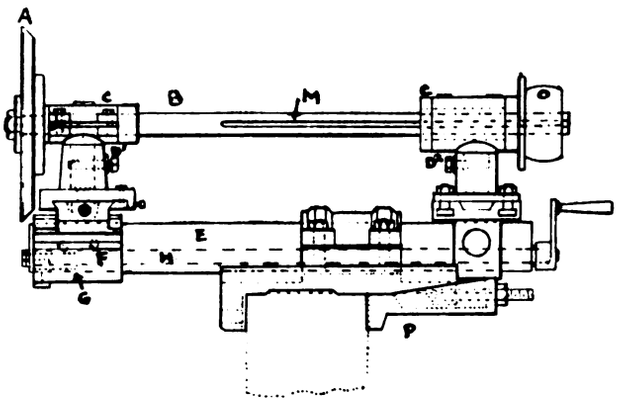

FIG. 5.

together. The motor is of the protected type, giving 1 b.h.p, the starting switch being provided with overload and no voltage release coils. The details of the sketch may, perhaps, prove self-explanatory. The compactness and portability of the arrangement will be readily appreciated by anyone who has done much commutator truing, and its advantages over any other method where the

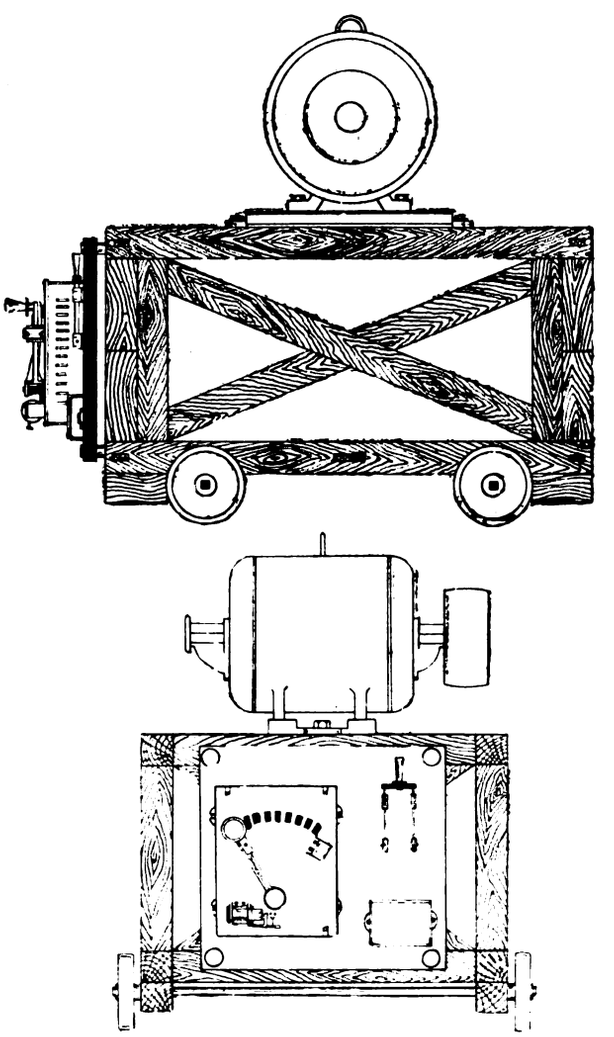

FIG. 6.

driving motor, starter gear, etc., require fixing in position before using each time, are obvious.

Before commencing to true up a commutator a large piece of stiff paper should be placed in the commutator pit to receive turnings, dust, etc., and the terminal blocks and any other bare current-carrying metal work kept well covered to prevent copper dust from being deposited

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thereon. The bearings should also be protected, in order to exclude dust and grit from the oil-wells. It is a good plan to fix a piece of stiff paper over the end of the armature winding from where the connections to the commutator are made. This will effectually prevent turnings, etc., from lodging between the windings. A dab or two of shellac varnish will hold the paper covering securely in place.

A useful tool designed by the writer for cleaning commutators is shown in Fig. 7. It is made up of well-seasoned pine, the two parts being glued and dowelled

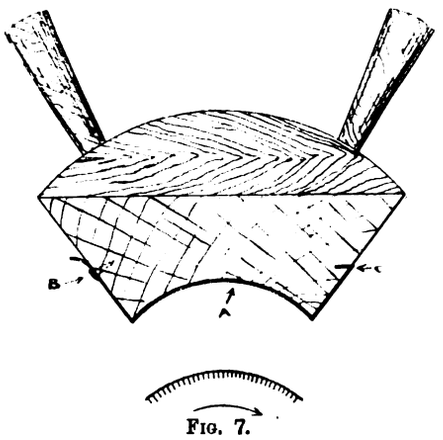

FIG. 7.

together. To use, a piece of emery cloth is placed in the hollow of the tool, one end of which is fixed in the saw-kerf at *a*, the other end being fastened down by means of two or three drawing-pins. A small quantity of oil should be smeared along the forward edge of the emery cloth to collect copper and emery dust, as these substances have a tendency to irritate the operator's nose and eyes. The tool is held firmly to the surface of the commutator, as indicated by the arrow—*i.e.*, against the direction of rotation of the commutator—and should occasionally be given a lateral motion.

A commutator burnisher made by the Ediswan Company is illustrated in Fig. 8. In operation, a strip of emery or polishing cloth, the same width as the burnisher, is cut, and one end inserted under the clip at the front end; it is then turned back under the flexible backing and applied to the commutator. The flexible backing is made in such a manner that it easily adapts itself to the curve of the commutator, but will not fall into depression on the surface. Thus the whole surface is evenly scoured with emery cloth to any degree of roughness required and afterwards polished.

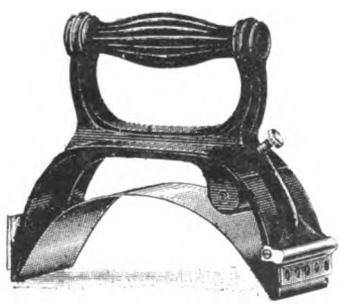

FIG. 8.

Another method of scouring commutators is to use a brick or block of carborundum. These blocks, measuring about 10in. by 4in. by 4in. can be obtained in various grades from 10's to 80's. The writer was connected with a large station across the water where seldom anything else but "the brick" was put on the commutators, and, as may be imagined, quite a large number were used, as the frequent application of the brick only aggravated the formation of "flats." This method, whilst being convenient for a temporary job, is somewhat barbarous, as the commutator is only rough scoured, and when using, if the brick is not cleared of the copper cuttings, very frequently the commutator gets scored and fluted badly.

In order to reduce the wear of commutators and brushes to a minimum, the pressure on the brushes should be as light as possible consistent with sparkless commutation. This is most important where copper gauze brushes are used, as undue pressure on the brushes causes the commutator to get scorched, owing to the foot of the brush having become fused together in a more or less solid piece, thereby rendering trimming a daily operation, whereas, if properly set, and given a fair amount of attention when working, copper brushes should not require trimming oftener than once every two or three months. A brush jig is a useful tool for holding the brushes in when being trimmed. This tool may be either of wood or metal; if of the former a hard wood such as birch or teak is best, the top of the jig being slipped with a guide-piece of steel set to the angle it is desired to trim the brushes to. When using, care should be taken not to take a back-stroke with the file; any stray strands of wire which may remain after filing are best removed by means of a pair of scissors or tinsmith's snips. One form of jig for holding two brushes is shown in Fig. 9.

Carbon brushes, which are now very extensively used, being hard and unyielding—unlike copper, gauze, or wire—require bedding very truly to the curvature of the commutator in order to get sparkless running. If not bedded properly, when working, the face of the brush gets red-hot, and, finally, the brush crumbles away altogether. The best way to bed carbon brushes is to slip a piece of medium,

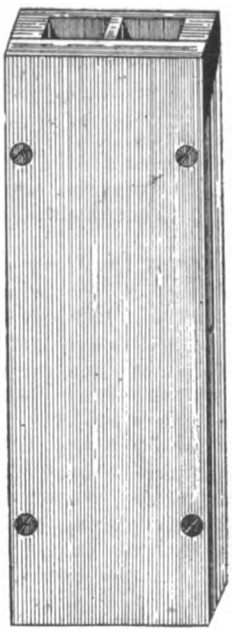

FIG. 9.

say 1's, glass cloth or paper (cloth is preferable) between the brushes and the commutator with, of course, the business side of the glass cloth towards the brushes, and work it forwards and backwards until the brushes are bedded accurately to the curvature of the commutator. The glass cloth should be kept quite close to the face of the commutator during the operation, otherwise, if allowed to chatter or kink the brush gets chamfered down at the heel and toe, thus reducing the effective collecting area of the brush. These remarks apply equally well to carbon brushes of both the block and slab types, though the latter are not now much used owing to their fragility under working conditions. The best qualities of carbon brushes have a fine close grain, wear slowly and uniformly, and present a very soft frictional surface. Carbon brushes are usually plated with copper or nickel on the parts which come into contact with the brush-holder, and care should be taken that the plating is never allowed to come in contact with the commutator, the plating being stripped off as the brush wears away. For a good quality of carbon brush the current density to be used may be taken at about 30 to 50 amperes per square inch of sectional area, this varying with different types of machines and conditions of working.

An improved type of metal brush, which possesses many advantages over the ordinary gauze or bunched wire type, consists of a number of very thin laminations of an anti-friction metal having a higher electrical resistance than that

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TABLE A.—PARTICULARS OF BRUSH-HOLDERS AND BRUSHES.

Size of machine. No.	Kw.	Volts.	Brush-holder.	Brushes. Quality.	Actual wearing length.	Pressure on brush.	Type.	Wear.	Remarks.
1	3	220	Swinging arm type	B	1in.	1½lb.	Fixed block or wedge type	Average life = 200 running hours	Commutator blackened frequently, necessitating regular cleaning. After three months' service, commutator worn out of truth nearly ¼in.
2	7	540	Swinging arm type	A	1in.	1½lb.	Fixed block or wedge type	After 5,000 running hours, wear = ⅛in.	Commutator, after nearly two years' service, in excellent condition. No cleaning required.
3	20	440	Swinging arm type	B	1in.	1½lb.	Fixed block or wedge type	Average life = 200 running hours	Commutator trued up after 1,200 running hours.
4	20	440	Swinging arm type	A	1in.	1½lb.	Fixed block or wedge type	After 5,000 running hours, wear = ¼in.	Commutator, after nearly two years service, in excellent condition; cleaned occasionally.
5	100	550	Fixed box type	C	1½in.	5lb.	Floating or box type	Average life = 1,500 running hours	Brushes trimmed—*i.e.*, bedded—on an average about once every 100 hours' run. Commutator trued up after 3,000 running hours.
6	100	550	Fixed box type	D	1½in.	5lb.	Floating or box type	After 2,000 running hours, wear = $\frac{5}{16}$in.	Commutator in excellent condition, no cleaning required. Since the initial bedding the brushes have not been trimmed in any way, the brush faces being in perfect condition.
7	100	550	Fixed box type	E	1½in.	5lb.	Floating or box type	After 200 running hours, wear = $\frac{1}{32}$in. (about)	Brushes very hard and brittle. Commutator after a short time became blackened, and scorched badly, necessitating truing up.

of copper. The laminations are sandwiched between copper-plates, and the whole held firmly together by means of two spring cheeks for about three-quarters of their length, the remainder of the brush being left free to allow of greater flexibility. Owing to the peculiar construction of this brush, each armature-coil when passing under the brush is cut in and cut out through resistance thus tending to reduce sparking. Another patent brush consists of sheets of anti-friction metal rolled to about the thickness of tissue-paper, folded, and formed under pressure to the size of the brush-holders. The metal of which these brushes are made has copper for its basis, and being very ductile, it possesses all the advantages of an anti-friction metal and is not effected by rubbing. With this type of brush practically no trimming is required, the corners being simply rounded off and the brush allowed to form its own bedding. It is essential to their good working that the commutator be perfectly true, and no lubricant of any kind whatever used on the commutator.

A great diversity of opinion exists among engineers as to whether anything of the nature of a lubricant should be used on commutators. Carbon brushes, if kept dry when running, have a tendency to produce a somewhat disagreeable screeching noise. The slightest trace of oil will usually stop this for a time, but the use of oil cannot be recommended, as, unless it is applied very sparingly, the oil carbonises and causes "flashing." Pads of oil, soaked rag, or waste are messy things to use, and are apt to cause trouble if left about open parts of running machinery. A substance which the writer has used for many years with success on machines fitted with carbon brushes is refined paraffin wax. For convenience in handling, the wax may be moulded in the form of round sticks. If rubbed lightly on the commutator occasionally, the wax should soon produce a good skin on the surface of the commutator. Sometimes carbon brushes may be improved by immersion for a few hours in melted paraffin wax. To keep copper brushes in good condition the foot of the brush should always be quite clean and flexible, and never allowed to get splayed out. A mixture used by the writer with excellent results on commutators with copper brushes is made up of the following ingredients: paraffin oil, five parts; olive oil, three parts; ammonia (spirits of hartshorn), two parts.

As mentioned before, the brushes should bear on the surface of the commutator with the least pressure consistent with sparkless commutation. The best pressure to use varies greatly with the many different types of brush-holders and brushes, and may be anything from a few ounces to as much as 6lb. or 8lb. Copper gauze brushes, if kept in good order, require about one-tenth of the pressure of that of carbon brushes. With the box or floating type of brush-holder the pressure on the brush is greater than in those of the hinged or swinging-arm type. In the former the brushes, being usually a good fit to prevent chattering, are apt to stick if dirt or grease is allowed to accumulate between the brush and box sides, hence it is well to see that the boxes be kept quite clean and smooth.

A weak point in nearly all types of brush-holders, and one which gives much trouble at times, is the bondings. The bonds frequently get broken owing to the vibration which they are subjected to when working, the break occurring usually close to the point of connection, particularly if the bonds have sweated connections. Many types of brush-holders depend almost entirely on the bonds for their efficient working. The writer has known of cases where defective bonds have been the cause of brushes and holders getting red hot. It is essential to the good working of any type of brush and holder that a continuous metallic path be provided for the passage of the current from the brush to the brush spindle or terminal, as moving joints cannot be depended upon; even if a close fit when new they sooner or later give trouble owing to the increased resistance which is set up at the joints as they become worn. Another weak point in nearly all holders of the hinged or swinging-arm type is that no provision is made for preventing the metal part of the holder from rubbing on the commutator when the brushes have been allowed to wear down too far. In the fixed box type this cannot occur owing to the brush-holder being rigidly fixed, the brush only being movable.

The writer has recently made a series of tests on various types and qualities of carbon brushes. The tests were carried out under everyday working conditions on machines ranging in size from 3 kw. to 100 kw. The results are shown in tabulated form in Table A. Type D is made by an American firm, the brushes being obtainable through a well-known English selling-house. Type A is manufactured in France, the firm having a direct agency in London. The writer concludes from the above that it pays in the long run to use a good quality of carbon brush, even though at first sight the prices may be rather high when compared with those of the poorer qualities. In the table, the brushes of machines (1), (2), (3), and (4) are all of the same size, quality A being the highest priced, B quality being about 40 per cent. cheaper. Machines (5), (6), and (7) have brushes all of the same size, D quality being the highest priced, qualities C and E being, respectively, 30 per cent. and 40 per cent. cheaper.

With some qualities of mica, particularly those of the "made-up" variety, the small particles of carbon and copper produced by wear become so firmly embedded in the mica that sometimes nothing short of turning or grinding up of the commutator will remove them. The mica between the

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commutator bars should be tested occasionally for insulation. A handy method is to use a portable lamp-fitting, the lead being, preferably, of twin workshop-flexible. One wire is cut at a convenient point, to each end of which is soldered a short piece of brass wire (say, 10's gauge), slightly pointed. To use, the mica insulation is explored gradually over its entire length by means of the brass wires. Any bad places which may exist will be shown at once by the lighting of the lamp, the degree of brilliancy obtained being a rough indication as to the amount of carbon or copper deposit present.

Sometimes, when oil has been used on the commutators in such large quantities as to cause excessive sparking—the oil being carbonised by the great heat produced, due to the increased resistance between the brushes and the commutator—the insulation between the bars becomes charred so badly as to cause "flashing-over" from brush to brush, and where the brush-holders of opposite polarity are pitched close together, as is usually the case in modern multipolar machines resulting, perhaps, in the burning out of the armature, and destruction of the brushgear and brushes.

Brushes and gear should be examined daily, and any dirt, grease, etc, which may have collected, removed before the machine is put in service. For removing loose dirt a pair of bellows or an air syringe may be used with advantage, the nozzle of which, if of metal, should be insulated with a few layers of adhesive tape.

In conclusion, the writers' thanks are due to Messrs. Phillips' Commutator Grinder Company and to Messrs. The Edison and Swan United Electric Light Company, Limited, for their kindness in placing at his disposal the facilities for illustrating their respective commutator appliances described in the foregoing article.

KROONSTAD (ORANGE RIVER COLONY) ELECTRICITY SUPPLY.

The supply of electricity for lighting and power purposes is making great headway in South Africa just now. Nor is this surprising in a country of recent development, with little existing provision for artificial illumination except by crude and altogether inadequate methods. There is a gratifying lack of hesitancy in the choice of systems, when that choice rests between gas and electricity and insufficient room exists for both. Thus we see electricity supply not only making rapid headway in the large towns even against gas competition, but also extending in no halting fashion to the smaller settlements. Now to deal with a typical example—Kroonstad, to boot. The idea of lighting this town was initiated during the late war period, and after much discussion and many meetings, at which the promoters promised some extraordinary things relating to the cost of electric light compared with paraffin illumination, invitations were issued for schemes. Several firms responded, and Mr. Ferdinand Saunders, consulting engineer, of Johannesburg, was then called in to advise the Council as to the best of the schemes. His decision was in favour of one submitted by Messrs. Hubert Davies and Spain, of Johannesburg, who were thereupon awarded the contract, and on Dec. 6, 1904, the plant was handed over to the municipality.

The requirements of the case were very modest; little Kroonstad cannot make a stir in the electrical world like its big neighbour Johannesburg may be expected shortly to do, but it can be safely said that no plant in the country has been able to show more satisfactory results in such a short time. When the plant was taken over from the contractors eight months ago the load consisted of some 60 amperes, 40 of which were for street-lighting. To-day about 4,000 8-c.p. lamps or their equivalent are connected, and only last month the price charged per unit for lighting was reduced from 1s. to 9d., while efforts are being made to cultivate a day load by supplying current at 6d. per unit for power. During the half-year commencing January the undertaking has averaged a monthly profit of £20 after paying all running expenses, including £96 per month for depreciation.

The plant at present installed consists of two Willans two-crank compound engines of 100 h.p. each, direct coupled to two 60-kw. continuous-current generators by the Electric Construction Company. There is also a

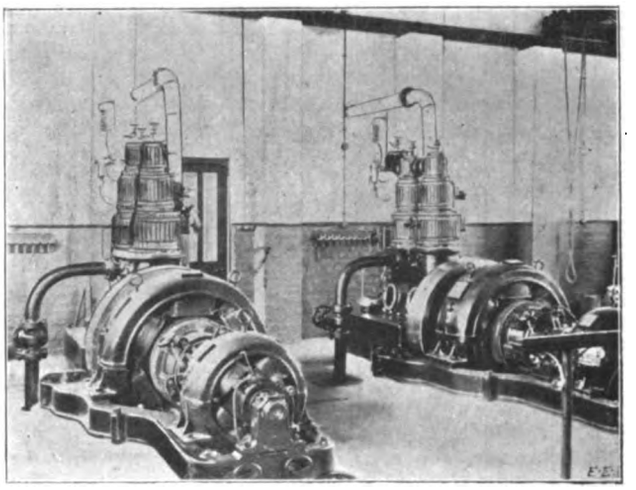

FIG. 1.—Engine-Room Plant, Kroonstad.

battery of 134 cells rated at 500 ampere-hours. This was supplied by Messrs. Pritchetts and Gold. The boosters for charging the battery are mounted on the same bed-

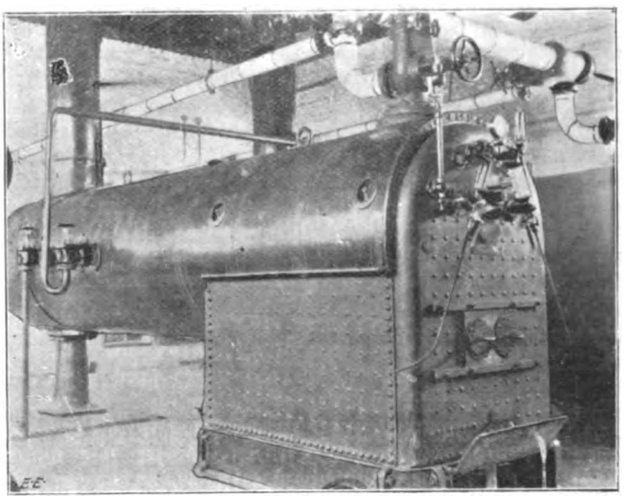

FIG. 2.—One of the Ruston and Proctor Loco.-Type Boilers, Kroonstad.

plate as the main generators. Fig 1 represents a general view of the engine-room. Steam is supplied by two Ruston and Proctor locomotive-type boilers (Fig. 2) of 40 n.h.p.

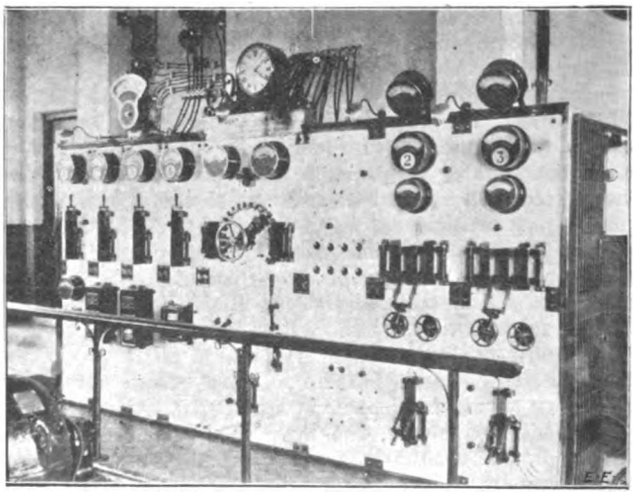

FIG. 3.—The Main Switchboard, Kroonstad.

each, at a working pressure of 140lb. The switchboard (Fig. 3) of white marble is divided into three generator, four feeder, and one battery regulator panels, while additional panels are provided for the necessary wattmeters

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and recording instruments. So far as the outside work is concerned, it is worthy of note that the mains are run overhead, as shown in Fig. 4, and the town is divided into four sections, each having its own feeder. Nernst and ordinary incandescent lamps are used for street-lighting, and in connection with the former it may prove interesting, at a time when controversies are rife, to record the highly satisfactory results obtained, 75 per cent. of them having been in use for seven months or 1,100 hours without renewal.

Current is supplied to consumers at a pressure of 230 volts, meters by Chamberlain and Hookham being provided by the municipality at a monthly rental of 2s. 6d. Much difficulty has, however, been experienced in convincing consumers of the accuracy of their meters as the result of the extraordinary promises to which reference has been made in the foregoing. The load on the plant will receive a nice addition on completion of the pumping scheme which the Council have adopted in connection with the town's water supply. So far as municipal work is concerned this scheme is probably unique. It will consist of a motor-generator, installed in the present generating station, supplying current at 460 volts to a 45-h.p. motor direct coupled to a Mather and Platt three-stage high-lift centrifugal pump having a capacity of 20,000 gallons per hour and working against a 200ft. head. It is anticipated that

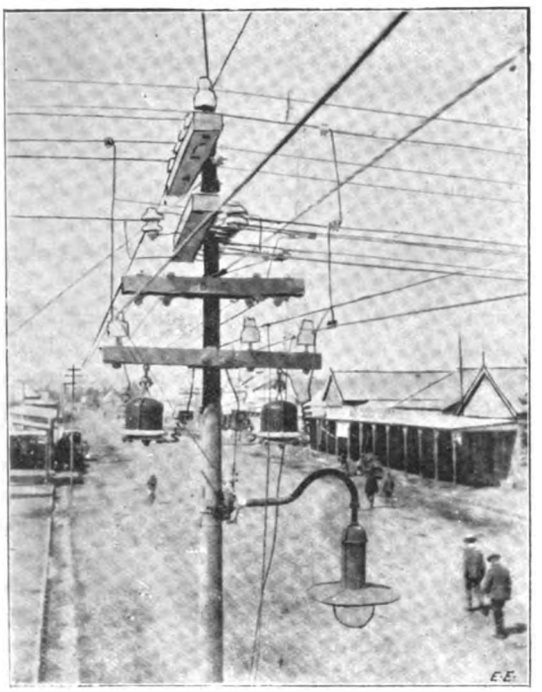

FIG. 4.—Overhead Mains, Kroonstad.

the cost of operating this plant will be considerably less than that of running the old steam-pumps.

We are indebted to Mr. Julian Vowles, the resident electrical engineer, for the particulars which have enabled us to prepare this article, also for the photographs from which the accompanying illustrations are reproduced. With regard to the latter, the excellence of the originals proves Mr. Vowles to be a skilful photographer. His abilities as an engineer and manager may be measured by the success which has favoured his charge in so short a time. In conclusion, we would heartily congratulate him upon that success.

THE FUSE FROM A PRACTICAL STANDPOINT.

(*Communicated.*)

The fuse question is of universal interest to all classes of users of electricity, from the employer of hundreds of motors in a factory down to the humble user of a few incandescent lamps. In view of the extremely important character of the device, it is a matter for surprise that a more determined effort has not been made to thoroughly standardise fuses *and* fuse carriers. It is quite useless to standardise fuse wire and strip and put it upon the market under such conditions that it will be used in connection with all sorts and conditions of fuse boxes and carriers. The mass of metal contained in the terminals of a fuse carrier exercises a great influence upon the carrying capacity of a fuse, inasmuch as the greater the mass of metal the more rapidly will the heat be conducted from the fuse and its carrying capacity be proportionately increased. It is, therefore, perfectly clear that the fuse and fuseholder should be tested together and sold as a standard piece of apparatus. Whatever the vagaries of fuses may be, the writer is perfectly convinced that it is upon the whole infinitely safer to use a carefully selected fuse upon all power and lighting circuits than to rely upon a circuit breaker only. Circuit breakers are useful and more easily and quickly replaced than a fuse, but they cannot be entirely relied upon, and a fuse should always be placed in series with a circuit breaker, the carrying capacity of the fuse being about 25 per cent. in excess of the current which will operate the circuit breaker.

The writer was once present when damage to the extent of £15,000 was done simply through the failure of a circuit breaker to act, and the circumstances of the case rendered it perfectly clear that practically no damage would have been done had a fuse been in series with the breaker. Such an object lesson as the above is calculated to leave an impression upon the mind which is not easily effaced, especially when accompanied by several other instances of a similar character, though upon a smaller scale.

In a power installation every motor should (whether provided with a breaker or not) be connected to the mains through a double-pole iron-clad fuse, careful attention being paid to the following points:

1. The fuse and fuse carrier must be of a tested and standardised type, carefully selected in accordance with the requirements of the particular motor it is to protect.

2. The fuse must be fitted into a removable insulated fuseholder, in order that it may not be necessary to handle live metal when replacing a fuse.

3. A supply of suitable fuses for replacement *must* always be kept in close proximity to the fuseholder, the best plan being to fix a small iron box containing the supply close to the fuse apparatus.

If the above simple precautions were honestly observed, the operation of fuses would be far more satisfactory, and there would be a marked falling off in the business of repairing burnt-out armatures.

ELECTRIC POWER FROM THE ANDES.

We notice that Mr. Emile Guarini, who has frequently contributed to our columns, has recently reported on the utilisation of the water stored in Lake Titicaca, in Peru. This lake is stated to be the highest in the world, its water-surface being no less than 12,644ft. above the sea-level. Here, as elsewhere in the Andes, there are enormous possibilities for the development of hydro-electric power, but the great difficulty is to find a commercial use for the power so obtained. Mr. Guarini, who has been commissioned by the Peruvian Government to look into the matter, advocates that in the present instance the water power should be used to drive electrically the southern railways of Peru. He estimates that the coal used on this line costs over £100,000 a year, and that the interest on the capital cost of the power plant would be much below this sum. Unfortunately, the railways in question would have to be electrified, and the cost of this would be no small matter. He also considers that there would be at least 6,000 h.p. to spare after the railways were electrified, and that this should be used for industrial purposes, for the lighting of the town, and for electric navigation. So far, figures have not reached us as to the fall which is easily obtainable from this lake, but from the map we see that the Andes lie between the lake and the sea-level—in fact, the waters from the lake find their way into the Amazon, and thence into the Atlantic, and not into the Pacific Ocean. The water power available all down the west coast of South America needs only a demand for power in order to form a most profitable field for electrical engineering.

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THE

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TO CORRESPONDENTS.

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TUNBRIDGE WELLS.

The farce of Tunbridge Wells still occupies the stage. The plot is simple, as is usual in farcical plays. A town with certain councillors plays with municipal trading—a strong and virulent opposition, aided by the paid services of anti-municipalist companies, sets to work to wreck all that is done municipally. The opposition makes a grand *coup* in one direction, and, having tasted blood, commences a vigorous attack on another point. In other words, the opposition, having succeeded in its telephonic effort, is now attacking the electric light undertaking, and the attack bids fair to succeed. We should have taken no part in this controversy but that the same old glaring mis-statements are made *re* depreciation and sinking funds. It is really painful to read the half-truths indulged in by the anti-municipal party, and though we in many cases prefer private enterprise, we have never hesitated to dub the tactics which use half-truths as the whole truth to be a disgrace to any controversialist. A writer in the *Courier* of Aug. 25 signs himself "An Accountant," deciding to use this *nom de plume* rather than give his name, because the latter "would not lend any particular weight to the discussion of this very important matter." That statement is about the only real truth in his letter. It is written to dispute the correctnes of Councillor Hicks, who previously wrote:

> "A trading company writes off every year depreciation, and has no sinking fund."
>
> "A municipal undertaking contributes every year to its sinking fund, and has no depreciation."
>
> "These two processes are identical. A sinking fund is a depreciation fund, and *vice versâ*."

"Accountant," with that arrogance so often associated with anonymity, says that "depreciation" and "sinking fund" "are absolutely and entirely different from each other." Well, no doubt he will maintain his assertion by quoting dictionary definitions of the word "identical." Mr. Hicks, of course, did not use the word identical in its strictly grammatical definition, but as the synonym of "equivalent." If "Accountant" is worth a moment consideration, it is because he, like others of his kind when driven into a corner, assumes the high and mighty in regard to rigid definition. Now, that will not do in this controversy, and we ask Mr. "Accountant," who poses as an expert, to point out, if he can, the practical difference in the following case: A borrows one thousand pounds of B, using that money as capital expenditure and repaying it periodically in equal instalments over a period of twenty-five years. A borrows one thousand pounds of B, C, D, etc., and expends it as capital, laying by periodically equal instalments over a period of twenty-five years. Never mind for a moment the asides of upkeep, etc. Assume the capital expenditure to be for ground rents for a period of twenty-five years, and that in both cases the renewal of the agreement can be made at the end of twenty-five years for another period of twenty-five, and so on. In the first case A has paid B the thousand pounds, and can borrow it again if he chooses and use it for the renewal of his agreement. In the second place, A holds the money for B, C, D, etc., and can use the money for a renewal of the agreement. Vary the second case slightly, and let B, C, D, etc., combine to furnish and use the capital, both in the first period of twenty-five years, and again in the second period, and so on. The cases are not identical, but the results are evidently equivalent, unless words and truth have lost their meaning. We have assumed a simple case without any of the asides which have to be brought in when dealing with such questions as municipal lighting or traction, but most of these asides can be treated just as

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simply as the case we have taken. As regards the Tunbridge Wells municipal undertakings, it paid the opponents to first belittle and then buy the telephone system. Here the reasons were obvious, as the purchase checked the spread of municipal telephony and decrease of telephone rates elsewhere. In the case of the electric lighting undertaking no such widespread result would be obtained by the purchaser, who would get his profit solely from the consumers or by trading with the undertaking as a whole. The fact that someone is keen to buy is, perhaps, the best answer to the depreciating letter of "Accountant." If, however, the councillors still distrust their own capabilities as managers, they might consider resignation as an alternative to realisation of the assets of the town.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL TELEPHONY.

SIR,—There is little satisfaction in arguing over a dead issue or in disputing about politics. Municipal telephony is a dead issue, and during its active existence has been mainly politics. The inconsistency and inaccuracy of much of Mr. Bennett's letter published in your issue of Aug. 18 must be as apparent to you, Sir, and to your other readers interested in telephony as they are to me. The inconsistency of complaining of abuse and misrepresentation and in the same breadth abusing and misrepresenting everyone and everything else concerned, is too obvious to need comment.

I have given a good deal of study during a good deal of time to municipal telephony in this country, and I very much doubt whether, even if it had been taken up on right lines, it could have been made a success under the existing political, legal, and practical conditions. It is clear that the conditions were discouraging, as, in spite of all the efforts to promote municipal telephone systems, only five competitive systems exist. The watchful onlooker would probably say that enthusiastic municipal traders—and apparently all municipal traders are enthusiasts—do not as a rule look very carefully before they leap. The municipal telephone enthusiasts certainly did not give the subject the study it deserved. A study of the conditions under which municipal telephone enterprises were to be conducted would have sufficed to deter most business men. The business was to be a competitive one, conducted under a Government license of limited term and surrounded by all the rules, regulations, and restrictions that Government officials have the peculiar art of devising. In many cases there is a multiplicity of local authorities in one legally-defined telephone area, which creates obvious complications, and in all cases the competitor was already well established and thoroughly experienced in the business. Under these conditions it is small wonder that out of the 59 local authorities who looked into the telephone question after the Act of 1899 became law, only six established competitive systems.

But, apart altogether from the discouraging general conditions, the municipal telephone movement was dammed from the beginning by the adoption of bad rate schemes and inferior plant. If the municipalities which did take up telephony had gone into the business on right lines, had adopted modern plant and modern rate schemes, and had thoroughly studied the future development of the business, it is quite conceivable that they might have established themselves so successfully as to overcome the various legal difficulties, or to compel their modification.

The opportunity in Glasgow in 1900 was unique. Had the Glasgow municipal system been scientifically laid out with a modern telephone plant, designed for unlimited expansion, had a sound and business-like tariff been adopted, and had a thoroughly efficient telephone organisation been formed, the scheme in all probability would have been a success, and it would been a magnificent advertisement for municipal telephony. Everything was in favour of the Glasgow Corporation—free use of the streets, command of unlimited capital, powerful local influence, and friendly public opinion. But the whole scheme was foredoomed to failure from the moment it was decided to adopt obsolete engineering methods and an inflexible tariff. The call-wire plant, the armoured cable, the defective distribution scheme, and the rigid flat-rate tariff, have been cancers which have prevented all possibility of healthy growth.

The plain truth is that Mr. Bennett himself has been the worst enemy of municipal telephony. Long after general telephone experience had proved common battery methods to be the correct methods, he has clung to obsolete and relatively inefficient call-wire and magneto plant. Telephone cables buried solid have been tried and found wanting many years ago, but Mr. Bennett persists in the extensive use of armoured cable buried solid. The advantages of a flexible tariff are well understood by all telephone men, but Mr. Bennett clings to low flat rates, talks about "cheap telephones," and seems always to ignore that it is not "telephones" that a telephone exchange supplies, but *telephone service*, and that the requirements of consumers vary. The fundamental importance of studying future development and planning for it, the necessity (and the cost) of carrying much spare plant, and the dangers and difficulties of competition with a well-established system are not light considerations in the conduct of a telephone business. To Mr. Bennett they have been trifles light as air. I pointed out to Mr. Bennett, in Glasgow in 1897, the importance of studying development and spare plant. Mr. Bennett politely retorted that I was an American, come over to talk about "Tammany." Mr. Bennett has continued to ignore the eminently practical questions of development and spare capacity, and he has always prophesied that the competition would be a negligible factor.

It is because a difficult and highly technical business has been approached in this ill-considered and superficial manner, and because the practical work has been laid out on fundamentally unsound lines, that the existing municipal telephone systems have been failures. That they *have* been failures there is no question. They have been squarely beaten in the competition—notably so at Glasgow, where the trial of strength has lasted the longest. The financial results, on paper, show that in some cases both ends are made to meet. But even if all the working expenses were fairly debited and all the revenue credited were collectable, the financial results would still be wholly invalidated by the unsoundness of the capital accounts, for the capital accounts carry at its full cost plant which is worth very much less than the sums which have been spent on it. Sooner or later this would be bound to tell, as stern necessity compelled the rectification of the original mistakes. The symptoms are clearly evident at Glasgow, where the fundamental inefficiency of the call-wire system compelled the committee nearly two years ago to consider a general change in the system. They have been considering ever since, because an effective general change would mean practically a reconstruction of the plant and a very large expenditure which could not be faced. As a result of clinging to a defective system of working, the Corporation exchange has been overwhelmed in the competition, and is now simply "marking time." Is it not unreasonable to claim successful financial results when it is clear that the capital account—the backbone of the finances—is in a most unsound condition? It is equally unreasonable to claim that the municipal telephone business is generally successful, when the facts are that each competing municipal telephone system is in reality only a sort of side-show, not carrying more than a fraction of the real telephone load of the town and not able to obtain more than a fraction of the new business which offers. And none of the existing municipal systems is able to improve on these conditions, because none of them is designed, equipped, or organised to do a serious telephone business.

There is much more in the telephone business than was dreamed of in Mr. Bennett's philosophy when he started in to organise the municipal telephone systems. He has always taken the ground that he cannot learn anything in telephony from anybody else, and that is his misfortune—

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and the misfortune of Glasgow, Hull, etc. Mr. Bennett's remarks on p. 235 on the new specification are characteristic of the manner in which he deals with technical and practical questions. He says, "In order to make the company's plant admissible for purchase, a much lower standard of efficiency than has prevailed with the corporations has been set up by means of a specification permitting of cheap and nasty methods." In the first sentence Mr. Bennett implies that the engineer-in-chief to the Post Office has been party to a conspiracy having for its object the purchase by the Post Office of inferior plant. Of course, that suggestion is too absurd for comment. In the next he states that the new specification admits of cheap and nasty work and a lower standard of efficiency than has prevailed with the corporations. On what *data* is such a sweeping assertion based? Apparently, Mr. Bennett's sole point is that it is modern practice to use in certain situations 600-pair cable, employing a 10lb. conductor, whereas the minimum conductor under the municipal specification is 12½lb. On this difference Mr. Bennett bases a most positive statement in the most general terms, in which he attacks both the good faith and the competence of the engineers of the Post Office and of the National Telephone Company, and ignores not only all the work that has been done of late years in the improvement of telephone cables and in the study of standards of transmission, but the very practical benefits that have resulted therefrom. When technical and practical questions are dealt with in this spirit by the chief exponent of municipal telephony, he unconsciously exposes the reasons for the technical and practical defects of municipal telephony.—Yours, etc.,

HERBERT LAWS WEBB

Westminster, Aug. 21, 1905.

[In conjunction with the above criticism of municipal telephony, which is largely a personal attack on Mr. Bennett, our readers should peruse the following extracts from a letter by Mr. D. M. Stevenson to the *Times*. The telephone question is now so far settled that further correspondence on the subject is unnecessary.—ED. *E. E.*]

THE TELEPHONE AGREEMENT.

Extracts from letter dated Aug. 19 to the Editor of "The Times."

SIR,—As chairman of the committee of representatives of the telephone-owning municipalities, which met in London from time to time during the sittings of the Select Committee on Post Office (Telephone Agreement), 1905, I should feel obliged by your allowing me to make some observations in the columns of the *Times* on your leading article of Aug. 10, and on the debate in the House of Commons of the 9th.

During its 10 weeks' sittings, the committee dealt with the question in the most painstaking and exhaustive manner. It made a number of recommendations, some of which the Postmaster-General adopted, but he declined to accept the one of most interest to the municipalities—namely, No. 28:

"While, therefore, we recommend that in the general public interest the House of Commons should not disapprove of the agreement, we think that the agreement with the modifications that we have proposed should not be allowed to become operative until a pledge has been given to the House that between now and January, 1912, nothing shall be done by the Government whereby the question of the future ownership and management of local telephone installations (as distinct from the ownership and management of trunk lines) may be prejudiced, and that, unless by a vote of the House it has otherwise been determined, the Post Office shall continue to grant licenses to municipalities on terms not more onerous in respect of royalties than the terms of the standard telephone license as revised in January, 1902."

Surely the only course open to Lord Stanley, in accordance with his pledge of May 22, was to let the agreement drop and commence *de novo* with a new agreement?

Dealing with the small number of municipalities owning telephone systems, the writer said Mr. Hanbury's Act empowering the granting of municipal telephone licenses was only passed in 1899 after five or six years' agitation. Glasgow, which got the first license, began operations in September, 1901, Portsmouth in 1902, Brighton and Swansea in 1903, and Hull in 1904. Municipal corporations are slow to move, and, with that prudence which the *Times* would be the first to commend, the bulk of them naturally preferred to wait the results of the experiments being made in Glasgow, etc., before embarking on the unknown sea of telephone enterprise. Long before there had been time to make trustworthy deductions from the experiences of the municipalities named, it emerged that the Post Office was determined to get complete possession, and with that object in view was endeavouring to arrange for the purchase of the National Company's undertaking in 1904. Mutually satisfactory terms could not be arranged, so negotiations for taking over the company's plant in 1911 were substituted, and ended in the agreement now under discussion.

If to all this be added the fact that paragraphs frequently appeared in the Press insinuating that the telephone-owning municipalities would have heavy losses on their plant when their licenses expired, because the licenses would not be renewed and the Post Office would only take over what plant it liked, your readers will have little difficulty in understanding why the Post Office was not besieged with applications for municipal licenses. Obviously it is only now that the municipal systems are beginning to show trustworthy financial results. These prove beyond doubt that in the telephone-owning municipalities telephone users, who are getting facilities incomparably better than they had formerly under the National Company, are only paying about half the rates paid to the company, and yet that the systems are self-supporting.

The London telephone service is admittedly much better since the Post Office entered the field, but I venture to say that Glasgow telephone users, accustomed as they have been for some time to the Corporation service, and to the enormously improved service that the National Company has been compelled to give in order to hold its own, would not tolerate for a week the delays and annoyances to which London subscribers are subjected, not to speak of the excessive rates charged there.

Mr. Austen Chamberlain said that no municipality which was not mad would start a telephone system in 1906 to terminate in 1911. I cannot agree with this view. If it were made clear that the future policy was to be, in the words of Mr. Benn, "the establishment of a useful State service worked in connection with the municipalities," many of them would undoubtedly apply for licenses nominally terminable in 1911, in the sure and certain hope that these would be renewed indefinitely. Moreover, it is inconceivable that if Parliament had stipulated that the agreement was only to become binding subject to the pledge embodied in Clause 28, the National Company would have refused to accept the modification. It was pointed out in the debate that their stock rose 33 per cent. as the result of the negotiations with the Post Office. The figures in the Stock Exchange lists show an even more remarkable appreciation, the deferred stock having been at 66¼ in 1903 and having touched 113¼ in 1905.

The directors of the company are far too able business men to have risked the wrecking of an agreement of such enormous advantage to their shareholders for the sake of preventing the establishment of the few additional municipal services which might have been in operation by 1911. In the same way they would certainly have yielded on the question of intercommunication and the abolition of terminals, had these been pressed for by the Postmaster-General in the interest of his licensees.

With regard to the policy of complete nationalisation, which the Post Office is endeavouring to force upon the country, with which I am sorry to find the *Times* agreeing, perhaps you will allow me to refer to an experience I had when inquiring into the question of telephone services some years ago in Germany, Denmark, Norway, and Sweden.

I found that for 100 miles south of the Danish frontier only the two large towns had telephones, whereas on the Danish side every village had its exchange, and each was connected to the Government trunk lines. The reason was obvious. Germany, centralised, had its uniform rate of £7. 10s., while the towns and villages on the Danish side were served by local companies at from £2. 4s. 5d. to £2. 10s. The city of Christiania has an admirable system covering a great area for £4. 8s. 10d. a year up to 6,000 calls, or £5 without limit. The famous Allmänna Company, of Stockholm, does still better, giving an unlimited service within a radius of 43 miles for £5. 11s. Think of it! On that basis Manchester subscribers would be able for £5. 11s. per annum to speak not only to all Manchester and Salford, but also, without extra charge, to all the towns within a circle round Manchester 86 miles in diameter—including Bolton, Liverpool, Preston, Oldham, Leeds, Bradford, Huddersfield, Halifax, and Sheffield—and all for a trifle more than half what is now paid for the Manchester area alone. Outside of London the maximum rate ought to be £6 or less, and the smaller towns and villages could be telephoned for half the money.

Surely, in view of facts like these, you will not persist in helping to get us swallowed up by a department which tells us frankly that it has no hope of reducing the £10 charge of the National Telephone Company? If it had its own way, and the Glasgow Corporation telephones were transferred to it to-morrow, the present subscribers would lose between now and 1913, when our license expires, some £250,000, not to speak of the loss to the thousands of citizens who would join the system between now and then if it remained under the control of the Corporation.

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You ask, "Why should a municipality have a private telephone system any more than a private Post Office telegraph system?" and in the debate there was a tendency to accept Lord Stanley's assumption that the postal and telegraph systems leave nothing to be desired. Your commercial readers know how far this is contrary to fact. Thanks to the efforts of such men as Mr. Henniker Heaton and others in Parliament, improvements are taking place, but is it not pitiful in this country, which depends more than any other on facilities for rapid intercommunication, that we should be without the facilities for posting letters in all mail trains, which every Continental country has given to its citizens for many years, and that thousands of railway stations should be without public telegraph offices, whereas in the leading Continental countries a railway telegraph office is available to the public at every station?

In the matter of telephones the Post Office has still less to brag about. The trunk tariff is out of all proportion to the rates charged in other countries. For instance, from Glasgow to London the charge is 4s. 6d. for three minutes' conversation. In Sweden for the same service the charge would be 6½d., in Germany 1s. 6d. (which would cover half as far again), and in France 1s. 7d.

If this letter were not already too long, I should have liked to deal with the amazing statement of the Postmaster-General that "the instant the agreement became law there would be free intercommunication without charge throughout the whole of the United Kingdom"; the absolute futility of his stipulations regarding "maximum and minimum rates"; the illusory nature of "the prohibition of favour and preference," and various other points. But it may suffice to remind your readers that the Select Committee, which spent so much time studying the subject in all its bearings, came to the conclusion that the municipalities were substantially correct in their contentions. As this remains on record, notwithstanding the adverse votes of 187 hon. members on the 9th inst. (many of whom know nothing about the matter and had not even heard the discussion), the municipalities may confidently rely on satisfactory treatment from a new House of Commons.—I am,

D. M. STEVENSON.

LINE CALCULATION.

SIR,—In the correspondence of your issue of Aug. 25 "Duplicator" suggests certain corrections in "Newcastle's" answer to Question 795. The writer has, perhaps, used the words "load factor" rather laxly, for, as "Duplicator" points out, the $C^2 R$ loss is not proportional to the load factor used strictly; but in correcting this expression "Duplicator" falls into the error of saying that the $C^2 R$ loss is proportional to the square of the load factor. This statement is no more the case than the one he criticises.

There is no definite relation between the $C^2 R$ loss and the real load factor that can be used as "Duplicator" suggests. This loss is proportional to the *mean square of the varying currents*, not to *the square of the mean current*, as would have to be the case to make "Duplicator's" law true. The difference is a vital one. It is thus obvious that the annual loss can only be approximated to at the best, and what the writer meant to convey, as his figures show, was as follows: the full load $C^2 R$ loss is known, the variations of the current are absolutely unknown. Assume as a basis to work on that the total units lost in a year are 25 per cent. of what they would be if the full-load current were on the whole time. The whole solution is an approximate one, and, if one chooses, one can assume the average current to be, say, 50 per cent. of the maximum—the losses would, of course, then be proportional to the square of the current *if it were constant at 50 per cent. the whole time*, which, of course, it is not, or it would never transmit the full load required. This assumption, however, is not likely to be much more correct than any other one.

With regard to the resistance of 40 miles of No. 8 S.W.G., as "Duplicator" points out, this is not 59·5 ohms. Through some slip the No. 8 S.W.G. has been substituted for No. 6 S.W.G. If the curve of cost is referred to, it will be seen at once that No. 6 S.W.G. is the correct size to use, specially if the power required is likely to increase. The writer believes his formula for voltage drop to be correct, and would be glad to know how "Duplicator" derives the expression volts loss $= \frac{\text{total energy loss}}{1\frac{1}{2}\,C}$. His own is obtained thus:

Let V = virtual volts at generator end of line;
V_1 = virtual volts at distant end of line;
Let R = ohms resistance of one line;
C = current;

then $$C V \sqrt{3} \cos\theta = C V_1 \sqrt{3} \cos\theta + 3 C^2 R$$

$$(V - V_1) = \text{lost volts} = \frac{C R \sqrt{3}}{\cos\theta}$$

or with a power factor of 1 $= C R \sqrt{3}$

Yours, etc., NEWCASTLE.

ALTERNATE-CURRENT MACHINERY—INDUCTION ALTERNATORS.*

BY WM STANLEY, ASSISTED BY G FACCIOLI.

In the following pages it is proposed to discuss some of the elementary phenomena found while studying the performance of alternators excited by alternating currents. The alternators have their rotors and stators wound with distributed windings. The rotor circuits are supplied with very low frequency multiphase currents, as shown in Fig. 1. These currents produce a field, or fields, which move around the rotor at a speed proportional to the frequency of the magnetising or exciting source.

If the connection of the multiphase exciter is such as to produce a clockwise electromagnetic rotation of the field (rotor), the rotor structure of the alternator may then be mechanically revolved either in the same or in an opposite direction. Let n be the frequency of the exciting circuit and n_1 the frequency of mechanical rotation, then if the electromagnetic and mechanical rotations are in the same direction, the speed of the flux will be proportional to

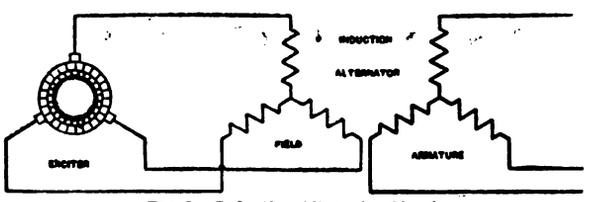

FIG. 1.—Induction Alternator Circuits.

$n_1 + n$; if they are in opposite direction to $n_1 - n$, and, as will be shown, these two relative arrangements produce very different phenomena. Call $n_1 + n$ or $n_1 - n = n_{11}$ = the frequency of the currents induced in the stator or armature conductors of the machine, evidently when $n = n_1$, $n_1 - n = 0$, and there is a stationary field in the space opposite to the stationary armature conductors; consequently no E.M.F. is induced. Suppose, however, that n is small compared to n_1—for example, let the exciting frequency $n = 1$ cycle, while the frequency of rotation $n_1 = 61$ cycles, then

$$n_1 - n = 60 \text{ cycles.}$$
$$n_1 + n = 62 \text{ cycles.}$$

Consider the first case for a moment. Suppose the stator or armature of the alternator is supplying current to an external circuit; then, if we have a clockwise rotation (revolutions per minute) of 61 cycles and a counter-clockwise electromagnetic rotation (exciting current) of one cycle, the effective field rotation is clockwise and 60 cycles; consequently, the armature (stator) currents are also of 60 cycles frequency. But these stator currents produce a field in the air gap of the machine, and this field revolves synchronously with the rotor induction, but not synchronously with the rotor conductors, for they (the conductors) are going faster—viz., at the rate of 61 cycles. They are, therefore, constantly overtaking the stator-produced field, and passing through it—that is to say, cutting it, and they, therefore, have E.M.F. induced in them of a frequency $= 61 - 60$ cycles $= 1 = n$, the exciting frequency; the final result being that an E.M.F. of the same frequency as that of the exciting current is produced in the rotor (field) conductors, by simply loading the alternator in the usual manner. This "stator-induced E.M.F." in the rotor conductors is evidently proportional to and in quadrature with the stator current. It is zero when the stator current is maximum, maximum when the stator

* Abstract from *Electrical Review* of New York of paper presented at the twenty-second annual convention of the American Institute of Electrical Engineers, Asheville, N.C., June 23, 1905.

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current is zero, etc. It is of the utmost importance in the phenomena to be described, for if the rotor circuit be of low resistance (great time-constant) the "stator-induced E.M.F." in the rotor will produce a current (called "stator-induced current") approximately equal in value, nearly opposite in phase to the stator current, and, consequently, competent to neutralise the magnetomotive force of the armature or stator circuit and to destroy almost completely the magnetisation due to the stator winding. In such an alternator there should be, then, no armature reaction, no back magnetisation, no distortion of the field of the machine.

At first sight it would seem that these machines should give a constant E.M.F. at all loads; when excited at constant potential they do not do this, but they give, when properly designed, a gradually rising potential at power factor = 1 with a slight drop of potential for lower power

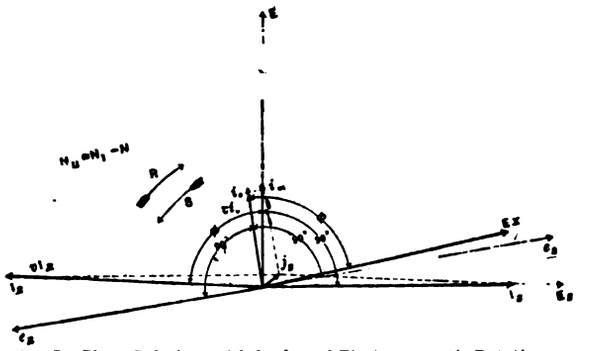

FIG. 2.—Phase Relations with Backward Electromagnetic Rotation.

factors down to power factor = 0. In Figs. 2 and 3, Mr. Faccioli has represented the phase relations of the E.M.F., currents, etc., when (Fig. 2) the effective frequency of the alternator is equal to the difference between the rotational and magnetising frequencies, and (Fig. 3) when it is equal to their sum. In the diagram here given the ratio of the rotor to the stator turns is assumed to be 1 : 1; the ohmic and inductive resistance of the exciter is zero—that is to say, the exciter is assumed to maintain a constant terminal potential.

In the case of Fig. 2 ($N_{11} = N_1 - N$) the flux of the alternator rotates in one direction regarding the rotor and in the opposite direction regarding the stator; therefore, the diagram is supposed to rotate in the direction R regarding the rotor, and in the direction S regarding the stator. v is the leakage coefficient of the rotor—that is, the ratio between the flux produced by the rotor which enters the

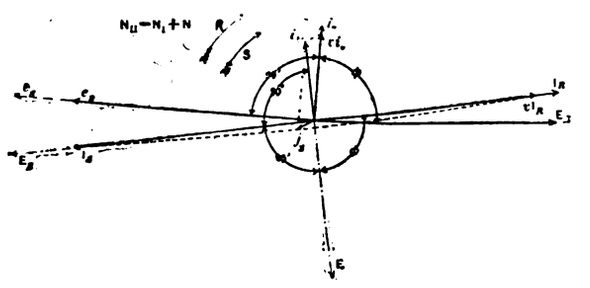

FIG. 3.—Phase Relations with Forward Electromagnetic Rotation.

stator and the total flux set up by the rotor. The leakage coefficient of the stator is assumed to be equal to the leakage coefficient of the rotor. E_x represents the E.M.F. of the exciter (low frequency) which is supplied to the terminals of the rotor, and is assumed as constant for any load of the machine. i_0 is the magnetising current of the machine at no load and lags behind E_x by the angle ϕ; ϕ being a function of the resistance of the rotor and the frequency of excitation. At no load the flux set up by i_0 will induce an E.M.F., e_R, of the terminals of the rotor; a part of the same flux proportional to $v\,i_0$, will induce an E.M.F., e_S, at the terminals of the stator.

Now consider the case in which the machine is loaded by the current I_S at power-factor unity. The current, I_S, of the stator (armature) induces at the terminals of the rotor (field) an E.M.F. in the direction of E, proportional to the frequency of excitation of the machine. The E.M.F., E, produces in the rotor a current, I_R, which lags behind E by the angle ϕ. I_S and $v\,I_R$ give a resultant, j_S, whose magnetomotive force is superimposed on the original magnetomotive force, $v\,i_0$, giving a resultant magnetomotive force, I_m, which is in quadrature with I_S. The E.M.F. of the stator is E_S in quadrature with i_m, and, therefore, in phase with I_S. In the case of Fig. 3, when ($N_{11} = N + N_1$), the diagram rotates in the same direction regarding the stator and the rotor. The same symbols represent the same quantities as in Fig. 2. In this case the E.M.F. e_S and e_R have the same direction, and the resultant magnetomotive force, j_S, has such direction as to decrease the original magnetisation, $v\,i_0$, of the machine; while in the case of Fig. 2, the magnetomotive force, j_S, due to the load currents, has the effect of increasing the no-load magnetisation of the machine. When, therefore, the generated frequency of the machine is equal to the difference of the frequency of rotation and the frequency of excitation, the magnetisation of the machine may be higher when

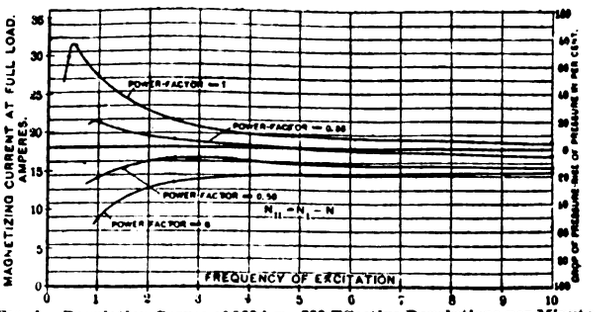

FIG. 4.—Regulation Curves of 100-kw., 900 Effective Revolutions per Minute, 60-Cycle Induction Generator.

loaded with non-inductive load than when running free; this result being principally due to the resistance of the rotor or field, which prevents the current I_R from lagging exactly 90deg. behind E, and, consequently, neutralising the magnetomotive force of I_S. On the other hand, the resistance of the rotor when the generated frequency is equal to the sum of the frequency of rotation and the frequency of excitation, has the effect of decreasing the magnetisation of the machine when loaded with non-inductive load. If the rotor of the machine had zero resistance and perfect mutual induction, then the rotor current, I_R, would lag exactly 90deg. from its E.M.F. in both Fig. 2 and Fig. 3, and would be exactly equal and opposite to the stator current, I_S. There would

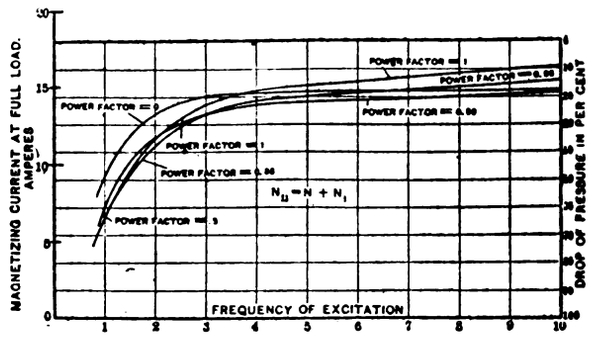

FIG. 5.—Regulation Curves of 100-kw., 900 Effective Revolutions per Minute, 60-Cycle Induction Generator.

be no resultant magnetomotive force due to the load, and, therefore, j_S would be equal to zero, and the machine would have constant E.M.F. at any load and at any power factor. It then appears that if a machine of this type—that is, a machine with almost perfect mutual induction and very low resistance—could be built, there would be very little difference in its regulation when excited by forward and backward running fields. The principal difference would consist in the fact that with a forward running excitation the exciter would supply energy to the alternator in proportion to the ratio of the exciting to the generated frequency, while with the backward running excitation the exciter delivers no energy to the alternator, but receives energy from it.

Fig. 4 shows the regulation of the induction alternator at different frequencies of excitation. The curves belong to a 100-kw., eight-pole, 60-cycle, 900 effective revolutions per minute machine built by the Crocker-Wheeler

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Company for experimental purposes. Figs. 2 and 3 refer to the same machine. The curves of Fig. 4 are in perfect accord with the actual tests made on the machine, the results of which are given later on. This figure shows that for each machine—that is, for each combination of resistance and leakage in any machine—there is a certain frequency of excitation below which trifling changes in the constants of the alternator produce great changes in its potential characteristics. For small high-frequency machines an exciting frequency of about five cycles may be required, while on large machines in which the resistance and leakage may be relatively lower, the exciting frequency may be as low as one cycle. In a similar way it is possible to study the influence of the variations in the exciting frequency in the case of the forward rotation of the field. Fig. 5 gives the regulation of the same 100-kw. alternator at different power factors for different frequencies of the field. The curves in Fig. 5 show that, in the case of forward rotation of the field, the potential of the alternator will drop at any power factor, due to the effect of the resistance and leakage, but the difference in regulation between power-factor unity and lower power factor is very small in comparison with the results obtainable with the alternators of standard type. (The phenomena in this machine are magnified by the high resistance of the rotor.)

The variation of the air-gap in these machines has a peculiar influence on their regulation. Doubling the air-gap of the same machine has very little effect on its regulation at the frequency which is used for its excitation (about five cycles). This is due to the fact that any increase in the air-gap involves an increase in the no-load

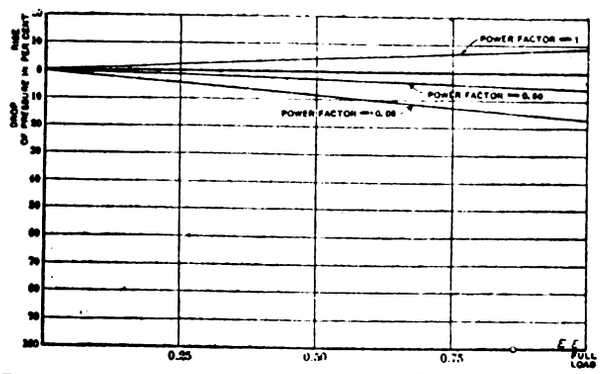

FIG. 6.—Regulation Curves of 100-kw., 900 Effective Revolutions per Minute, 60-Cycle Induction Generator.

magnetising current of the machine and an increase of the leakage coefficient, v, and these two phenomena have conflicting influences on the regulation of the alternator. When, however, the leakage of the machine is comparatively low, as in the case of high-speed alternators with a small number of poles, and the no-load magnetising current is high (large air-gap), then something is gained in regulation by increasing the length of the air-gap. For instance, this is the case with turbine alternators where a large air-gap is required for mechanical reasons.

Considering now the phenomena of the system, the following general conditions are found: the current in the exciting circuit is composed of two parts or components—first, that due to the exciter E.M.F., which is the no-load magnetising current; secondly, the current due to the E.M.F. generated in the field (rotor) conductors by the stator load current. The first of these, the no-load magnetising current (volt-amperes), is for any given capacity of the alternator inversely proportional to its speed—that is, is proportional to the number of poles of the alternator for any given generated frequency, or is proportional to the frequency of the alternator driven at constant speed. This magnetising apparent energy is therefore small with high-speed machines of given frequency, and small with low-frequency machines of given speed; consequently, it is smallest in low-frequency turbine alternators and is larger in slow-speed direct-connected high-frequency machines. It is to be remembered, however, that the magnetising current is only a fractional part of the full-load current in the exciting circuit; therefore it is not necessarily a limiting condition, and does not determine the size of the exciter.

The second component of the exciting current is the superimposed component, and is approximately equal in total amperes to the armature current of the alternator. The E.M.F. of the exciter is proportional to the E.M.F. of the alternator multiplied by the ratio of the exciting to the generated frequency. The two components of the exciting current (the magnetising and superimposed) have the following phase relations. When the alternator is delivering current at power-factor unity, the magnetising and superimposed components are nearly in quadrature; when the alternator delivers current at power-factor zero, the components are nearly in phase. If we call M the no-load magnetising volt-amperes of the exciter, N_1 the frequency of excitation, N_{11} the generated frequency of the alternator, W the capacity of the alternator in kilovolt-amperes, we have the size of the exciter approximately proportional to

$$\sqrt{M^1 + W^2 \frac{N^2_1}{N^2_{11}} + 2\,M\,W \frac{N_1}{N_{11}} \sin\phi};$$

ϕ being the maximum angle of lag of the current that the alternator is called upon to deliver. Thus, if the alternator is a 100-kw. 25-cycle machine excited at a frequency of 2·5 cycles, and the no-load magnetising volt-amperes are five kilovolt-amperes, and if the alternator is called upon to deliver its full-load current at power factor 0·5, the size of the exciter is:

$$\sqrt{5^2 + \left(100\,\frac{2{\cdot}5}{25}\right)^2 + 2 \times 5 \times 100 \frac{2{\cdot}5}{25} \times 0{\cdot}86} = 14{\cdot}5 \text{ kilovolt-amperes.}$$

It will then be seen that the exciter is called upon to carry a current practically equal in total amperes

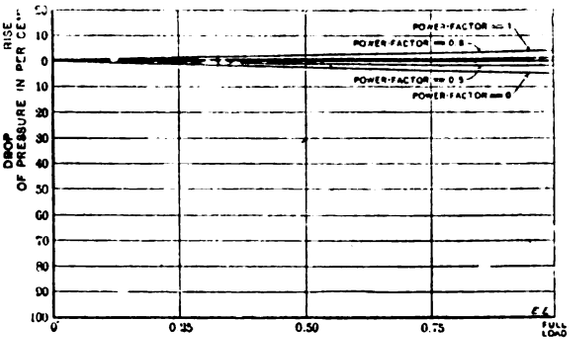

FIG. 7.—Regulation Curves of 1,500-kw., 1,500 Effective Revolutions per Minute, 25-Cycle Induction Turbine Alternator.

to the load current of the alternator, the apparent energy of which is dependent on the frequency of excitation; consequently, the aim of the engineer is to so design his machines that they will require the minimum exciting frequency.

Fig. 6 shows the regulation curves obtained from tests of the 100-kw., eight-pole, 60-cycle, 900 effective revolutions per minute alternator above mentioned, as a function of the load of the machine when its field is excited by five-cycle current at constant potential (backward rotating field). For full load of alternator at power factor 0·8 the size of the exciter is 13 kilovolt-amperes, or 13 per cent. of the size of the alternator. The curves agree very closely with the calculated characteristics of the alternator. Fig. 7 refers to a 1,500-kw., 25-cycle, 1,500 effective revolutions per minute turbine alternator. The frequency of excitation is 0·75 cycle, and the exciter at full load of the alternator power factor 0·8, has a capacity of 95 kilovolt-amperes—that is, 6·5 per cent. of the size of the alternator. Fig. 8 gives the exciting watts for different loads of the 100-kw., 60-cycle, eight-pole alternator (at unity and lower power factors). As shown by these curves, the energy delivered to the alternator at no load is small and positive. As the alternator load increases the current in the rotor magnetising circuit increases, but the watts fall to zero and reverse—that is, the current in the rotor-exciter circuit lags until it exceeds 90deg. behind the exciter E.M.F. It therefore flows through the exciter against the exciter's E.M.F., just as a current delivered by a generator flows through a motor circuit against the counter E.M.F. of the motor.

The all-important factor in the design of induction alternators is, then, the excitation. At first sight the designing of an efficient and economical exciter to deliver multiphase

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exciting currents of five cycles or lower frequency would appear to be an almost hopeless undertaking, for if an exciter of, say, three-cycle frequency and 50 kilovolt-amperes is necessary to furnish the field and controlling current for a 500-kw. alternator, working on old lines, we should be compelled to design a two-pole machine of 180 r.p.m. to deliver 50 kilovolt-amperes at power-factor zero to unity power factor. The manufacture of such a machine would ruin any going concern. We are therefore compelled: (1) to find such a method of generating the exciting currents as will permit the use of normal speeds and consequent reduction of size of the exciter—that is, the exciters must be designed to give low frequencies at high speed; (2) to produce the desired potential gradient on the alternator, we must so design the exciter that it will have a characteristic complementary to that of the natural characteristic of the alternator it excites. These are severe conditions to impose upon any machine, but they have been met in a novel manner in the machine about to be described. It is evident that if the field of an ordinary direct-current machine is slowly alternated, corresponding alternations in the E M F. of the armature will occur. Such a machine could evidently be driven at any speed and would give alternating current through its commutator and brushes corresponding in frequency to the frequency of its field, but it could furnish single-phase currents only. It is evident also that two such machines could be coupled on the same shaft, each

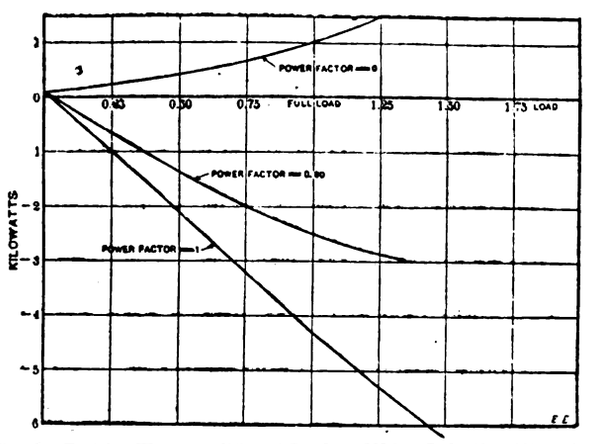

FIG. 8.—Exciting Watts for different Loads of 100-kw. Induction Alternator.

machine having its field excited by low-frequency and phase-differing currents; and such an arrangement would generate from the two armatures two phase-differing currents, whose frequency is independent of the speed of rotation. If, now, these two fields are combined in one machine—that is, if the field is a Ferraris or rotating field instead of a simple periodic field—it is evident that a single armature with a simple commutator and four brushes placed in quadrature around the commutator will deliver two sets of alternating currents, differing in phase by the angle of the brush displacement, and at the same frequency as the rotating field, and that the figuring of the generated currents will be independent of the speed of rotation. Such an arrangement might be a machine in which the stator consists of a four-pole structure having energising coils diametrically located on opposite poles and connected to a two-phase source of excitation, while the armature and commutator deliver two-phase currents to external circuits. But this arrangement presupposes and employs a third element to furnish the original exciting current of the exciter.

In order to make the exciter self-exciting and self-contained, and to reduce the apparatus to the simplest terms, the following scheme for excitation has been devised (Fig. 9). A pair of brushes corresponding to those of an ordinary generator is connected to a field coil, so located with reference to these brushes that the flux it produces will be displaced by a predetermined angle dependent upon the number of phases desired. Thus for a two-phase machine a pair of brushes is connected to a field coil so located as to produce a flux, by means of which and by rotation an E.M.F. is generated upon the other pair of brushes, while the second pair of brushes is connected to a coil so located as to produce a flux that will generate an E.M.F. on the first pair of brushes. This is shown in Fig. 9, which illustrates the connection and operation of self-excitation by means of two and three phase currents. Let the residual magnetism of the machine be as shown in the diagram. Then, on rotating the armature, an E.M F. will be developed on brushes 2—4. These brushes are connected to the field winding at X—X¹ instead of at Y—Y¹, as is usual in exciting continuous-current machines, consequently a current will flow, say, from X through a—a to X¹, producing a flux through the armature at 90deg. to the residual magnetism. A resultant field will, therefore, lie between the points Y—X and Y¹—X¹, but this field will generate an E.M.F. on brushes 1—3, and these brushes will deliver a current through Y—a—a—Y_1 in such a direction as first to oppose the residual magnetism and afterward reverse its direction. At the instant that the residual magnetism is zero the only field operating in the machine is that due to the currents from the brushes 2—4; subsequently this field combines with the vertical reversed field to brushes Y—Y_1, producing a resultant with polar line between X—Y¹. These operations being cyclic, they recur at periodic intervals, and the phenomena become continuous. At the resistance of the energising circuit a—a is low in comparison with its inductance, the currents delivered from each pair of brushes lag nearly 90deg. behind the E M.F.'s, and, therefore, little energy is wasted in field excitation. This process of excitation presents many curious and interesting features. If, for example, one of the magnetising circuits, such as X, be disconnected from the armature, the field immediately dies out, even if there is no current in circuit at the instant of the breaking.

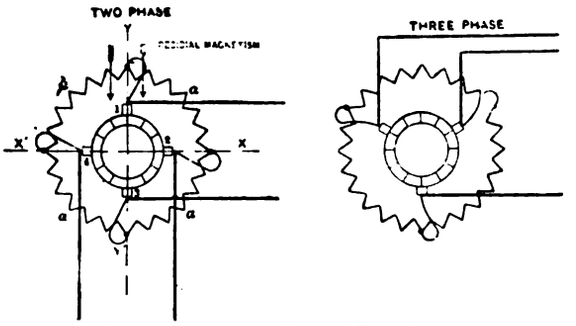

FIG. 9.—Self-Excitation by Two and Three Phase Exciters.

The approximate calculation of the frequency of self-excitation as given by Mr. Faccioli will be found by considering for a moment the physical phenomena that occur. Assume the speed of rotation of the armature to be n_1; let the machine be a single magnetic circuit machine with X conductors in the armature and Y conductors on the stator. A moment's consideration of the laws of induction will show that the direction of the current delivered by the armature to the field must be such as to produce a field rotating in the same direction as the rotation of the armature. Let the frequency of this rotating field be N, then evidently the effective frequency of the armature conductors will be:

$$N_1 - N = N_{11}.$$

We therefore have X armature conductors cut by the flux of the machine at frequency n_{11}, and Y conductors of the field cut by the same flux at frequency N; therefore there will be two E.M.F.'s, one on the rotor and one on the stator for each magnetising circuit, and, as is evident, the condition of equilibrium of current flow will be obtained when these two E.M F.'s are equal and opposite to each other. This condition of equilibrium will always be fulfilled for a certain frequency of self-excitation; such, in fact, as will make

$$X N_{11} = Y N.$$

But $$N_{11} = N_1 - N,$$

so $$Y N = (X N_1 - N),$$

and $$N = N_1 \frac{X}{X+Y}.$$

That is, the frequency of self-excitation will be equal to the frequency of rotation times the turns on the rotor divided by the sum of the turns on the rotor and stator. By

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this formula we can easily determine the winding of a machine for a given frequency of self-excitation; for instance, in the case of a two-pole machine in which the speed of rotation is 900 r.p.m. (15 cycles) the number of armature conductors is 200 and the frequency of self-excitation desired is three cycles, we find that the number of turns required on the stator is

$$\frac{200\,(15-3)}{3}=800.$$

Evidently these results are only strictly true when the resistance and leakage of the machine are zero, or not considered, as these quantities have a slightly modifying effect. When the windings are similarly disposed in rotor and stator it is not necessary to take into consideration the winding distribution coefficients, but the proper coefficients should be employed when the stator has salient poles. This type of machine satisfies, therefore, the first condition laid down as necessary for a commercial exciter, for it produces low-frequency multiphase currents at normal speeds. It also fulfils the second condition—that it should deliver zero and negative power-factor currents at constant or rising potential with much greater exactness than the ordinary type of alternator; for the reason that the armature reaction of a machine of this type may be made practically zero, because the field of the machine progresses in the same direction as the rotation of the armature, and consequently tends to maintain the E.M.F. at low power-factor loads, and because it may be compensated to give a positive potential gradient.

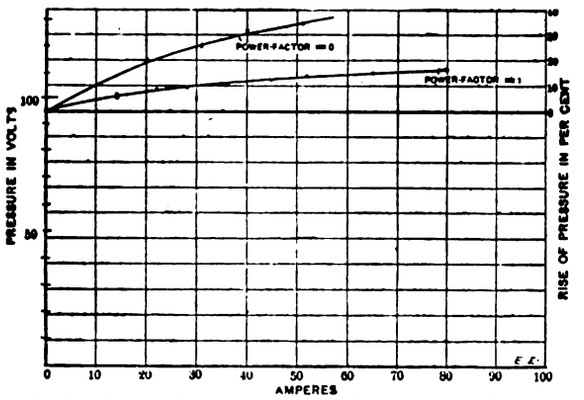

FIG. 10.—Voltage Characteristics of a 10-Kilovolt-Ampere Exciter.

Fig. 10 gives the voltage characteristics of a 10-kilovolt-ampere exciter as a function of the amperes of load for power factor = 1 and power factor = 0. The frequency of self-excitation of this machine, when run at 900 r.p.m., is five cycles. An examination of the characteristic curves of the induction alternator ($n_1 - n$) type (Fig. 6) shows that the potential gradient of these machines is positive for load currents of unity power factor, zero for load currents of (about) power factor = 0·8, and negative for currents of power factor = 0. If, therefore, the exciter is given such a characteristic that the E.M.F. of the exciter will be slightly lower when the alternator is full loaded with power factor = 1 currents, and slightly higher when the alternator is delivering low power-factor currents, the potential of the alternator may be maintained practically constant for any variation in load or power factor. It is to be remembered that the exciter when used with ($n_1 - n$) type of alternator is never called upon to furnish power-factor unity currents, but to receive them, and that the magnetising reaction of such currents upon the exciter field is exactly the reverse of that found when the power-factor unity currents are delivered; therefore, the exciter should be so designed when used with this machine as to give an increase of potential when delivering power-factor unity currents (that it may have a negative potential gradient when receiving them), as well as a slight increase of potential when delivering power-factor zero currents.

Oxford.—Mr. Worby Beaumont, who has been reporting on the traffic facilities of Oxford, has advised that the tramways should not be electrified, but that a motor omnibus service should be started. The Corporation called in two experts, and we expect that Mr. Stephen Sellon's advice will conflict with the above.

TRADE NOTICES AND NOVELTIES.

Automatic Devices.

From the Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., we have received an interesting list of their automatic time integrating devices, of which we have selected two for special reference herewith. Where

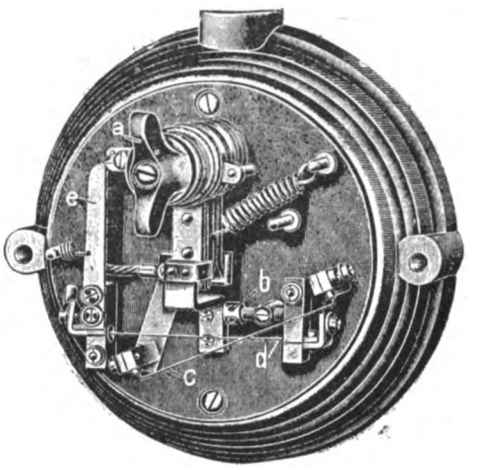

FIG. 1.—Maximum Switch.

current is supplied at time rates for small motor, arc, or incandescent lamp circuits, it is desirable to have a switch which automatically opens the circuit when the maximum agreed current is exceeded. It is claimed that the maximum switch (Fig. 1) does this both safely and effectively without adding materially to the cost of the installation. A cover of either stout insulating material, zinc or iron, encloses the mechanism, which consists of a hand switch operated from outside against a spring. The switch blade is held in the contact position by a detent operated by a control wire through which the main current flows. Excess of current lengthens this control wire, *d*, thereby permitting the lever, *e*, to move sufficiently to release the detent holding the switch. By means of the screw, *b*, the regulation can be altered to about 20 per cent. + or −. The device Fig. 2 is designed for cases where it is desired to switch on or off, at a distance, one or more circuits of considerable ampere capacity by means of either a high or low voltage operating circuit. It consists of a powerful switch with quick make and break, controlled by a spring mechanism and worked by a small current in a fine-wire operating circuit. This operating circuit can be closed by either the firm's contact clock or by one or more of their contact makers coupled in parallel. There are two finishes, one in an oak case and the other in a metal watertight case. For the rest it must

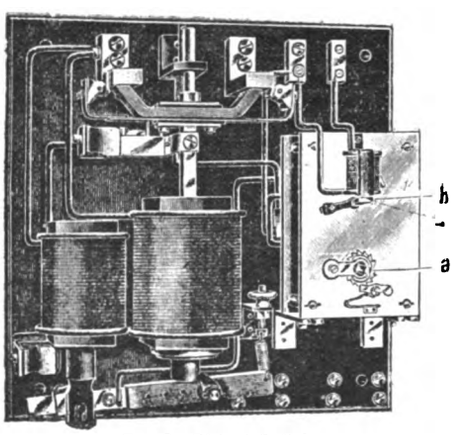

FIG 2.—Distant Switch.

suffice to say that the devices described in the list under notice embody many new principles in the way of determining the charges for the supply of current and controlling the current in use.

B.T.H. Motors and Generators.

We are indebted to the British Thomson-Houston Company, Limited, Rugby, for particulars of a new line of continuous-current motors and generators which they are introducing to the trade. These machines will be known as the "D B" and "M P" types respectively, the first-mentioned ranging in capacity from 25 h.p. to 70 h.p. as motors and from 20 kw. to 50 kw. as generators, while the "M P" type will be made in standard sizes for capacities from 70 h.p. to 100 h.p. as motors and 50 kw. to 100 kw. as generators. The "D B" motors and generators are supplied either without covers, with perforated

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covers, or with solid covers. The ventilated machines are fitted with removable perforated covers, and the totally enclosed machines with removable solid covers, and although well protected, the brushes, commutator, and bearings are made very easy of access. On the other hand, the "M P" machines are supplied in "open" type only, and are not suitable for enclosure. In both "D B" and "M P" machines the frame, which is also the magnet yoke, is of cast iron and circular in form. The "D B" machines are provided with end shields (see Fig. 1), which afford protection and support the bearings. The commutator end shield is in the form of a commutator box with

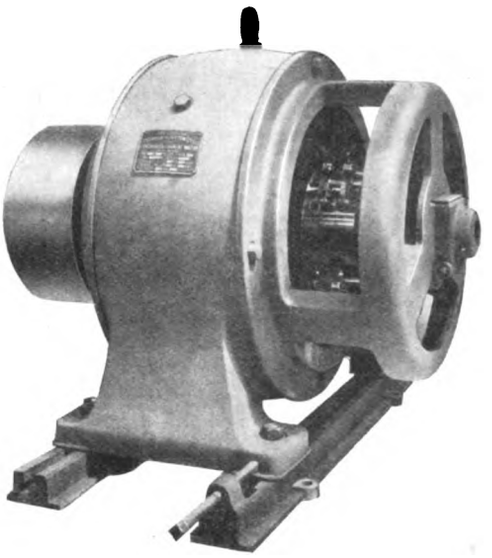


FIG. 1.—"DB" Protected Motor.

hand holes, and the pulley end shield is of dished form with three openings. The hand holes give access to the commutator and brushes, and allow of general inspection of the moving parts, at the same time permitting a thorough circulation of air through the motor. The "M P" machines have no end shields, the bearings and frame being supported on a common bed-plate (see Fig. 2). The frame and bearings, it will be seen, are divided in a horizontal plane, permitting easy removal of the armature. In both types the field coils are held in position by means of the projecting pole tips, and can be readily removed. The magnet cores are of laminated iron punchings. By turning

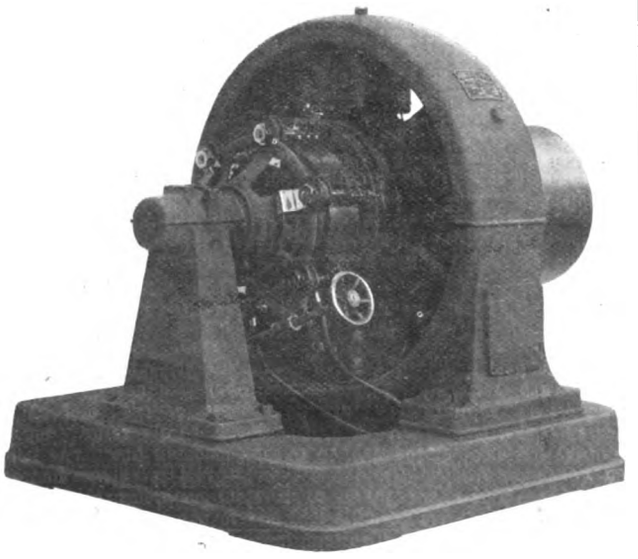


FIG. 2.—"MP" Motor.

the end shields 90deg. or 180deg., the "D B" motors may be arranged for operating on wall or ceiling. The bearings of the "M P" machines are of the self-aligning type. In both cases the bearings are lubricated automatically by oil wells and rings, and are provided with gauges. Further, in both types the armature (Fig. 3) is drum wound, and consisted of a laminated core with slots in which the form-wound coils are embedded. The core is built up on a spider keyed to the shaft. The armature is so constructed as to permit a thorough circulation of air through core, windings, and commutator. The commutator is mounted on an extended sleeve on the armature spider, so that the shaft may be removed without interfering with the windings of the armature. The commutator shell is provided with air ducts running parallel to the shaft to allow of air passing into the armature from each end. The brush-holders of these machines contain a coil spring, which exerts a uniform pressure throughout the wearing length of the brush. With this type of pressure spring there is no appreciable friction which would tend to change the pressure on the brush after it is properly adjusted. An adjustable lever in the rear of the holder enables the pressure to be regulated throughout the whole life of the brush. The brushes are of carbon with pigtail connections, ensuring perfect electrical connection independent of the contact between the brush and holder. Any brush can be removed whilst the machine is in operation without disturbing the others and without removing the holder from the stud. The protected "D B" machines and type "M P" motors and generators will run for six hours at rated load and voltage with a temperature rise above the surrounding air as measured by thermometer on any accessible part of the machine not exceeding 40deg. C. (72deg. F.), the temperature of the air during

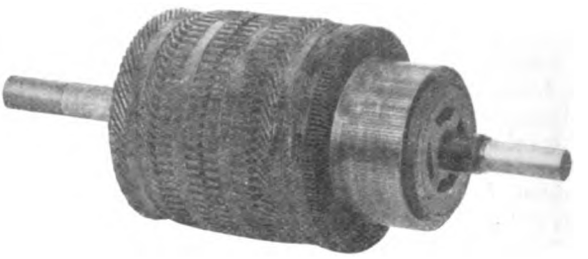
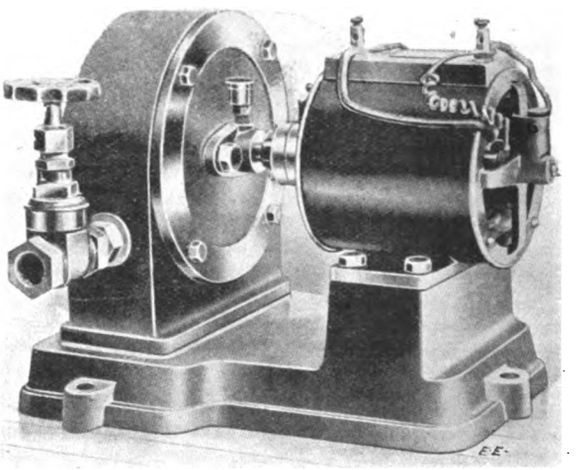


FIG. 3.—Armature for "DB" or "MP" Machines.

test not exceeding 25deg. C. (77deg. F.). Both "D B" and "M P" machines will operate without movement of the brushes and without sparking at the commutator from no load to 10 per cent. overload, and with overloads of 25 per cent. for one hour and 50 per cent. momentarily without injurious heating or sparking. Standard motors, either shunt or compound, are wound for circuits of 110 to 120, 220 to 240, 440 to 480, and 500 to 525 volts respectively. The "D B" and "M P" generators, it may be added, are also supplied both shunt and compound wound.

Combined Water-Motor and Dynamo for Charging Accumulators.

Accompanying is an illustration of a Pitman "Hector" water-motor coupled direct to a dynamo, the whole being mounted on one cast-iron bedplate. The "Hector" water-motor consists of a cast-iron body fitted with three adjustable nozzle tips of phosphor-bronze, the jet of water striking a small Pelton water-wheel, and exhausting at the bottom of the case by way of a small pipe, not shown in the illustration. The Pelton wheel is



Hector Water-Motor Combination.

a steel plate, fitted with phosphor-bronze buckets of special improved shape, and gives 85 per cent. efficiency with any pressure of water over 40lb. per square inch. With lower pressures a belt drive is necessary to get the requisite speed. The dynamo is of a special iron-clad type, wound to give any voltage desired, and the bearings are of great length, the whole apparatus being of thoroughly up-to-date and substantial construction. A ½in. bore pipe off the ordinary town's main is all that is required to drive it, and as the nozzles are extremely small (1/16in., ⅛in., and 5/32in.), and only one used at a time, the water consumed is negligible. The combination is silent running, and involves no risk of fire where motorcars and petrol are about. By means of the full-way regulating valve provided

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the speed of the motor can be reguiated as desired, and the machine may be left running without attention if fitted with a cut-out. We are indebted for the above particulars to the manufacturer, Mr. Percy Pitman, of Bosbury, Ledbury, where we understand similar combinations to that described above may be seen arranged for charging motorcar accumulators and for house lighting, with only 6ft. fall of water as motive power.

Network Ohmmeter

To meet the want of a rapid and reliable means of testing the joint insulation resistance of a complete three-wire network, without interrupting the supply, the ohmmeter shown in Fig. 1

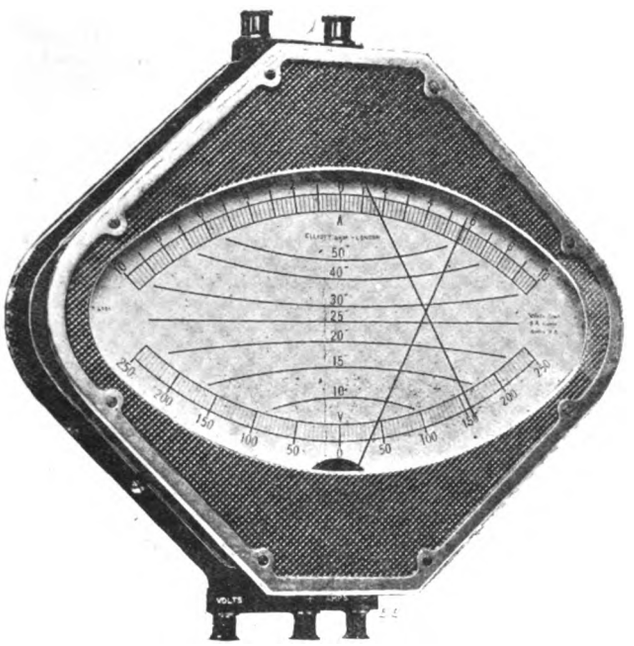

FIG. 1.—Network Ohmmeter.

herewith has been devised by Mr. Groves. The formula employed is $F = \frac{V_1 - V_2}{C} = \frac{V_1}{C} - R$; where F = joint insulation resistance in ohms; V_1 = potential between neutral and earth when there is no artificial earth connection; V_2 = potential between neutral and earth when an artificial earth connection

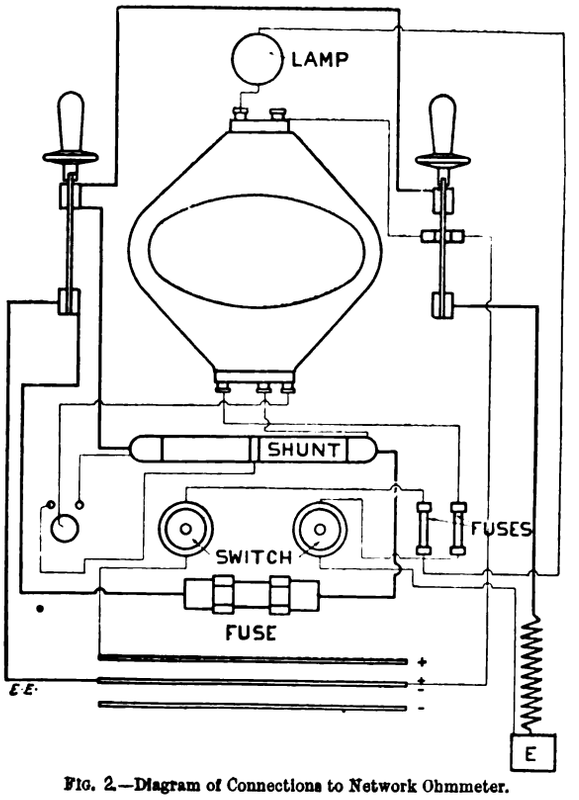

FIG. 2.—Diagram of Connections to Network Ohmmeter.

is made; C = current passing through the earth connection; R = resistance of artificial earth connection. R, being of low resistance, not exceeding, say, two ohms, may be ignored, and $F = \frac{V_1}{C}$. The instrument consists of a combined ammeter and voltmeter. The pointers move in parallel planes and overlap, the point of intersection of the pointers giving the required readings, F, on the scale. Fig. 2 shows a method of connecting up the instrument. The ammeter shunt of the ohmmeter is short-circuited by a switch, which is only opened when the test is being made, and when the recording ammeter shows a reading not exceeding the limits of the ampere scale of the ohmmeter. This switch is first opened, and then the operating switch. As the required deflection of the ammeter and voltmeter movements are obtained under different conditions, the operating switch is provided with an attachment which locks the ammeter pointer while the voltmeter pointer deflects. For the above particulars we are indebted to the makers of the instrument, Messrs. Elliott Bros., Century Works, Lewisham, S.E., who have also sent us an illustrated pamphlet describing their "Century" portable mains testing set. This set has been designed, we are told, with a view to provide the mains superintendent and cable engineer with an instrument that will cover the whole range of testing likely to be met with in laying and maintenance of underground cables. We must refer the reader to the pamphlet in question for details.

Catalogues, etc., Received.

LUBRICATION AND LUBRICATORS.—From Messrs. Rimington Bros., Carlisle, and 63, Queen Victoria-street, London, E.C., comes a catalogue dealing with lubrication and lubricators. This publication is a comprehensive one of its kind, and contains some information of an instructive and useful character for reference. It also includes particulars and illustrations of a great variety of oiling devices, etc.

ELECTRICAL COMPANY'S LITERATURE.—The following is a list of publications which we have received *en masse* from the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C.: Pamphlet No. 155 Nernst lamps for street and shop lighting; Leaflet No. 163, patent suspension chain; Card No. 166, flame arc lamp instructions; Leaflet No. 175, watt-hour meter; Leaflet No. 176, switchboard meter; Leaflet No. 177, new Nernst lamp reflector; Leaflet No. 178, artistic Nernst lamp fittings; Card No. XIII., 142/62, small motors; Card No. XIII., 146 A5, electric fans.

ALDERSHOT ELECTRICITY ACCOUNTS

The accounts of the Aldershot electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £25,619. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	1,332	11	8
Distribution of electricity	91	9	2
Attending and repairs to public lamps	26	7	7
Rents, rates, and taxes	105	8	10
Management expenses, salaries, etc.	372	2	7
Special charges, insurance, etc.	36	18	2
	1,964	18	0
Bad debts	11	7	2
Balance of revenue account	1,549	16	2
	£3,526	1	4

Cr. Income.	£	s.	d.
Sale of current to private consumers by meter	3,071	9	7
Ditto for public lighting	334	11	3
Rental of meters	5	2	0
Sale and repair of lamps, etc.	81	14	5
By accumulator charging	33	4	1
	£3,526	1	4

GENERAL BALANCE-SHEET

Dr. Liabilities.	£	s.	d.
Capital account—amount received	25 837	0	0
Sundry creditors	1,666	5	11
Balance at credit of net revenue account	29	5	2
	£27,532	11	1

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	25,619	6	8
Stores on hand	104	11	4
Sundry debtors for current supplied, etc.	1,085	19	6
Cash with treasurer and in hand	722	13	7
	£27,532	11	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		224,476
Quantity sold { Private consumers by meter	153,842	186,196
Quantity sold { Public lamps	32,354	
Quantity used on works		24,616
Total quantity accounted for		210,812
Total maximum supply demanded (kilowatts)		185

Number of public lamps: 17 arcs, 23 incandescents.

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BARNSTAPLE ELECTRICITY ACCOUNTS.

The accounts of the Barnstaple electricity department for the year ended Dec. 31, 1904, show a total expenditure on capital account to that date of £28,062. Abstracts of the revenue account, etc., are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	1,165	2	7
Distribution of electricity	53	17	10
Attending and repairs to public lamps	75	14	3
Rents, rates, and taxes	126	6	4
Management expenses, salaries, etc.	350	5	7
Special charges, insurance, etc.	48	15	6
	1,820	2	1
Amount carried to net revenue account	1,265	5	3
	£3,085	7	4

Cr. Income.	£	s.	d.
By sale of current per meter	1,255	7	10
Public lighting	1,602	14	6
Rental of meters	33	6	0
Sale of lamps, carbons, etc.	190	5	10
Charging accumulators, etc.	3	13	2
	£3,085	7	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	27,051	1	0
Sundry creditors	833	19	5
To treasurer	2,030	9	5
	£29,915	9	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	28,062	6	4
Stores on hand	136	7	3
By stores (capital)	194	12	4
Sundry debtors for current supplied	514	13	5
Other debtors	11	13	9
Balance of revenue account	995	16	9
	£29,915	9	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		220,122
Quantity sold { Private consumers by meter	68,853	145,014
Quantity sold { Public lamps	76,161	
Quantity used on works		55,876
Total quantity accounted for		200,890
Quantity not accounted for		19,232
Number of public lamps		137
Total maximum supply demanded (kilowatts)		180

APPOINTMENTS VACANT.

Head of the Department of Physics and Electrical Engineering, Portsmouth Education Committee. Salary, £175 per annum. Application by Sept. 4. See advertisement.

Draughtsman for switchboards. Apply to Box H 91, *Electrical Engineer* office. See advertisement in last issue.

Draughtsman for works in North of England. Apply to Box O 8, *Electrical Engineer* office. See advertisement.

Canvasser, wages 25s. per week and commission. Letters only, Midland Electric Corporation for Power Distribution, Limited, 73, Lichfield-street, Wolverhampton. See advertisement.

Engineers in charge of a H.T. generating station. Salary from £7 to £9.—Apply to X 55, *Electrical Engineer* office. See advertisement.

District Representative for firm of manufacturing electrical engineers. Apply to "Electric," care of Hart's Advertising Offices, 6, Arundel-street, Strand, W.C. See advertisement.

LEGAL INTELLIGENCE.

A LONG-FIRM PROSECUTION.

At the Guildhall last week, George Webber, ironmonger, of High-street, Putney, and Richard Thomas Rosenberg, described as a motor-car driver, of 66, Gardener's-lane, Putney, surrendered to their bail to answer a charge of conspiring with others to obtain money and goods by false pretences.

Mr. BODKIN (who, with Mr. Boyd, appeared for the prosecution) said that defendants were charged with conspiracy with two other persons whose names were now public property—William Leslie, and a woman, Frances Cheeseman—to cheat and defraud various firms of electrical appliances manufacturers. Money and goods to the extent of many thousands of pounds were obtained by these four persons. Rosenberg posed as a "Mr. Knight" in connection with a company called the Electrical Accessories Co., which came into existence in November last. Its offices were at 83, Terminus-chambers, Holborn, and Rosenberg, *alias* Knight, in an affidavit had described himself as manager. The company's premises consisted of one small room in the back of a building that was formerly the Holborn Viaduct Hotel. So far as the prosecution were aware, no goods were ever stored in this one room occupied by the Electrical Accessories Co. Webber was an ironmonger who had been doing odd jobs for a year or two past at the Fulham Theatre, and in that capacity he came in contact with Leslie the electrician, who was engaged permanently at £3 a week. In December, 1904, the theatre changed hands, and it was just before this, and when the intending change would be known, that the Electrical Accessories Co. came into existence. Mr. Arthur, who was taking over the theatre, required the electric light installation seen to, and Mr. Henderson, the outgoing proprietor, requested Leslie to furnish an estimate of the cost of the material that would be necessary. Leslie gave his estimate—£53. This was the opportunity for commencing these frauds. Webber assumed the position of constructor of the electrical work to be carried out, which by this time had been considerably inflated, and sent out orders broadcast over London for many thousand pounds' worth of goods of all kinds connected with electrical appliances and motorcars.

After evidence had been called the case was adjourned.

Bail for Webber was fixed at £2,000, and for Rosenberg at £100.

BREAKING TELEGRAPH INSULATORS.

At Seaham Petty Sessions James Bolton was charged with committing wilful damage to telegraph insulators, the property of the Postmaster-General, on the Stockton-road, near New Seaham, on Aug. 6. Defendant pleaded guilty. Sergeant Jobling deposed that about 3 p.m. on the day mentioned he saw defendant and another young man sitting near a telegraph post on the Sunderland and Stockton road. Returning about an hour later witness found that two of the insulators on the post had been broken, and from inquiries made he found Bolton had broken them. When charged by the officer defendant admitted the damage. A fine of 10s. and costs and 5s. damage was imposed.

John Hogg and John Allen were charged with a similar offence committed on Aug. 9. Both pleaded guilty. Defendants, aged 10 and 12, were seen by P.C. Ogleby throwing stones at the insulators, four being broken. They were reprimanded by the Bench, and ordered to pay costs and the damage, 10s.

Robert Norman was also ordered to pay costs for attempting to break insulators. He threw stones at them, but did not break any.

QUESTION OF ROAD REPAIRS.

An application was made to the local magistrates last week by the Jarrow Corporation to compel the County of Durham Electrical Power Distribution Co. to put certain roads in repair.

Mr. JOHN PETREE, borough surveyor, stated that on July 21 he gave the company notice of dangerous places near the Hill-street railway bridge which had not been properly filled up. He had communicated with the company two or three times since, and it was impossible to obtain any reply. The object of the company, he alleged, was to put the responsibility on the town, and a summons was granted.

COMPANIES' MEETINGS AND REPORTS

CHLORIDE ELECTRICAL STORAGE.

The annual general meeting of this Company took place at the Works, Clifton Junction, on the 23rd ult., Mr. W. Bannister, J.P., presiding. Particulars of the report appeared in our issue of the 18th ult.

The CHAIRMAN, in moving the adoption of the report, announced a most successful year's training. The profit for the year was £27,298, and after deducting debenture interest, depreciation, and interim dividend paid in March last, and adding the amount brought forward from last account, the disposable balance of profit was £11,979. A dividend of 6 per cent. on the preference shares and of 8 per cent., free of tax, on the ordinary shares was recommended. These together amounted to £4,520, leaving to be carried forward to next account £7,459.

The report was adopted.

The retiring directors, Messrs. W. Bannister and J. de Berniere Smith, were re-elected; and Messrs. Parkinson, Mather, and Co. having been reappointed auditors, the meeting closed with a vote of thanks to the directors and the staff for their services during the year.

An extraordinary meeting was afterwards held for the purpose of making certain alterations in the articles of association, which were unanimously decided upon. The shareholders were subsequently conducted through the extensive new works, and were much impressed with the explanations of the different processes.

ABERDEEN SUBURBAN TRAMWAYS.

The half-yearly meeting of the Aberdeen Suburban Tramways Company was held last week at Aberdeen, Mr. George J. Walker, chairman of directors, presiding.

The report showed that the sum standing at the credit of the profit and loss account was £2,166. 1s. 9d., which the directors proposed should be applied as follows: in setting aside for a renewal and depreciation account, £1,000; in payment of a dividend of 2½ per cent. for the past year on the paid-up capital of the Company, £780. 19s.; and in payment of directors' fees, £42; leaving to be carried forward to next half-year's accounts, £343. 2s. 9d.

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The CHAIRMAN, in moving the adoption of the report, stated that the question of depreciation had been carefully considered by the directors, who had obtained the fullest possible information as to the necessary requirements from past experience of other tramway companies in England and Scotland. Compared with the amount of the Company's capital it is a larger sum than is set aside by any electric tramway company last year, and larger than is set aside by the corporations of several towns where the tear and wear is as great or greater than on the lines of the Company. The Company's greatest drawback was, the chairman remarked, the price they had to pay the Corporation for energy—2¼d. per unit. He thought they might very well be supplied at 1½d., which was more than the Corporation trams were debited with.

The report was adopted unanimously.

NEW COMPANIES REGISTERED.

Torquay Tramways Construction Syndicate, Limited.—Capital, £140,000. Objects: to adopt an agreement with the Dolter Electric Traction Limited, and to carry on the business of railway and tramway proprietors, suppliers of electric light and power, electrical engineers, etc. Registered office: Queen Anne's-chambers, Westminster, S.W.

Sydsvenska Elektriska Aktiebolaget.—A Reuter's telegram states that a company has been formed at Halmstad, Sweden, under the above name for the purpose of generating electric power. The share capital is not to be less than 3,500,000 kronor (about £194,500), and not more than 10,000,000 kronor (about £555,500). The object of the undertaking is to supply the towns and industrial centres of the southern part of the province of Halland and the western portion of Scania with electrical power, which, in the first instance, will be generated by means of the Lagaa waterfall.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Stockport.—Tenders are required for supply and laying of cables. Tenders by Sept. 14.

Oban.—Tenders are required for supply and laying of feeders and mains. Tenders by Sept. 11.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Plasencia (Spain).—The municipal authorities require tenders for an electric lighting installation. Tenders by Sept. 15.

Pontypridd.—The Urban District Council invite tenders for (Section A) permanent way. Tenders by 12 noon on Sept. 2.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct coupled steam set.

Carlisle.—The Guardians invite tenders for installation of electric bells from 15 wards at the Fusehill Hospital. Tenders by noon on Sept. 4.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Zaragoza. Tenders by Sept. 12.

Bishop's Stortford.—The Urban District Council invite tenders for lighting such of the public streets as are at present lighted, for two or three years from Sept. 30. Tenders by 4 p.m. on Sept. 25.

Edinburgh.—Tenders are invited for the electric lighting installation at the mortuary buildings, High School Yards, Edinburgh, for the Lord Provost, Magistrates, and Council. Tenders by Sept. 11.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10 000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Chelmsford.—The Town Council invite tenders for lighting the public streets and public clock within the borough with electricity, gas, or other illuminating power for three or five years from March 25, 1906. Tenders by Sept. 8.

Ramsgate.—The Corporation invite tenders for a complete system of electric call bells between the new fire brigade station, Effingham-street, and the various firemen's residences within the borough. Tenders by noon on Sept. 4.

Paris.—The Waterworks Department of the Municipality require tenders for supply and erection of motors, pumps, and generators for the proposed waterworks at Chantilly. For particulars apply to above authority. Tenders by Oct. 12.

Ipswich.—The Guardians invite tenders for supply and erection of a dynamo and motor (to be made by Crompton and Co.), a battery booster, and alterations and additions to the main switchboard at the workhouse. Tenders by 10 a.m. on Sept. 14.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Merthyr Tydfil.—Tenders are invited by the Urban District Council for the erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith. Tenders by Sept. 1.

Dublin.—The Lighting Committee invite tenders for the supply of (*a*) sub station switchboards, transformers, etc.; (*b*) extra high-tension and low-tension mains. Tenders to Chairman of the Lighting Committee, 3, Cork-hill, Dublin, by Sept. 18. See advertisement.

Pembroke (Ireland).—The U.D.C. invite tenders for electricity supply mains, arc lamps and pillars, house meters, and switchboard panels. Tenders to Mr. J. C. Manly, Town Hall, Ball's Bridge, Co. Dublin, by 10.30 a.m. on Sept. 22. See advertisement in last issue.

Ashton-under-Lyne.—The Electricity Committee invite tenders for (Section A) one 500-kw. direct-current generator; (B) one water-tube boiler with superheater, to be worked in conjunction with a refuse destructor; (C) two superheaters for Lancashire boilers. Tenders by 12 noon on Sept. 2. It will be seen by a note and from an advertisement appearing among "Contracts Open" in to-day's issue, that tenders should be sent in addressed to the borough comptroller, Mr. John Neal.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Morton Banks (near Keighley).—The Keighley and Bingley Joint Hospital Board invite tenders for the following works at the isolation hospital, etc.: (1) for keeping the private telephones, wires, and apparatus, and the electric bells, wires, and apparatus at the hospital (including the small-pox hospital) in good working order and repair and properly charged for one year from Sept. 8 next; also (2) for the supplying and fixing of a lightning conductor and telephone for new diphtheria pavilion. Tenders by Sept. 4.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23.

RESULTS OF TENDERS.

Stirling.—The Town Council have accepted the tender of Messrs. J. and W. Brown, Glasgow, for the supply of Broomrigg nuts, at 7s. per ton, to the electric station for the year to June, 1906.

Neath.—The Rural District Council have accepted the tender of Messrs. Johnson and Phillips, Old Charlton, for four sub-station switchboards for the districts of Skewen, Melincrythan, Cadoxton, and Aberdulais.

Poplar.—The Board of Guardians have accepted the tender of Messrs. Ashwell and Nesbit for a continuous-current motor, at £45, and a 60in. Runwell exhauster fan, at £40. 10s., for the engine-house and pump-room at the workhouse.

Buxton.—The Urban District Council have sealed the following contracts at schedule prices for the electricity extensions: Callender's Cable and Construction Co. for supply of cable, and Ellison and Mitchell for supply of tar and liquor.

Earsdon (near Newcastle-on-Tyne).—The Urban District Council have received the following tenders for carrying out work in connection with the lighting by electricity of part of the district: Northern Electric Supply Co., Borough-road, North Shields, £214. 16s. (accepted); G. H. Armstrong, Chester-le-Street, £197; Ried, Ferens, and Co., Newcastle-on-Tyne, £295. 5s. 9d.

BUSINESS NOTES.

TRACTION.

Portsmouth.—There is a surplus of £21,000 on the year's working of the Corporation trams.

Kashmir.—The electric railway project is said to be now before the Government of India.—*Indian Engineering.*

Halifax.—The Tramways Committee have decided to introduce ½d. fares for children, commencing on Oct. 1.

Singapore.—It is reported that attempts are made daily to wreck the electric trams, which do not find favour with the inhabitants.

Bradford.—The Corporation have decided that they cannot accede to the men's application for a week's holiday per annum with pay.

Hastings.—The section from the High-street to Ore has been opened. Up to the 24th ult. the number of passengers since the opening of the line totalled 411,137.

Lancashire and Yorkshire Railway.—The Lancashire and Yorkshire Railway Co. have decided upon making a trial of roller-bearing axle boxes, made by the Empire Roller Bearings Co., on the electrical section of their system.

Dover.—The work of laying the double line on Crabble-hill has been completed, and gangs of men are now giving the finishing touches to the equipment on the road between the athletic ground and River Church. The line may be opened some time this month.

Leicester.—Alterations to the tramway lines are in progress with the object of relieving the congestion of traffic in Church-gate. A new siding is to be laid down on the Eastgate side of the Tower from the

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West-end line to the Belgrave line, so as to relieve the congestion at the Church-gate siding.

Paris Metropolitan Railway.—The receipts of the Paris Metropolitan Railway for July illustrate the great progress the undertaking is making. The number of travellers was 10,122,390, as against 8,008,346 in the corresponding month last year, and the receipts represented £72,390, of which the Municipality takes £25,000.

Swansea.—Messrs. Dick, Kerr, and Co., the contractors for the tramway extensions, have sent in their bill for extras in connection with the permanent-way works, and this amounts to about £3,000, or 5 per cent. on the amount of the contract. The extras are mainly the result of the gas company's attitude over the gas-mains in certain thoroughfares through which the tramlines were laid.

Ipswich.—An inquiry was held last week by the Local Government Board with regard to an application on the part of the Town Council for sanction to borrow £19,550 for the purposes of defraying expenditure on works of street improvement in connection with the reconstruction of the tramways. The Corporation ask for 30 years for repayment of the loan, much of the work being of a permanent character.

Brighton by Motor 'Bus.—An experimental service of motor omnibuses was started from London to Brighton on Wednesday by the London Motor Omnibus Co., proprietors of the Vanguard service. The vehicle is a facsimile of those running in London. The journey, which, including an hour for stoppages, occupied 5½ hours, was performed satisfactorily. The fares at present will be from London to Brighton, outside seats, 7s. 6d., return, 12s. 6d.; inside seats, 6s. and 10s.

Liverpool.—Some excitement was caused on Tuesday evening through a tramcar leaving the lines at the bottom of Dale-street and rushing upon the footpath. The exact cause of the mishap is not clear, but it is surmised that the driver of the car lost control of his vehicle as he was turning from Byrom-street into Dale-street, with the result that the excessive speed caused it to leave the metals on the curve and continue its career over the footwalk. The damage was comparatively slight.

Electrocution.—A lamentable fatality occurred on Monday at the power station of the Hastings Tramways Co. A young electrician, Sidney Dixon, aged 21, was engaged in conducting a labourer named Benham round the works, instructing him which wires he should avoid and which were not dangerous. In the course of the walk round the station, and while still explaining the dangers which were to be avoided, he himself unwittingly rested his left hand on one of the live wires. In an instant he was rigid, and though Benham immediately pulled him away, he was past aid.

Keighley.—At the monthly meeting of the Town Council the town clerk reported that the provisional order with relation to the tramways in High-street and Bridge-street had been confirmed by Parliament. The Mid-Yorkshire Tramways Co. are applying to the Board of Trade for a year's extension of time for completion of the work authorised by their order of 1903, but it is not clear whether this applies to the Keighley section. The town clerk is to make inquiries. The system of return 1d. fares has not so far met with the degree of support from workmen that was anticipated. It will be continued for the present so as to give it a complete trial.

Bombay.—The Bombay tramways were to have been transferred to the new company on the evening of July 31, but on an application at the Bombay High Court on behalf of Mr. William H. Bingham, a rule *nisi* was granted against the Bombay Corporation and the Municipal Commissioner requiring them to show cause why they should not be restrained from granting any concession for the tramways and electric lighting purposes, referred to in the agreement of March 11, 1901, to any persons other than Mr. Bingham or his nominees and assigns, pending the hearing of the suit filed by him against the Bombay Corporation.—*Indian Engineering.*

Blyth.—At a joint meeting of the Blyth and Cowpen Urban District Council's last week, it was stated that over three years had elapsed since powers were granted to a company for the construction of tramways. It was decided that the directors of the company be asked to receive a deputation from the two Councils to ascertain if anything could be done to get the tramway system into operation as soon as possible. In the event of an unfavourable reply, the local authorities may approach the North Shields Tramway Co. with a view to an extension of their system, or in two or three years' time, when the two Councils are amalgamated, they may apply for powers themselves.

Spen Valley Tramways.—With reference to the application of the British Electric Traction Co. for leave to abandon a section of their Spen Valley tramway scheme, a letter has been addressed to the Board of Trade by the Liversedge Urban District Council. It is pointed out in this communication that the Council were induced to support the company's scheme by an undertaking that it should be carried out in its entirety, the details being embodied in an agreement at the time of the public inquiry at Dewsbury. With reference to the contention of the company that the lines already constructed do not pay, the letter remarks that, as less than two years have elapsed, it is too early to pronounce upon the financial possibilities of the line. In conclusion, the letter urges that consideration should be given to the needs of the inhabitants.

Electrification in America.—It is reported that the West Shore Railroad Co., with which Mr. W. K. Vanderbilt is associated, intends to electrify its line between Utica and Syracuse. Each car's equipment will consist of a 75-h.p. motor, operated by the Sprague-Thomson-Houston system of control, so that the cars can be coupled together and operated by a motorman in the front car. At Oneida it will be necessary to build a third or middle track over what is known as the Vernon grade. Middle tracks will be built at Canastota, and between New York Mills Junction and Genesee Street in Utica. The movement of the trains will be controlled by block signals, and there will be interlocking switches and signals at all points where switching will be necessary. There will be four electrical sub-stations, located as follows: Clark Mills, about two miles east of Vernon, at Canaseraga, and at Manlius Centre. It is stated that the contract for the equipment of the sub-stations and cars, amounting to some £40,000, has been awarded to the General Electric Co., of Schenectady.

Level Crossings.—A van driver named George Bettany, of Great Crosby, was summoned at the instance of the Lancashire and Yorkshire Railway for having obstructed and impeded a signalman in the execution of his duty. The defendant arrived with a horse and van at the St. John's crossing at 5.42 p.m., and as two trains were signalled to pass the signalman closed the gates, and after they had passed through he opened them again for traffic. The defendant then drove his horse and van to the centre of the crossing, where he came to a standstill, and although requested by the signalman to hurry up and get across as soon as possible, as another train was coming along, he refused, and used bad language, saying that as the signalman had kept him he would keep the signalman. While the defendant was on the crossing an electric train had to pull up. For the defence it was stated that the horse had been standing some seven or eight minutes before the gates were opened, and when it got on to the crossing it was seized with a fit of staggers, and would not move. The Bench dismissed the case.

Ramsgate.—Apropos of the recent accident, the *Globe* makes the following observations: "The tramway company will be undertaking a most serious responsibility if they continue to run their vehicles over the dangerous stretch in Madeira-walk. A man does not need to be an engineer to see that this piece of the line, with its excessively steep gradients, numerous sharp curves, and precipitous boundary at the most critical point, must be exceedingly perilous if the slightest thing goes wrong with the machinery of a car traversing it, or if the driver makes any error. Whether a lighter and more easily controlled vehicle than the heavy cars now in use might safely be employed is for the experts to decide, but there is no doubt but that the place, in existing circumstances, is a perfect death-trap, and the Board of Trade will, in our opinion, seriously neglect their responsibilities if they allow the present system to continue. The public have a right to assume that public vehicles shall be at least reasonably safe, and shall not be run under conditions which manifestly involve great risk, and if the Board of Trade cannot enforce this right, we really do not see of what use the department is."

New York Central Railway.—The New York Central has placed an order with the General Electric Co. and the American Locomotive Co. for 35 electric locomotives to haul the through trains of the system into New York City, and 176 cars to be used in the suburban service. The original order for 30 locomotives was placed some time ago, and as a result of the satisfactory tests on the first one the contractors have been instructed to proceed with the remaining 29, and the company has ordered five more, making 35 in all. The cars are similar to the cars now in use on the Interborough Railway. The total order is said to aggregate over £1,200,000 for electrical equipment. The engines, which are to be ready by Aug. 1, 1906, will weigh about 100 tons, having eight driving wheels with a diameter of 44in. apiece, and will develop 2,200 h.p. A telegram from the New York correspondent of the *Standard* states that "advices from Buffalo state that the New York Central Railway has purchased the undertaking of the Canadian Water Power Co., and has also purchased 60,000 h.p. from the American company. The capacity of the combined companies is 580,000 h.p. The New York Central's acquisition of these interests is believed to indicate a very extensive scheme of electrification on its system, beginning with the Syracuse-Buffalo section."

Perth.—A meeting of the Special Tramways Committee was held last Friday for the purpose of hearing the reply from the Board of Trade with reference to the height of the new cars. The Board have approved of the alteration in the height of the cars so as to enable them to pass under bridges. The committee have given instructions to the builders of the cars to have the alterations carried out immediately, and to send on the first car whenever it is completed. The resident engineer intimated that the postal authorities considered the arms on the poles erected along Scone-road were in too close proximity to the telegraph wires. If a storm of wind were experienced, in all probability the telegraph wires would break by coming into contact with the back parts of the arms. A suggestion was made that the parts of the arms in question should be cut so as to obviate the danger. Another point raised was in connection with the laying of Glasgow-road with granolithic blocks. The 18in. margins which the tramway contractors had to lay on each side of the lines were stated to have been improperly laid, consequent on the Town Council having ordered the remaining part of the street to be causewayed. In the above-mentioned section this margin had to be lifted, while it is said that where repairs are necessary to other streets the margins will also require to be put right. The committee instructed the engineer to report on the matter.

Wigan.—The following extract from the town clerk's report upon the omnibus Bill promoted by the Corporation and passed during the last session of Parliament relates to tramways. The measure authorises the construction of two additional tramways: (1) from the terminus of the existing tramway at Lamberhead-green through the urban district of Orrell to the Abbey Lakes; (2) from the terminus of the existing tramway at New Springs to Scot-lane, in the urban district of Aspull. The agreement between the Corporation and the South Lancashire Tramways Co. for the purchase of the tramway from Platt Bridge, through Abram and Golborne, to Lowton (or certain parts thereof), has also been confirmed, and it will be necessary within the next three months for the Corporation to serve a notice on the company stating whether they desire to purchase the powers to construct the whole of

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the said tramway, or only a part thereof, but the part in respect of which the transfer of powers is required cannot be less than three miles, except in the event of the Abram Urban District Council refusing their consent to the proposed transfer unless the Corporation undertake to widen Dover Bridge, in which case the Corporation shall be at liberty to give notice in respect only of so much of the tramway as is situate on the north side of the bridge. The consideration for the transfer of the above-mentioned powers must be calculated at the rate of £1,000 per mile of tramway, the powers to construct which are transferred to the Corporation. The whole of the statutory powers relating to the Corporation tramways have been consolidated in the Act, which will be found a great convenience to those having to deal with the tramway undertaking.

The Underground.—The District Railway has commenced running a service of electric trains from Wimbledon and Putney to Whitechapel. With the exception of the Inner Circle service and the London and North-Western trains, the whole of the various services run by the District Railway are now being worked electrically. On Tuesday the final preparations were made for the removal of steam traffic on the District Railway system. Two special electric motors for hauling London and North-Western trains between Earl's Court and Mansion House, or any other companies' trains that may require in an emergency to use the company's lines, were attached to an ordinary London and North-Western train of 10 coaches, and a trial run was made from Mill Hill Park to South Harrow and back. The area selected includes many heavy gradients, but the trial proved quite satisfactory. It is reported that in two or three weeks' time the Metropolitan trains will be ready to run on the District system, the alterations to the collecting skate being well advanced. It is also stated that the Metropolitan Co.'s service of electric trains over its own part of the Circle will shortly be augmented. The electrical extension to East Ham, in connection with the Tilbury and Southend Railway Co.'s system, enabling passengers to travel between Richmond and East Ham without changing, is working satisfactorily. It is reported that Messrs. De Dietrich, of Luneville, France, are building a number of carriages for the Electric Underground Railways Co. Messrs. De Dietrich have already delivered 52 of these vehicles, and are now finishing 16 more, which will be delivered shortly.

London General Omnibus Co.—At the half-yearly meeting last week the chairman stated that out of the profits of the past six months another £20 000 had been transferred to the motor 'bus fund, so that a total of £40,000 had been set apart during the past 12 months for experimental motor services. Of that sum £6,800 had been expended up to June 30 last, leaving £33,000 in hand. They had organised a repair department under a competent engineering expert had trained practically a number of drivers, besides building omnibus bodies in their coach factory, and, as the chassis were delivered, they would be prepared to put more motor omnibuses on the roads under the most favourable working conditions. It was expected that before now the company would have had a larger number of motor omnibuses running. Those delivered had all been behind time, some were found on examination to be unsatisfactory, and the Board preferred to wait for machines which they believed to be reliable and durable rather than put a number of vehicles on the road which would probably result in a heavy working loss. He believed that the motor omnibus had come to London to stay, but he was equally convinced that some of those now working in our streets would cause their proprietors to wish that they had not embarked in so speculative an enterprise. For the first few months, or for a year, there was little or no difficulty in showing a good profit on the running of a service of new motor omnibuses, but maintenance charges increased with the age of the vehicles, and it would be interesting to watch the results of those undertakings which were dependent on motor omnibuses alone. For several years yet horse traction, which had given them such good results in the past, would be the backbone of this company.

Dundee.—At a meeting of the Tramways Commitee Mr. Fisher, the manager, presented a report as to the reason of the disparity between Dundee and Glasgow in regard to percentage of operating expenses to receipts. For Glasgow the figure is 49 per cent., while for Dundee it is nearly 63 per cent. The following figures apply to Glasgow and Dundee respectively: traffic receipts per car mile, 10·58d., 11·15d.; operating expenses per passenger, ·45d., ·59d.; cost of power per car mile, ·3d., ·63d.; traffic expenses per car mile, 2·91d., 2·9d.; general expenses per car mile, 1·04d., ·62d.; cost of maintenance per car mile, 1·01d., 96d.; total operating expenses per car mile, 5·26d., 7·11d. In explanation of this the report stated that the cost per car mile in Glasgow for power was ·3d., while in Dundee the cost was 2·63d.. a difference of 2·33 l. per car mile run. The mileage run in Glasgow during the year dealt with was 16,291,082, and taking this number at 2 33d., the difference per mile between Glasgow and Dundee represented a sum of fully £158,159. Adding this to the Glasgow working expenses (£356,820) gave £514,979, a sum equal to 71·C0 per cent. of their receipts, which amounted to £724,851. It was pointed out that in Glasgow, Huddersfield, and Leeds separate power stations were used for the tramways, consequently the cost for power placed to the debit of working expenditure on these undertakings did not include interest, sinking fund, depreciation, etc., on the power stations; while in the cases of Aberdeen, Burnley, Brighton, and Dundee the items for power included all these standing charges. The one item of power alone explained the difference referred to, consequently it was unnecessary to refer to other financial advantages which all the undertakings mentioned had as compared with Dundee. The committee ordered the report to be incorporated in the minutes.

Cairo Tramways.—The Cairo Tramways Co. (Société Anonyme des Tramways du Caire; registered office, Brussels) have always had under the Electric Tramways of Cairo Concessions Act the preference, providing there was no better offer forthcoming, for any extensions and new lines in that city and district. Under a new concession just signed they have obtained leave to construct five branches, as follows: A (to be constructed within two years)—From the Cairo main-line railway station along the Saptieh to the Schoobrah line. The public works department will reconstruct the road, kerbs, lighting and sewers, subways, etc., at the expense of the company. B (limit five years)—From the Boolak tram terminus to the Rod El Farag line, double line. C (limit one year)—From the Khalig and Abbassieh lines to the Abbas-avenue, double line. D (two years)—A small branch of the Schoobrah line, double line. E (Aug. 31, 1908)—Doubling of line in Old Cairo; £3,200 has been paid for this concession. F (after approval of bridges)—Ghizeh line (to the Pyramids), double line; £50,000 has been paid for this concession. This will connect systems on the right and left banks of the Nile. G (13 years)—From the Citadel to the El Imam Mosque, double line. H (one year)—Substitution of a line to the abbatoirs instead of part of the Khalig line. Phœnix rails, weighing 100lb. per yard, are specified for all new works and all repairs to new and existing lines, with the exception of the old line to the Pyramids, where Vignoles rails at 40lb. per yard are allowed. The company have to maintain a strip of 18in. on each side of the rails. The minimum radius for curves is fixed at 25m., except in special cases. The company must at their own cost provide for the uninterrupted passage across their line of the courses carrying the water required for irrigation and drainage purposes. The company have to acquire the necessary properties at their own cost; if necessary, they can act under the Public Expropriation Act. There is a penalty of £10 for stoppages save by *force majeure*. The company can only carry passengers and their small luggage, and must make no charge for such packages. The previous concessions are prolonged by five years, and all concessions expire Dec. 5, 1951, when the whole becomes the absolute property of the Government.

LIGHTING AND GENERAL.

Ripon.—The electric lighting order granted to the Corporation in 1901 has been revoked.

Northern Counties Electricity Supply Co.—The directors have declared an interim dividend at the rate of 5 per cent. per annum.

Liskeard.—The General Post Office are about to fix an overhead telegraph line, also three poles and the necessary stays in the new cattle market.

Personal.—Mr. J. C. Cooper, of Newcastle, has been appointed traffic superintendent of the Halifax Corporation tramways at a salary of £2. 5s. per week.

Portsmouth.—Last year's profits on electric lighting were £4,000, on telephones £1,500, and on tramways £21,000. Neither have ever drawn upon the rates.

Worksop.—It is proposed in connection with the proposed extensions at the electricity works to put down a water-softening plant estimated to cost about £250.

Leeds University.—The next session of the departments of civil, mechanical, electrical, and mining engineering will begin on Oct. 3. Particulars appear in another column.

British Insulated and Helsby Cables.—The directors have declared an interim dividend for the half-year ended June 30 of 8 per cent. per annum on the ordinary capital.

Catalogue.—The Electrical Power Storage Co., 4, Great Winchester-street, E.C., have issued a handy interleaved pocket catalogue giving full and illustrated particulars of their manufactures.

Ormskirk.—In consequence of the action taken by the Board of Trade with regard to Wisbech, as mentioned in our issue of the 18th ult., it is doubtful whether the Ormskirk scheme will be proceeded with.

Malton.—The agreement with the Northern Counties Electricity Co. for the lighting of the town has been signed, and the Council have asked the company to complete the work with all possible speed.

Calcutta Electric Supply Co.—The number of units delivered to consumers during the four weeks ending July 28, 1905, were 416,207 compared with 318,617 in the corresponding four weeks of the preceding year.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Electric Supply Co. of Victoria £160,000 5 per cent. first mortgage debenture stock.

New Icelandic Cable.—It is announced from Reykjavik (Iceland) that both sections of the Althing have now finally approved the agreement with the Great Northern Telegraph Co. for the establishment of cable communication between Iceland and the Shetland and Faröe Islands. The cable is to be completed by the autumn of 1906.

Telephones to France and Belgium.—On and after to-day the London subscribers to the National Telephone Co. will be able to use the Anglo-French and Anglo-Belgian telephone services on the same conditions as Post Office subscribers, and similar facilities will be available to the company's subscribers connected with the main exchanges in the provincial towns with which communication is practicable.

Stirling.—Reports by Mr. Hanson show the following progress of the electric light undertaking: for the four weeks ending June 10 the total in equivalent 8 c.p. lamps connected for all purposes was 17,392; July 8, 17,452; Aug. 5, 17,466, as compared with 15 334 for August last year. A revised scale of charges for public lamps, making the charge for each type of lamp uniform, and so effecting a slight decrease on the total charge, has been approved.

Dundee.—With the view of increasing facilities for motive-power customers, Mr. Richardson, the engineer, has proposed that arrangements should be made for utilising certain of the tramway feeders for the supply of current for power purposes only to industrial establish-

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ments on the line of the tramway routes. The committee have received the proposal favourably, and have asked Mr. Richardson to prepare a detailed report for further consideration.

Greenwich.—The construction and fitting up of the huge generating station at Greenwich, which is destined to generate the electric current for the London County Council trams, was commenced in the autumn of 1902. The work will not be completed till next year, and meanwhile the Council buys its electricity from a private company. As the County Council have decided to electrify the North London system without delay, the work of the second portion of the Greenwich station has been put in hand, and will be completed in 2½ years' time.

Glasgow and West of Scotland Technical College.—The next session begins on Sept. 26, in the new buildings recently erected for the college. The diploma of the college is granted in the following departments: civil engineering, mechanical engineering, electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics, and physics. In conjunction with the Glasgow School of Art a course for a joint diploma in architecture has been arranged. Particulars appear in another column.

Stourbridge.—At the last meeting of the District Council the Electric Powers Committee asked for permission to negotiate with the Shropshire, Worcestershire, and Staffordshire Electric Co. with a view of the Council taking current from them in bulk on similar terms as were proposed in the agreement formerly proposed with the Midland Electric Corporation, who found they could not legally supply the town. On account of the delay which has arisen, notice was given of a motion instructing the committee to take immediate steps to generate their own current. This resolution, it was explained, would be withdrawn if terms were arranged with the Shropshire and Worcestershire Co. before the next Council meeting.

Morse Chain.—We are informed that the Westinghouse Brake Co. have secured the exclusive rights, under the Morse chain patents, to manufacture and sell the Morse rocker joint silent high-speed chains in Great Britain and on the continent of Europe, and have just completed a new building at York-road, King's Cross, N., for the manufacture of these chains. The new works are equipped with a selection of the most modern machine tools for chain making and testing, and the Westinghouse Brake Co. are now prepared to supply these chains to suit every description of power transmission. The Morse rocker joint chains with the double-pintle design to eliminate all sliding friction have met with great success since their introduction in America.

Stoke Newington.—Hitherto supply has been taken in bulk from the Hackney Borough Council, the supply being given at two feeder points at 480 volts across the three-wire system of direct-current distributors. The demand has outgrown the system, the Hackney authorities being unable to serve the rest of the district on the low-tension system at a reasonable rate of charge. Power is now to be taken in bulk on the three-phase system at 10,000 volts served from the Brimsdown works of the North Metropolitan Electric Power Supply Co., and will be transformed to 480 volts direct current, three-wire. For the latter purpose a sub-station is being erected at Edwards-lane, and this work and the extension of mains will not be completed until the end of the year.

Improvements in Trestles and Steps.—Occasionally the wireman or lamp attendant needs tall trestles, but more often shorter ones and at times a ladder, and it has been the rule to keep these items at hand in the shape of separate articles, but for the future this need not be the case, as Mr. Heathman, of Parsons Green, Fulham, who has given us so very many improvements already, has made another and patented it, so that now the two sides of trestles or steps can be separated and used as two ladders, or put together to slide up and make a longer ladder, or hinged together as trestles. And two of these when extended as a ladder can be "coupled" together to form tall trestles, and even a bit more, one side can be longer than the other so as to stand upon inclines or staircases.

Cambuslang.—The works which the Lanark County Council are erecting at this place will be equipped with two Lancashire boilers by Penman, worked at 200lb. pressure, two Howden 80-h.p. engines, and two Parker 55-kw. dynamos. In conjunction with this plant a Meldrum three-cell destructor is to be worked. The feeders are 2 triple-concentric cables laid in Howard troughing, and the distributors are three-core and armoured laid direct in ground. The supply will be given on the three-wire system—250 volts for lamps and 250 and 500 for motors. The charges for current will be as follows: private lighting, 4d. flat rate; power, 2d.; street-lighting, 3d. The consulting engineers for the works are Messrs. Hunter and Jack, and the resident engineer is Mr. A. J. Abraham, A.M.I.E.E.

Agency.—Mr. A. H. Hunt, 115-117, Cannon-street, London, E.C., has been appointed agent in London and suburbs for the sale of the Reason Manufacturing Co.'s arc lamps. Owing to increasing demand the company have extended this department of their works at Brighton, and are now making enclosed arc lamps for both alternating and continuous current working in the standard and also the miniature sizes. The company are making a speciality of twin-carbon lamps, both miniature and standard sizes, for running direct on 200 to 250 volt circuits—a great advantage in the case of a change over from low to high voltage. The chief feature in the Reason lamps is that under their patents they are able to entirely dispense with shunt coils, thereby eliminating what has always been a source of trouble to arc lamp users.

South Shields.—The last electricity account shows a total capital expenditure of £151,838 of which £2,481 was spent during the past year, principally for machinery, meters, and connecting consumers. Receipts amounted to £18,346, and the payments, including interest and redemption, to £16,358, leaving a balance of £1,988. The balance on revenue account at the beginning of the year was £1.709, to which was added the profit of the year, amounting to £1,988, making a total available balance of £3,698. This sum was disposed of by transferring £1,304 to reserve fund and £300 to the relief of the general district rate. The balance of £2 094 has since been added to reserve, making the latter over £4,000. Out of the profits of the Mill Dam Quay £300 has also been devoted to the relief of the general district rate.

Malton (Yorks).—The Northern Counties Electricity Supply Co. are erecting electricity works at this place, which are to commence supply of current on Oct. 25. The system chosen is the three-wire, with 230 volts for lighting and 460 for motors. Power for the former will be supplied on a sliding scale of 5½d. to 4d., and for the latter 2½d. to 1½d. The street-lighting has been contracted for at a charge of £362 per annum. The plant consists of two Crossley gas-engines of a total of 120 i.h.p., two Bruce Peebles dynamos, and Chloride L R type accumulators of a normal output of 75 kilowatt-hours and maximum discharge rate of 150 amperes. The feeders and distributors have been supplied by Callender's Cable and Construction Co. The work is being done under the direction of the company's engineer, Mr. C. S. Vesey Brown, the resident engineer being Mr. J. Chandler.

York.—The estimated income and analysis of cost of the York electricity department, which will be laid before the York City Council at the meeting on Monday is as follows: units generated—public lamps, 5,869; power and private lighting, 41,464; used at works, offices, and battery, 6,463; unaccounted for, 5,183—total, 58,979. Estimated income—public lighting, £99; power and private lighting, £421. 3s. 1d.; motor and radiator rents, £35—total, £555. 3s. 1d. Total estimated income per unit sold, 2·81d.; horse-power of motors connected during month, 26; total horse-power of motors connected to date, 717; 8 c.p. lamps connected during month, 261; total 8-c.p. lamps connected to date, 47,907; equivalent 8-c.p.'s connected—total, 65,832. The city electrical engineer is about to prepare estimates for the lighting of Gillygate and Fishergate by arc lamps, cables having been already laid in these streets.

Frinton.—Messrs. Christy Bros. and Middleton have reconstructed the Frinton-on-Sea electric light station within a week of its destruction by fire on Saturday, 19th ult. Part of Monday was occupied in clearing the ground, and the local contractor, Mr. A. E. Farr, has since raised the building to a height of 12ft., and has erected a substantial temporary roof. Night and day shifts were worked. The new building is 60ft. long by 28ft. wide, handsomely built in white brick with red brick piers, strongly cemented, and with a stout party wall dividing the engine-house from the accumulator room. The 40-h.p. Crossley gas-engine has been restored, and is again in perfect order, whilst the smaller engine will probably be also running in a couple of days. The Frinton Electric Light Co. are now supplying current up till 12 15 each night. New accumulators will be placed in position in a day or two. On Friday evening last a concert was given for the benefit of the station engineer, Mr. Hockley, who lost a good deal of personal property—including his wedding presents and a new bicycle—through the fire.

Trowbridge.—The Urban District Council have received a report by Messrs. Talbot and Stevenson on the cables laid by the Western Electric Distributing Corporation, in which they express an adverse opinion on the laying of the cables directly in the ground without troughing or protection of any kind, as the ground undoubtedly contained corrosive matter, but they do not consider that there is any cause for apprehension of danger to the public resulting from an accidental puncture of a protected cable by pick or other tool. On the question of the Corporation's responsibility for damage caused to the side paths, they thought it would be reasonable to insist upon their laying the cables in the roads. They had formed the opinion that the Corporation intended to faithfully fulfil their obligations—that was to say, to complete the work and give the supply within the stipulated time. They were naturally anxious to keep down the capital expenditure, and to ensure a satisfactory financial result. The letter was referred to the Lighting and Paving Committee and the Electricity Committee for report. The question of costs was referred to Mr. Pearson, of Bristol, with full powers.

Todmorden.—To-day has been fixed for the opening of the electricity works, which have been equipped from the plans of Mr. H. Waring, the Corporation's electrical engineer. The sum authorised for the purpose was £20,000, and of this £16,500 has been expended up to date. The structure has cost £6,000, machinery £3,200, meters and instruments £700, mains and services £4,500, and accumulators £1,100. Two Lancashire boilers, worked at 160lb. pressure, have been supplied by Messrs. Yates and Thom, and a Green's 96-tube economiser is also installed. Two Belliss and Morcom engines of a total horse-power of 370 are in position, and also two Bruce Peebles dynamos of a total capacity of 225 kw. The accumulators are of the E.P.S. Co.'s P-11 type (260 cells), and give a normal output of 600 ampere-hours and a maximum discharge rate of 250 amperes. Both feeders and distributors are single cables, paper-insulated, lead-covered, and laid solid. The station is to be worked in conjunction with a Meldrum refuse destructor, and the electrical supply will be given on the three-wire system at 230 volts for lamps and 230 and 460 for motors. The charge for lighting is a flat rate of 5d. and that for power 3d. The Corporation own the gasworks, the charge for gas being 2s. 6d. per thousand cubic feet.

Aberdeen.—The electricity accounts for 1904-5 show a revenue of £39 047, made up as follows: Sale of current per meter, £23,964; public lighting, £2,319; traction (Corporation), less £1,137 difference between amount charged and actual cost, £9,890; traction (Suburban), £1,357; hire of motors, £840; and attendance on harbour and fish market lamps, £617. The expenditure under this account amounted to £17,037, including fuel, £5 875; wages at generating station, £1,779; repairs on plant, £934; main and service repairs, £987; taxes, £3,402; and engineer's salary (proportion), £513. The balance carried to net revenue account was £22,009. The amount paid in interest on mortgage and loans was £7,694; depreciation on

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buildings, machinery, etc., accounts for £6,723; £4,891 is added to the sinking fund; and the surplus carried to the reserve fund amounts to £2,753. At July 31 the amount at the credit of the reserve fund account was £16,336. The amount expended on works in the general balance account was £269,329, less depreciation written off, £31,882—£237,441. The total assets amount to £275,448. During the year the quantity of electricity generated was 4,899,050 units, as compared with 4,158,141 units last year. The total amount sold was 4,069,831 units, compared with 3,539,026 last year. Of the total quantity sold 2,105,279 units went for traction, 1 709 012 units to private consumers by meter, and 255,540 units were consumed by the public lamps. The quantity used in the works and subway was 377,793 units, the total quantity thus accounted for being 4,447,624 units. The quantity lost in distribution or otherwise not accounted for was 451,426 units—a percentage of 9·21. The total number of arc lamps is 127, the same as last year. The prices per Board of Trade unit were 6d. and 2d., 6d. and 1½d., 3d. and 1d., 2½d. and 1·2108d.

Yorkshire Electric Power Co.—The new power station which the company have erected at Ravensthorpe has during the last week been thrown open to visits from municipal representatives, the Midland Institute of Mining Engineers and the Colliery Managers' Association, etc. The company some years ago acquired parliamentary powers for supplying current throughout and beyond the industrial portion of the West Riding—from Goole to Skipton and from Wetherby to Sheffield, 1,800 square miles in all. This is the first station they have completed. Three other stations will be erected as occasion demands, but for the present the company expect to be able to distribute current on advantageous terms within a radius of 20 miles. Already mains have been laid in the districts of Thornhill, Dewsbury, Soothill Nether, Ravensthorpe, Mirfield, Kirkheaton, Liversedge, Gomersal, Birkenshaw, Drighlington, Leeds, and Pudsey. The company are now supplying electricity in bulk to the local authorities of Pudsey and Mirfield, and agreements are in process of completion with the Councils of Birstal and Liversedge. Current for industrial purposes is, in fact, being supplied to mills at Gomersal and at Pudsey, the use of electricity increasing the output by something like 15 per cent. Electric installations have also been made at the mines at Chickenley Heath, Mirfield Moor, the Farnley Iron Co. at Three Nuns, and of the Low Moor Co. at the Calder Colliery The engine-house is designed to contain generating plant of 8,450 kw., or 11,000 h.p., capacity, and extension can be made to secure a capacity of 60 h.p. Provision has been made for six boilers, four already having been installed, and the stoking is accomplished by an ingenious electrically-driven contrivance, by which one man can see to the feeding of two or even three boilers. The main generating sets are Curtis turbo-generators, the turbines running at a speed of 1,000 r.p.m. The alternators attached to the turbines generate three-phase alternating current at 10 000 volts. An interesting feature of the engine-house is the gigantic control switchboard, from which the whole of the main switchgear is operated by means of low-pressure current. The main switches are worked by means of small motors. Working at top speed the station can generate more than 250,000 units per week.

Grimsby.—The electrical engineer's monthly report shows that the number of private lamps and motors connected and applied for was 45,842 in July, as against 45,931 in June, being a decrease of 89. The number of services run showed an increase of four, while there was one more consumer. Units had been sold for traction purposes to the number of 36,627 in July, as against 36,452 in July last year, being an increase of 175; public lighting £4,323, a decrease of 32; and to private consumers 23,604, an increase on last year of 17,126. The decrease in the number of lamps connected was due to the temporary lights for illuminations having been connected last month and disconnected this month. The recommendation to borrow £18,000, noted in our last issue, has been approved. The following estimate has been prepared: engine and dynamo, 500 kw., speed 350 r.p.m., delivered and erected, £3,400; boiler, with automatic stokers, etc., normal evaporation 14,280lb. of water per hour, £1,220; switchboard, one panel for dynamo and three sets of feeder fittings, £120; feed pump, 4,000 gallons per hour capacity, £100, less value of small pump 1,000 gallons capacity, which has to be removed, £60; pipework, steam exhaust, circulating water, drains, and all necessary pipes, £830; condenser, with necessary motor-driven pumps, £1,200; water purifier, increasing the capacity of the present plant from 1,500 to 3,000 gallons per hour, £160; building extension of engine-room, £900; foundations, boiler setting, etc., £400; coal conveyor, £400; sundries and contingencies, £810—total cost of new plant, £9,500. Estimate of mains work to be carried out during the next three years: new store for meters, cables, etc., £230; mains, feeders, distributors required during next three years to supply consumers, including 460 yards of feeder to connect up to the feeder laid by the railway company on their own property, £4,790; estimated expenditure on services, £2,100; estimated expenditure on meters, etc., £1,380—total cost of mains work, £8,500. Total capital expenditure during the next three years: plant, £9,500; mains, £8,500—total, £18,000. At the last Council meeting it was also proposed that the scale of discounts to consumers for current for lighting purposes be altered, and that the charges for current for lighting in future be as follows: for the first 20 units per quarter 7s. 6d., and for all current above this at the rate of 4½d. per unit, subject to discounts as follows: for a consumption exceeding 20 units and not exceeding 250 units per quarter, 5 per cent.; 250 units and not exceeding 500 units, 7½ per cent.; 500 units and not exceeding 1,000 units, 10 per cent.; 1,000 units and not exceeding 2,000 units, 12½ per cent.; 2,000 units, 15 per cent. The discounts only to be allowed for payment of account within 21 days after presentation, time to be the essence of the contract note. The engineer pointed out that the present scale of charges was as follows: for the first 20 units per quarter 7s. 6d., for all current above this at the rate of 4½d. per unit, subject to discounts as follows: exceeding 500 units and not exceeding 3,000 units, 2½ per cent.; 3,000 units and not exceeding 5,000 units, 5 per cent.; 5,000 units and not exceeding 8 000 units, 7½ per cent.; 8 000 units and not exceeding 11 000 units, 10 per cent. Discounts allowed at the end of each year for cash within one month. An amendment that the matter be not entertained that night was carried.

Rochdale.—With regard to the partial shut-down here on Saturday, the 26th ult., we are informed that at about 8.30 p.m. the main fuse on one of the generators supplying the lighting mains blew, and as only one machine was then running, the supply, of course, was thus cut off from the town. The generating plant consists of direct-current machines and three-phase alternators, also a motor-alternator which is capable of receiving three-phase current, and generating for either tramway or lighting purposes, and also *vice versâ*. At the above-mentioned time one machine was running the lighting load and one the traction load. This latter was assisted by the motor-alternator receiving its supply from one of the steam-driven alternators, the exciting current for the steam alternator and also the motor-alternator being supplied from the lighting 'bus bars. The condensers and station motors were also being supplied from the lighting 'bus bars, as well as the lighting arrangement in the station. The blowing of the fuse cut off the excitation of the alternators and also the supply to the various motors and station lighting. The loss of vacuum threw off the steam sets on to the atmospheric exhaust main, which naturally to a certain extent reduced the power of the sets. The traction load was too much for the direct-current machine supplying, and was further added to by the fact that, the motor-generator losing its excitation on the alternate-current side, the direct-current side received current, and was motored off the traction 'bus bars, the alternate-current machine becoming a generator driving the alternate-current steam generator, thus throwing a heavier load still on the traction machine. The latter started pulling up, and it was necessary to trip the automatics on some of the traction feeders rather often so as to relieve the machine. It was about half an hour before the tramway supply was righted, but it was never totally stopped. As the machine fuses on the lighting board had not previously given any trouble, it appeared probable that it was due to some fault on the mains (during the last few days a number of faults have occurred due to cables being damaged during the tramways construction and also by some work carried out by other departments of the Corporation). It afterwards proved that the fuse had been faulty. A separate machine was run up to take the station lighting and motors, and in the meantime the lighting network had, to a certain extent, been sub-divided. Some difficulty was experienced in recommencing the supply, as, of course, only having motor balancers and a motor-generator, which alone would not be sufficient to take the load, the engines had to be run up and kept on the stop valve until such time as the balancers could be got in. As soon as this was done the various sections of the distributors had to be reconnected, which accounted for the main portion of the delay in renewing the supply. The various sections of the town were out from periods varying from 10 minutes to 1½ hours, but by 10 o'clock everything was straight again. This is the first complete shut-down due to any fault in the generating station since the plant commenced supply in October, 1900, and is not a bad record when it is remembered that during that time for many months the station had to be run without any spares, and, further, that during the last winter both the traction and lighting switchboards were completely dismantled, and temporary arrangements had to be made until such time as the reconstructed boards could be erected and connected up in their new positions in the switch-room.

PROVISIONAL PATENTS, 1905.

AUG. 21.

16891. Improvements in electric heating apparatus. Charles McIntyre and Alfred Upton Alcock, 1, Queen Victoria-street, London.

16905. Improvements in and relating to electric alternating-current machines. Pierre Antoine Joseph Lapeyrade, Thanet House, Temple Bar, London. (Date applied for under Patents Act, 1901, Aug. 23, 1904, being date of application in France.) (Complete specification.)

16936. Improvements in the electrolytic manufacture of copper wire strip or the like. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

16943. Improvements in and relating to electric resistances. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

16945. Improvements in or relating to apparatus for automatically lighting and extinguishing electric lamps of a circuit at certain hours varying with the seasons. Ernest Capt-Lecoultre, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Sept 3, 1904, being date of application in Switzerland. (Complete specification.)

AUG. 22.

7006A. Improvements in earth galvanic cells. Emil Jahr, 73, Cheapside, London. (Date applied for under Rule 5 of the Patents Rules, 1905, April 3, 1905.) (Complete specification.)

16971. Improvements in, or in and relating to, commutators of dynamo-electric machines and electric motors. William Armistead, Prince's-chambers, Wolverhampton. (Complete specification.)

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16983. **Improvements in magnetic trembler sparking plugs for electric ignition of gases.** Rankin Kennedy, 60, Norse-road, Scotstoun, Glasgow.

17032. **Improvements in electrically-operated fans.** William Phillips Thompson, 6, Lord-street, Liverpool. (The firm of Reiss and Klemm, Germany.) (Complete specification.)

AUG. 23.

17043. **Improvements in electric alarm apparatus.** William Ashburn and William Bamber Ashburn, 6, Bank-street, Manchester.

17050. **Improvements in the distribution of electricity on the overhead wire system.** James Robson, 3, Devonshire-place, Selby Park, Worcestershire.

17079. **Improvements in and relating to receivers for electric waves.** Ferdinand Schneider, 60, Queen Victoria-street, London. (Complete specification.)

17084. **Improvements in and relating to electric train-lighting systems.** Siemens-Schuckertwerke, G. m. b. H., Queen Anne's-chambers, Broadway, Westminster, London. (Date applied for under Patents Act, 1901, Aug. 25, 1904, being date of application in Germany.) (Complete specification.)

17091. **Improvements in audible electric signalling apparatus.** Willie Dickson Kilroy, Sydney Evershed, and Evershed and Vignoles, Limited, 1, Queen Victoria street, London.

17093. **Improvements relating to magnets for electrical measuring apparatus.** Josef Herman, 322, High Holborn, London.

17106. **Improvements in or connected with arc lamps.** Erwin Rudolf Grote and Milton Victor Ely, 40, Chancery-lane, London.

17107. **Improvements in or connected with enclosed arc lamps.** Edwin Rudolf Grote and Milton Victor Ely, 40, Chancery-lane, London.

AUG. 24.

17116. **Improvements in or relating to certain parts of phonographs, gramophones, and the like.** The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

17126. **Manufacture of tyres and wheels for motor cars and other vehicles propelled by steam, electricity, oil, or any other motive power.** Frederick Rodgers, Hope, near Sheffield.

17133. **An improved lifeguard to be attached and driven forward for electric tramcars, steam cars, engines, or any other locomotive driven on roads, rails, or metals.** John Stanley Bailey, 29, Princess-street, Manchester.

17152. **Improvements in apparatus for agitating electrolyte alkaline or other solutions during electroplating, depositing, boiling, or mixing processes.** Francis John Clarke, 138, Birchfield-road, Birmingham.

17170. **A device for conveying fresh air, telephonic and other messages to the interior of submerged submarines, applicable also for other purposes.** Frederick Arthur Smith, 165, Queen Victoria-street, London. (Complete specification.)

17181. **Improvements in thermo-electric couplers.** British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.) (Complete specification.)

AUG. 25.

17133. **Improvements in and relating to mercurial vapour electric lamps.** Joseph Skwirsky and Francis Harrison, 157, Grange Park-road, Leyton, Essex.

17204. **Improvements in dynamo-electric generators and motors.** Frank Johnston, 55, Spencer-road, Bedford, Beds.

17222. **Improvements in electrical transformers for measuring apparatus and the like.** Camillo Olivetti and Dino Gatta, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 25, 1904, being date of application in Italy.) (Complete specification.)

17223. **Wireless telegraphy.** Walton Harrison, 1, Broad-street-buildings, Liverpool-street, London. (Date applied for under Patents Act, 1901, Aug. 26, 1904, being date of application in United States.) (Complete specification.)

17235. **Improved construction of appliances for producing electric light displays.** Alexander Elias Dakhyl, Antonio Galanti, and Hanna Nassyf Dakhyl, 173, Fleet-street, London.

17238. **Improvements in electrodes for secondary batteries.** Henry Francis Joel, Norfolk House, Norfolk street, Strand, London.

17243. **Improvements in electricity meters.** Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

17257. **Improvements in automatic switches for telephone installations.** Paul Hildebrand, 31, Bedford street Strand, London. (Complete specification.)

AUG. 26.

17260. **An electric indicator for showing, at a distance, the rise and fall of liquids in reservoirs and the like.** William John Blenheim, 3, Grange-road, Egham.

17270. **Improvements in or connected with electrical hand lamps.** Claude Gerald Napier-Clavering, 48, Corporation-street, Birmingham.

17280. **Improvements in and relating to magneto ignition apparatus for use with internal-combustion engines.** Josef Gawron, 51, Deansgate-arcade, Manchester. (Date applied for under Patents Act, 1901, Aug. 26, 1904, being date of application in Germany.) (Complete specification.)

17283. **Improvements in or applicable to automatic breakers for electrical apparatus.** Heber Moorhouse, 4, St. Ann's-square, Manchester.

17286. **Improvements in or relating to electrical contact makers and breakers, particularly for use in conjunction with internal-combustion engines.** Frederick Henry de Veulle, 18, Hertford-street, Coventry.

17288. **Improvements in electric candle lamps.** Charles Clark Regnart, 29, Anson-road, Cricklewood, London.

17302. **Improvements in or relating to telephone or like transmitters.** Hahnemann Adolphus Outmore and the Telaupd Syndicate, Limited, 315, High Holborn, London. (Complete specification.)

17308. **A new or improved apparatus for producing electrical discharges.** Herbert John Haddan, 31, Bedford-street, Strand, London. (The Synchronous Static Company, United States.) (Complete specification.)

17312. **Improvements relating to telegraphic signalling systems.** Giovanni Bogni, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 31, 1904, being date of application in Italy.) (Complete specification.)

17314. **Improvements in automatic regulators for electric currents.** Patrick Kennedy, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 12, 1904, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 14.

1904.

11668. **Electric telegraphy.** Muirhead.

16038A. **Central exchange telephone system.** Brander. (Date applied for under Patents Rule 9, July 20, 1904.)

17975. **Control of electrically-propelled vehicles.** Raworth.

18105. **Transformation of repulsion motors, when running at speed, into rotating field asynchronous motors.** Latour. (Date applied for under International Convention, Aug. 27, 1903.)

18163. **Arc lamps** Andrews.

18174. **Speed-changing mechanism.** British Thomson-Houston Company, Limited. (General Electric Company.)

18185. **Means for controlling electric power distributing systems.** Routin.

18683. **Control of alternating-current electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

18790. **Apparatus for indicating and recording electrically at a distance the movements of instruments indicating physical conditions.** Le Page. (Post-dated Sept. 30, 1904.)

20314. **Electric capstans.** Dixon.

20554. **Apparatus adapted for indicating or automatically controlling or varying the flow of electric current.** Fricker.

20672. **Connection of electric or other wires.** Ford and Sadworth.

21045. **Single-phase dynamo-electric machines.** Carolan. (General Electric Company.)

21401. **Method of effecting communication between telephone exchanges and apparatus therefor.** Thomson.

21422. **Electrical switches.** Nunns.

22744. **Electric switches.** British Thomson-Houston Company, Limited. (The General Electric Company.)

22820. **Variable-speed windings for alternating-current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

22822. **Alternating-current electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

23201. **Third rail insulators of electrical railways.** Chambers.

25191. **Application of a coherer to any electric transmission by means of conductors for any distance, for telegraphic, telephonic, signalling, bell, or other systems.** Magini.

25406. **Method of amplifying variations of energy in electric circuits.** Hewitt.

1905.

860. **Trolley heads for overhead system of electrical traction.** Orme.

1247. **Conduits for the protection of electrical conductors.** Maxwell.

1380. **Telephone systems.** Watkins, Bolster, and Goodsell.

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2922. Electric accumulators or secondary batteries. Vickers, Sons, and Maxim, Limited, and Hall.

2944. Rectifiers for alternating electric currents. De Faria. (Date applied for under International Convention, Feb. 20, 1904.)

5369. Electric motor meters and other measuring instruments, more especially designed for reducing the effects of friction in such instruments. Davis and Haskins. (Date applied for under International Convention, March 15, 1904.)

5577. Telephone calls. Geyerman.

6640. Electricity meters. Busch and Roosen.

6640A. Electricity meters. Busch and Roosen. (Date applied for under Patents Rule 9, March 29, 1905.)

7159. Telephone apparatus. Ehrlich.

7498. Air-insulated telephone and telegraph cables. Emanuel Jensen and H. Schumacher Aktieselskab. (Date applied for under International Convention, April 9, 1904.)

8615. Electric switches. Jones, Macmillan, and Neybergh. (Date applied for under International Convention, Jan. 12, 1905.)

9439. Fireproof casings and covers for electric conductors. Romney.

10067. Treating of patients by static, galvanic, or like electrical currents. Macaura.

10112 Insulating base for electric switches, plugs, pushes, and the like. General Contract Company, Limited, and Salamon.

10187. Electric couplings. Boutfield. (Firm Julius Pintsch.)

11773. Magneto-electric ignition apparatus for petrol engines and the like. Simms and Bosch.

12822. Electric door-locking device. Peter.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¼ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	15/16-1 1/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5⅛-6
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	100-102
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	85 89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100	..	92-95
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	107½-109½
—— Ordinary	5	..	10-11
—— 5 per cent. Pref.	5	..	5 -5⅜
Crompton and Co.	3	..	1¼-1⅜
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1¼-1⅜
—— "A" Shares, 01-017,139	5	..	2-2½
—— 5 per cent. Debentures	100	..	89-94
—— 4 per cent. Deb. Stock, Red.	100	..	85 88
Electric Construction, Nos. 1 to 112,100	2	..	5/8-5/7
—— 7 per cent. Cumulative Pref.	2	..	1⅜-2⅛
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-101
W. T. Henley's Telegraph Works, Ordinary	5	..	11½-12½
—— 4½ per cent. Preference	5	..	5⅜-5⅝
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	32½-34½
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	11⅜-12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9⅜-10¼ xd
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red	100	..	105-107
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	10-10½ xd
—— 7 per cent. Preference	5	..	9⅜-10¼ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9-9½
—— Nos. 60,001-80,000	5	..	8⅜-9⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	6⅞-7¼ xd
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	6¼-6⅜ xd
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	..	4 13/16-5 1/16
—— ditto (1903) 40,001-80,000	5	..	4¼-5⅛
Chelsea Electricity Supply	5	..	6¼ 6⅜
—— 4½ per cent. Debentures	100	..	108-110
City of London, Ordinary	10	..	10½-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	105 105
County of London Electric Supply, Ordinary	10	..	8½-9 xd
—— 6 per cent. Cum. Pref.	10	..	12-12½ xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5	..	6 1/16-6 5/16
—— 4½ per cent. First Mort. Deb.	100	..	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90

Name.	Amount paid.		Last price.
	£		£
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	99-102
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	7⅜-8¼
Isle of Wight Elec Lt. and Pwr., 4½ p c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	..	⅜-½
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	11⅜-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10½
London Electric, Ordinary	3	..	2-2⅛
—— 6 per cent. Pref.	5	..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 00,001-300,000	5	..	9⅞ 10¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98-100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	99-101 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0.9	5	..	7⅜ 8¼
—— do., 57,0 0-75,000	5	..	7⅜-8¼
—— 5 per cent. Pref., 1-57,000	5	..	6 6¼
—— do., 57,0 0-75,0 0	5	..	6-6¼
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6¼-7
—— 4 per cent. Debenture Stock	100	..	98-100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-104
Smithfield Markets Electric Supply, Ord 1-12,000	5	..	2⅜ 2¾
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	106-109
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13¼-14½
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	87 99
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5¼-5⅜
Westminster, Ordinary	5	..	12½ 13½
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6¼-6⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5⅞-6¼
—— Ord.	5	..	9-9½
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p c. 1st Mor. Deb. Stk., Red.	100	..	104-106
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-14½
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9½-10
—— 5 per cent Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75 001-150,606	1	..	13/16-15/16
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4½
—— 4½ per cent. Deb. Stk, Red., Prov Certs. all pd.	100	..	95-98
British Columbia Electric Railway Co., Ord. Def.	100	..	104-112
—— Ord. Pref.	100	..	99-102
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	102-105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c
—— 4½ per cent. Vancouver Power Deb.	100	..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	8¼-8⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10¼-11¼ xd
—— 5 per cent. Perpetual Debenture Stock	100	..	122-124
—— 4½ per cent. 2nd Deb. Stock	100	..	97-99
Buenos Ayres and Belgrano Trams	5	..	3 3½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	106-107
—— Prov. Cert., all paid	100	..	102 105
Buenos Ayres Electric Trams., 5 p c. Deb. Stk., Red.	100	..	96-98
Calcutta Tramways, 1-102,268	5	..	9⅜-10¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1⅜ 1⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅞-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13¼-14½
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14½
—— 6 per cent. Pref., Nos. within 1-60,0 0	10	..	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14¼
—— 4 per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9⅜ 10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	99 102
Madras Elec. Trams (1904), 5 per cent. Deb. Stk., Rd.	100	..	102 104
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	¼-5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	106-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	102-105
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9⅜-9¾
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8⅜-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9-9¼ xd
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,142 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	89-90 xd
—— 4 per cent. Pref.	100	..	101-103 xd
—— " " deferred	100	..	77-80
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	40-42 xd
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-120 xd
—— ,, ,, ,, '95	100	117-120 xd
—— ,, ,, ,, '01	100	115-116 xd
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	93¼-99½
Waterloo and City, Ordinary	100	83-91 xd

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	109¼-110¼
—— Deferred Stock	100	107¼-109½
—— 6 per cent. Cum. First Pref	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb Stock, Red.	100	99½-101½
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 26	1,614	1,501	- 285	— h	25½	* 20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 26	424	403	+ 21	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 27	1,063	1,061	+ 2	- 493	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 26	352	345	+ 7	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 23	1,011	1,013	+ 2	+ 773	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 24	2,837	2,822	- 15	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 26	2,041	1,852	+ 189	- 673	16½	16½	Dec 3	31 846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 27	2,325	2,095	+ 230	—	40	38	March 31	96 765	20,215 196	2 161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 23	2,083	1,497	+ 585	—	16 82	16 82	,, 31	55,276	10,058,288	1 121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 25	4,685	4 458	+ 227	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 27	1,422	1,375	+ 47	+ 820	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 25	5,120	4,981	+ 149	—	51½	51½	Dec. 31	259,739	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 26	1,151	1,053	+ 98	—	10 60	10·60	March 3	—	—	—	—	—	—	
Burton Corporation	,, 27	323	428	- 105	- 804	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2 058	6·76
Cardiff Corporation	,, 12	2,707	2,172	+ 534	+ 635	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 26	226	222	+ 4	- 385	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 26	5,300	5,480	- 180	- 1,157	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway	,, 27	2,161	2,257	- 96	- 223	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	,, 10	341	358	- 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 24	524	481	+ 35	+ 793	15½	15½	,, 31	24,835	5,814,376	882,256	1·01	6 61	—	4·69
Darwen Corporation	,, 25	257	263	- 6	+ 214	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 13	344	317	+ 27	—	4½	4½	,, 3	11,250	2,853,900	281,743	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 25	147	141	+ 6	+ 104	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 25	4,455	4,429	+ 26	—	47	46	,, 31	267,489	50,050,949	7,077,372	1 23	9 07	5,691	5·55
Dublin S. District, Electric	,, 25	1,698	1,953	- 255											
Dundee City Tramways	,, 16	893	842	+ 51	—	22	21	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 26	877	759	+ 118	—	23	23	March 3.	36,652	13,589 658	863 816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 26	15,059	3 9 1	+ 1,073	+ 9,936h	143½	143	May 3.	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 23	1,714	1,561	+ 153	—	35,	33	March 31	71,019	17,819,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 26	1,418	1,264	+ 154	+ 671	35	35	,, 3	69,938	12,838,150	1,665 262	1 24	9·71	1,923	—
Hull Corporation	,, 26	2,201	2,155	+ 45	+ 662	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 21	116	150	- 34	- 536	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 25	253	276	- 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 25	5,972	5,577	+ 395	—	89	89	March 25	288,233	64,223,616	7,121 038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec 31	26,011	12,039 252	1,223,507	1	9·79	—	4·82
Liverpool Corporation	,, 19	11,012	10,441	+ 571	—	103	103	,, 31	547.625	116,642,663	12 166,419	—	—	—	—
Liverpool Overhead Railway	,, 27	1,584	1,638	+ 54	- 409h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 19	15,745	13,429	+2,316	+52,783	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	11,511	3,128 867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 24	145	178	- 33	-	2½	2	—	4,740	850 121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 26	13 230	12,485	+ 745	+12,039	43	131½	March 31	631,956	126,930,875	14,123,124	1 19	10 75	4,293	6·99
Nelson Corporation	,, 26	139	130	+ 9	+ 293	—	23	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 26	3,658	3,608	+ 50	+ 2,818	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 26	1 981	1 364	+ 617	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 25	2,627	2,573	+ 54	+ 1,702	—	29	,, 31	95,702	19,625,320	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4	,, 31	14,881	2 837,110	336,517	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 3	440	645	- 205	—	9½	7½	,, 31	23,569	5 251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 28	4,280	4 295	+ 85	—	101	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	July 22	343	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 27	4,566	4,646	+ 520	+ 5 089	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 23	1,137	1,071	+ 66	- 204	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	July 6	472	435	+ 37	+ 407	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	Aug. 18	1,129	697	+ 432	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 27	1,452	1,446	+ 6	+ 786	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 16	253	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Wallasey U.D.C.	,, 26	912	848	+ 64	+ 264	11·85	10 5	,, 31	38,768	7,412 881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	July 13	342	332	+ 10	+ 175	7½	—	,, 31	17,157	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	Aug. 24	2 165	1,147	+1,018	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 23	903	748	+ 155	—	—	7½	,, 31	—	—	—	—			

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Wireless Telegraphy.—In consequence of applications for patents having been presented to the Canadian Government by Mr. de Forest, Mr. R. A. Fessenden, and Sir Oliver Lodge, a dispute has arisen as to which was the inventor of certain arrangements of apparatus for wireless signalling. The parties have agreed to refer the matter to the arbitration of Messrs. Aylen, K.C., Ridout, and Thompson.

Tramways and Light Railways Association.—The *Official Circular* for August contains Mr. J. H Rider's paper on "Charges for Supply from Combined Lighting and Traction Stations," and the text of the Bill introduced into Parliament last session by the Hon. Arthur Stanley (president of the association) "to provide for the establishment of a highway commission for England and Wales, and for the amendment of the laws relating to highways and bridges in England and Wales, and for other purposes" It is expected that the measure will be brought up again next session.

Michigan School of Mines—We have received the year-book of this institution for 1904-5, from which we observe that the college continues to do good work in providing tuition in civil, mechanical, electrical, and mining engineering. Although the larger proportion of the students belong to the State itself, it is open to those all over the Union, and, in fact, to those of other countries, England being a contributor to its roll, which numbers over 220. The year-book is accompanied by a collection of picturesque views illustrating the various buildings and laboratories of the college.

A Use for Arc Lamp Carbon Ends.—An economical method of using up arc lamp carbon ends is described by L. Bernard in the *Elektrotechnische Zeitschrift*. It consists in cementing several ends together so as to form a single long carbon. The cementing is carried out by cutting the ends of the pieces so as to allow them to fit together, covering these ends with a paste made of water glass and powdered carbon, and then lightly pressing the pieces together. Such made-up carbons were found to be satisfactory in every way. They burnt, both with direct and alternating currents, just as well as new carbons, even at the junctures. Tests proved that the resistance was but little greater than that of new carbons, whilst as regards mechanical strength the made-up carbons, when subjected to a uniform stress, were found, if anything, more liable to break between joints than at the joints.

Engineering and the Army.—Hitherto it has been rather the fashion to regard the engineering arm of the national forces as merely auxiliary to the combatant ranks, but the Russo-Japanese war has served to emphasise the primary importance of this branch of the services, especially for field work, such as telephony. In view of this the Army Council has decided to move the depôt and training Battalion of the Royal Engineers from Rochester to Tidworth, and the School of Military Engineering will be stationed on Salisbury Plain, where adequate accommodation for training will be available. The organisation of the corps mentioned is to be readjusted, as between the fortress, field, and telegraph units, so as to fulfil the latest developments of latter-day warfare. The abolition of submarine mining has liberated a number of sappers, many of whom will be absorbed by the new searchlight companies about to be created. It looks as though this time the military authorities realise the need of adaption to modern conditions.

A Combination Accident.—A curious combination of accidents is described in the *Scientific American*. At an opening of one of the bridges over the Milwaukee River a large and heavy street car was just leaving the swing-bridge over this river, and its forward truck was on the abutment when a steamer, through some misapprehension, ran into the opposite end of the bridge. The result was to turn the bridge on the turn-table, and to move it round until the street car almost fell into the river. The car broke the end truss of the bridge, causing the floor to drop, which further imperilled the street car. The street railway company immediately made the necessary arrangements to place the car back on the track, and this they did by floating a scow beneath the car and building up a mass of blocking, by means of which the car was jacked up and run on to the tracks on shore. A fortunate feature of the accident was that no lives were lost, and that all the passengers made their immediate escape. The forward set of trucks remained on the abutment, but the after set fell into the river when the floor of the bridge collapsed.

Electrical Progress in Ceylon.—From our contemporary *Indian Engineering* we gather that the annual report for 1904 of Mr. A. S. Barnard, the consulting electrical engineer to the Ceylon Government, is again a record of multifarious duties performed. Certain of these are scarcely of an electrical nature, such as serving on a condensed stores committee, but others include inspection of electricity meters, and the preparation of various lighting schemes for hospitals and Government buildings. The Nuwera Eliya telephone scheme is again postponed owing to lack of funds, but a proposal to erect a generating station and to supply electricity for public and private lighting at this popular hill station is under consideration. The estimates under this heading involve an initial outlay of Rs.112,000 (about £7,500), and an annual expenditure on street-lighting of Rs.5,629 (about £375). In Kandy, the complaints of too poor a pressure of supply have been checked by the laying of more underground mains and feeders. In Colombo there have been troubles in the Fort area through storms and lightning, but no interruption in the Cinnamon Gardens district. New lifeguards, of the trigger pattern, are to be attached to some of the cars on the Colombo tramways, and the whole of the track is to be relaid with considerably heavier sections of rails.

British Association.—The visit of the association to South Africa is likely to bear fruit in the way of cementing the link between scientists at home and those in our Colonies. The president announced, at the conclusion of his address, that a movement is on foot to found a medal for South African students, and it is expected that a definite scheme will be formulated before the visit closes In this connection it is interesting to note some remarks by Sir Richard Jebb in a supplementary address. The eminent educationist remarked that South Africa had experienced great difficulties in regard to higher education, but a great advance was now being made. Dealing specially with the technical side of education, Sir Richard outlined a scheme, which will probably come into operation at an early date, for organising a university having faculties in engineering and mining, law, agriculture, and general education. This project is a welcome sign that the great engineering needs of the Colony are to be provided for by the establishment of a native technological foundation. On the arrival of the party at Pretoria they were entertained by Sir Arthur Lawley, who saw in the efforts of the association the means of developing the great industries of the South African continent, for, as Sir Arthur remarked, it was at the shrine of that wonderful oracle Science that inspiration for this purpose should be sought.

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Electricity and Therapeutics. — A congress of physical therapeutics was held at Liége on Aug. 12-15. The meeting was well attended, and numerous papers were presented. Among the latter we observe that the subjects included the physiological effects of static electricity, high frequency, and radiotherapy. This is a gratifying token that the prejudice formerly entertained by many of the medical profession towards electro-therapeutics is giving way at least to tolerance. At the same time, the following sentences from our contemporary, the *Lancet*, seem to indicate that the attitude of the profession towards lay electricians, to which we have referred in previous issues, has not undergone any change for the better. Thus: "It is probable that the movement set on foot at this first congress will in time lead to the rescuing of all branches of physical therapeutics from the hands of empirics, and of establishing them on a firm scientific basis in the hands of medical men. The feeling in this direction was very strongly implied in all the sectional meetings." As the feeling was "very strongly implied" in all the sectional meetings, the inference is that those outside medicos who engage in electro-therapeutics are included among the "empirics" against whom the promised crusade is directed. To expel the charlatan is a highly desirable aim, but who is there that is competent to administer electricity if an electrician is not? This does not infringe upon the strict function of the physician, and the somewhat narrow-minded attitude of the latter is scarcely worthy of a great profession.

Japanese Customs Tariff.—The events of the last few days have attracted attention to the commercial developments that may be expected in the Far East with the cessation of the war, and in this connection it is of interest to note the tenor of the customs tariff lately compiled by the Japanese Government, which became operative on July 1. This provides that the dutiable value of imported articles shall be their actual cost "at the place of purchase, production, or fabrication," with the addition of packing, transportation, insurance, and all other charges up to the arrival of the articles at the port of disembarkation. In the event of an article coming under more than one rate of duty, it shall be assessed according to the highest rate. There is also a schedule of varying rates, in accordance with a scheme of general and conventional duty. Those countries with whom Japan has a most-favoured-nation treaty are accorded the benefit of the lower, or "conventional," rate of duty. The following scale is of interest to the electrical industry: electric light apparatus or instruments, 10 per cent. *ad valorem*; telephones, 10 per cent.; telegraph wire (other than galvanised), 5 per cent. *ad valorem*; cars and carriages for street railways, 10 per cent. *ad valorem*; submarine telegraphic cables, and underground telegraphic lines or cables, 10 per cent. Many articles are subject to an additional war tax, to remain in force for a year after the cessation of hostilities; but countries participating in the most-favoured-nation treatment are exempt from this, provided that the goods are accompanied by a certificate of origin.

"The Physical Review."—The September number of the *Physical Review* contains a number of articles which are of electrical interest, but which concern rather the scientist than the commercial man. Amongst these is one on "Billitzer's Method for Determining Absolute Potential Differences," by H. M. Goodwin and Robert B. Sosman. In this experiments are described on the Billitzer method of determining the absolute potential difference between a metal and a liquid, which, however, do not confirm the accuracy of the method. The results obtained by it, while agreeing more or less amongst themselves, differ largely from the potentials measured by other methods. Another article by Edward L. Nichols on the "Distribution of Energy in the Visible Spectrum," gives some valuable information as to the energy obtained from the various sources of light. The article on the "Evolution of Nitrogen from the Cathode and its Absorption by the Anode in Gases," by Clarence A. Skinner, is a continuation of experiments which were described in the July issue of the *Review*. In that case the evolution of hydrogen from various metals when used as cathodes in helium was described. In the present investigation nitrogen in conjunction with carbon electrodes was used. The observations showed that a vessel used as an anode also takes up nitrogen. The other articles in the issue are on the "Residual E.M.F. of the Carbon Arc," by G. G. Becknell, which is referred to elsewhere; "Some Physical Properties of Current Bearing Matter," by Paul R. Heyl; and on the "Variation of a Capacity with Temperature," by Earle M. Terry.

Personal.—A presentation of a set of silver was made last week by the staff and workmen of Messrs. Crompton and Co., Limited, to Mr. S. L. Brunton on the occasion of his resigning the position of works manager to that firm after a lengthy period of service. Mr. A. G. Hodgson, manager of the arc lamp and switch department, in voicing the sentiments of the staff, referred to Mr. Brunton's early services in building up the present Arc Works, which would remain a monument to his energy and ability. He testified from long personal experience to the kindly relations subsisting between Mr. Brunton and the staff generally—indeed, their late manager had been a friend as well as a chief. He had always had the interests of both masters and men at heart, and had invariably treated the staff with fairness. Messrs. P. G. Cheverton, W. Bickmore, and C. Perry, old members of the staff, added their meed of praise, the first-named defining Mr. Brunton's motto as "Know thy work and do it," after which Mr. Brunton was presented with the memento, which bore the inscription: "Presented to S. L. Brunton, Esq., as a token of esteem from the staff and workmen of the Arc Works, August, 1905." Mr. Brunton, who was received with loud cheers on his rising to acknowledge the gift, expressed pleasure at the cordial relations which had always existed between himself and the staff. He had been served loyally by everyone, and no grave difficulties had ever arisen. Both he and his wife and family would view the handsome present as a lasting token of their esteem. In conclusion, he wished every prosperity to the business, and trusted that there would be plenty of work to keep all employed continuously.

Commercial Intelligence.—The Board of Trade has issued a list of the members of the new Advisory Committee on Commercial Intelligence, their names being: Sir Frank Forbes Adam (Manchester), Lord Avebury, Sir Alfred Bateman, Sir Hugh Bell, Mr. H. Birchenough, Mr. T. F. Blackwell, Mr. H. Mitchell (Bradford), Mr. F. Brittain (Sheffield), Mr. T. Craig Brown, Mr. A. Wilson Fox (of the Board of Trade), Mr. C. A. Harris (of the Colonial Office), Mr. T. W. Holderness (India Office), Sir William Holland, M.P., Sir Francis Hopwood (Board of Trade), Mr. A. Bonar Law, M.P. (Board of Trade), Mr. Algernon Law (Foreign Office), Mr. R L. Paterson, Sir Albert Rollit, M.P., Mr. H. Llewellyn Smith (Board of Trade), Lord Strathcona, and Mr. D. A. Thomas, M.P., with three others not yet appointed, who are to represent South Africa, Australia, and New Zealand. The President of the Board of Trade will be chairman of the committee, and Mr. W. F. Wintour secretary to the committee. The period of five years for which the Advisory Committee on Commercial Intelligence was appointed in 1900 having terminated on May 24 last, the new committee is appointed for a further

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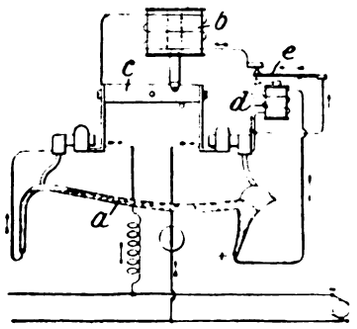
period of three years to continue the work. The functions of this committee, subject to confirmation by Parliament of the Bill for the creation of Secretaries of State for Trade and Local Government, will be to "advise the Board of Trade on the work of their Commercial Intelligence Branch and on such matters relating to foreign tariffs and other commercial questions as the Board may refer to them; to improve the means of obtaining and diffusing information for the benefit of British trade by means of commercial missions and correspondents abroad and otherwise as they may think fit."

Mercury Vapour Lamps.—A patent has been granted to Mr. C. O. Bastian for a mercury or other luminous vapour electric lamp, to be started by tilting, which is so arranged that the liquid metal does not form a closed circuit through the lamp when this is inactive, the starting being effected by the operation of a shunt coil or other electrically-operated device. In the accompanying diagram, when current is supplied, the shunt coil, *b*, tilts a lever, *c*, carrying the lamp, *a*, in opposition to gravity, to cause the mercury to complete the circuit through the tube; a series electromagnet, *d*, then attracts an armature, *e*, to open the shunt circuit, so that the shunt coil, *b*, drops the lamp, the mercury divides, and the light is produced. The cut-out, *d*, *e*, may be dispensed with, and a series electromagnet may be provided to return the lamp after the shunt coil has acted. The lamp may be arranged so that the mercury is divided by a further movement of



the lamp after connection has been effected, instead of by a return movement. In order to add red or yellow light to the light given directly by the lamp, reflectors or reflecting surfaces near it are coated with rhodamine or other fluorescent material. The lamp may be enclosed in a chamber containing ammonia gas, or any other gas opaque to radiant heat, the chamber and the lamp being both sealed. The inventor mentions that the lamp may be of heat-resistant Jena glass, and the defective seals in this are not important if the outer chamber is of ordinary glass and sealed perfectly. A little air in the lamp facilitates starting.

Electrical Fire Risks.—The *Journal* of the Western Society of Engineers, published at Chicago, for June, contains a paper, by Mr. W. T. Benallack, on "Electrical Fire Hazard," a paper which was read before the electrical section of the society in the spring. The author has had many years' experience in inspecting electrical work on behalf of insurance companies, and hence his general conclusions on the subject are the outcome of practical knowledge. He blames, as other experts have blamed, the users of electric light and power for their desire to have work carried out on the cheapest possible lines. Frequently fires have been caused due to the purchaser insisting on using cheap and inferior materials against the advice of the electrical engineer installing the same. There is no doubt that fire insurance companies have done a great deal to raise the standard of electrical work, and that their inspections are by no means unfavourable to the electrical contractors as a whole. For instance, the author states that during 10 years he secured the rewiring of some 3,000 buildings where defects existed, and the conditions were similar to those that had caused serious fires in other localities. He also secured the adoption of the National electrical code in 11 of the larger towns within his district, who appointed municipal inspectors to supervise all electrical work. We do not propose here to refer to the illustrated burn-outs which are also described in the paper, as in many instances they are due to faults of a nature which are not likely to occur in this country. We agree with the author that many large fires have been written up in the daily papers as due to electrical wiring, when investigation has proved that electricity had nothing whatever to do with the outbreak. Such loss as there is when considered in conjunction with figures for other illuminants prove that electrical distribution, if well designed and carefully executed, provides a smaller fire hazard than any other means of lighting.

The Victoria Falls.—The consideration by the Engineering Section of the British Association of the problem of harnessing the Victoria Falls was initiated by Mr. Robert Hammond, who read a paper entitled "Electric Power Distribution for the Rand," the following extract from which, reproduced from the *Times*, is interesting: "There were no engineering difficulties in the way of supplying electrical energy to all the mines on the Rand from a central power-house utilising the Victoria Falls, but the cost would far outweigh the annual outlay on coal. He sketched in detail a more economical scheme for distributing power by burning coal nearer the Rand. He estimated that they would be able to supply power at the rate of 0·7d. per unit, and he had little doubt that those now using steam power would find it economy to adopt electric power." The debate generally was in favour of this view, though Mr. Alexander Siemens contended that users could generate their electricity as cheaply as any central station could supply it. Prof. Ayrton reviewed the subject at considerable length, and it will be observed from the following remarks of his that the professor incidentally figured in the *rôle* of æsthete: "The pioneering development which American enterprise had brought about, combined with the extraordinary commercial success which electric power distribution had won on both sides of the Atlantic, made people ask, 'Is such an industrial revolution in store for South Africa?' At first sight the answer was 'No,' in view of the fact that coal-fields blackened the map, and the produce of some was reported to be nearly equal to the best Welsh. On the other hand, he pointed to the experience of South Wales and Tyneside, where electric power was now largely utilised. Considering the possibilities of Victoria Falls, and contrasting them with Niagara, he stated that the water which was utilised, and which would ultimately cease to pass over Niagara, would be nearly five times as large as the total amount passing over the Victoria Falls at the present moment. A convenient spot for a power station was at the end of the second gorge, but he advised them jealously to guard the beauty of the falls. While he advocated the electric transmission of power, he thought they should not start by constructing a transmission line from the falls to Johannesburg, not because it was unworkable, but because there was not yet sufficient demand for power along the route." This latter objection is one that often confronts the pioneer of power supply, but with the anticipated industrial expansion of South Africa it may disappear in the not distant future.

A Safety Device for Telephone Lines.—As a safeguard against damage to telephone users through

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excessive acoustical effects produced by atmospheric discharges, Herr H. Steidle suggested, and has recently tried, a special form of coherer connected across the telephone terminals. In attempting to make the decohering after a discharge automatic, however, several difficulties were met with, and an improved type of rotating coherer (described in the *Elektrotechnische Zeitschrift*) is now employed. This consists of a steel disc, *s* (Fig. 1) kept in continuous rotation by means of a small electromotor. Two German-silver springs, f_1 f_2, press lightly against the highly-polished sides of this disc, and a small cushion, P_1, with a wick, D, dipping into an oil-well, provides the necessary lubrication. The telephone to be protected is connected across the terminals, K_1 and K_2. The variation of the resistance of

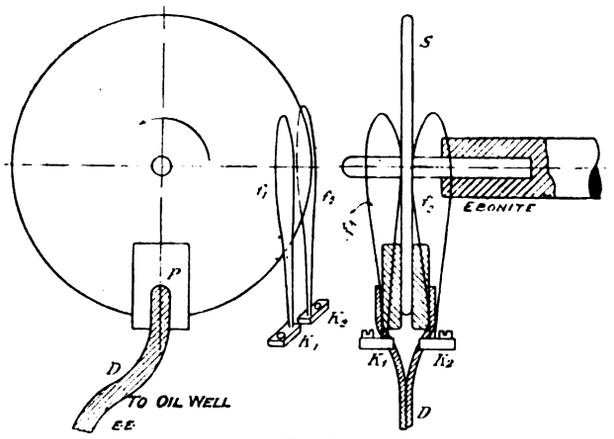

FIG. 1.

the apparatus with the voltage applied is shown in Fig. 2 This test was made after the disc had been running at the best speed—about 1,000 r.p.m.—for many hours. As soon as the disc came to rest, the resistance sank to a few ohms, but reached its original high value again immediately the rotation was restarted. The pressure of each spring against the disc was about 10 grm. The effectiveness of

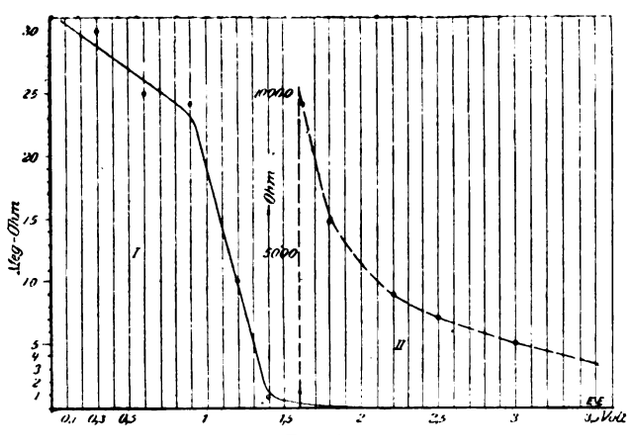

FIG. 2.

the arrangement is readily proved by discharging a condenser between the terminals, K_1 K_2. This produces a hardly noticeable effect on the telephone when the safety device is in use, although without it the noise produced by the same discharge is almost intolerable. Since decohering takes place instantaneously after a discharge, a telephone conversation can be carried on with practically no interference from such condenser discharges.

North-East Coast Institution.—The *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders issued this last week contain the report of the closing meetings of the past session. In it the paper on "Boiler Furnaces and the Effect of Oil on their Ultimate Strength," by D. B. Morison, is reproduced, with the discussion on the same and the author's reply. In the same volume is given Mr. J. F. C. Snell's reply to the discussion on his paper on "The Application of Electricity to Industrial Purposes." In the course of this reply Mr. Snell had to deal with several speakers who had criticised both his figures of cost and also those for working isolated plants for electrical driving. He agreed with one speaker that the figures he gave in his paper as to the first cost per kilowatt for power stations might be too high. It is the concentration of power into one large station which enables the maximum reduction to be made in the capital expenditure per unit of plant. In reply to the remarks of Mr. W. A. Mountain, Mr. Snell adhered to his figures as to the first cost of small plants for the private supply of power, which was from £12 to £15 per kilowatt. Mr. Mountain's figure, as given in an estimate, was £45 per kilowatt. The discrepancy between these two is explained by differences of opinion as to how much spare plant is needed. Individual items of cost as given in the latter estimate are also disputed by Mr. Snell. On the ground of cost of production the author was also strongly criticised. For instance, Mr. Mountain said that in the Rhondda Valley, including interest and depreciation, the cost per unit generated was 0·4d., and in a small colliery near Newcastle the price was 0·45d., and that for a small installation of only 124 kw. As against these Mr. Snell gives figures from a colliery where a three-phase plant of 100-kw. capacity is used. The load factor is 66 per cent. and the cost per unit 0·726d. These latter figures agree fairly closely with the curves given in the paper, and show that Mr. Mountain's item for cost is either incorrect or phenominally low. The last part of the reply is devoted to support of the different charges made to consumers within the Sunderland area. Mr. Snell points out that it is the variation in the load factor of the consumer which accounts for the difference in the price per unit, and not the magnitude of the maximum load. He also, in reply to one speaker asking some information as to the power factor and load factor of a shipbuilding yard, states that in one particular yard within the Sunderland area there were 837 kw. of motors installed. The power factor was found to be 71 per cent. and the load factor 47 per cent. With the copy of the *Transactions* above referred to, Mr. John Duckitt, the secretary of the society, has forwarded to us a list of the subjects on which original papers would be acceptable for discussion during the forthcoming session. This commences in October next, and amongst the subjects we find the following, which deal more or less closely with electrical engineering: "Electric Wiring of Ships"; "Application of Electricity to Auxiliary Machinery in Steamers"; "Calorific Value of Coal and Oil Fuel from Various Districts and Countries"; Economies effected in the Consumption of Fuel during the last 20 Years"; "Electric Motive Power for driving Machinery in Shipyards and Engine Works"; "Overhead Travelling Cranes (Electric or otherwise)".

Two-Phase Service from a Three-Phase System—A method of utilising a four-wire three-phase system for rendering 400-volt two-phase service in case of emergency is described by Mr. H. B. Gear, of Chicago, in the "Wrinkles" department of the National Electric Light Association. The load was approximately 400 kilovolt-amperes, and to accomplish the desired transformation resort was had to eight 50-kw. standard lighting converters, four of which had a ratio of 10 to 1, with 208-volt secondaries, and the other four a ratio of 9 to 1, with 230-volt secondaries. Following the Scott system of transformation from three-phase to two-phase, the scheme of connections was worked out on the basis of using two transformers in series on both primary and secondary. The

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normal primary voltage being 2,080 from neutral to either phase wire and 3,600 between the phase wires, it was necessary to employ two 2,080 volt windings in series on the primary side. The voltage of the motors being 400, it was likewise necessary to connect the secondaries in series. In order to secure approximately 400 volts on each of the secondary phases, it was necessary that the primary pressure should be about 4,160. The pressure was obtained by inserting boosters in the three-phase line. Voltmeter readings, taken without load, indicated unequal pressures on the transformers, and upon attempting to start a 5-h.p. motor the voltage on the vertical phase receded almost to zero, whilst that on the horizontal phase was but little changed. On connecting a separate transformer to the three-phase wires, it was found impossible to render any service with this scheme of connections. A theoretical analysis of the trouble suggested that the current which passed from the intermediate phase to the other two was choked by the impedance of the two transformers connected between the two outer phases, due to the fact that their windings were not in the same magnetic circuit. It was, therefore, found necessary to adopt the scheme of connections shown in the large diagram (Fig. 1), which we

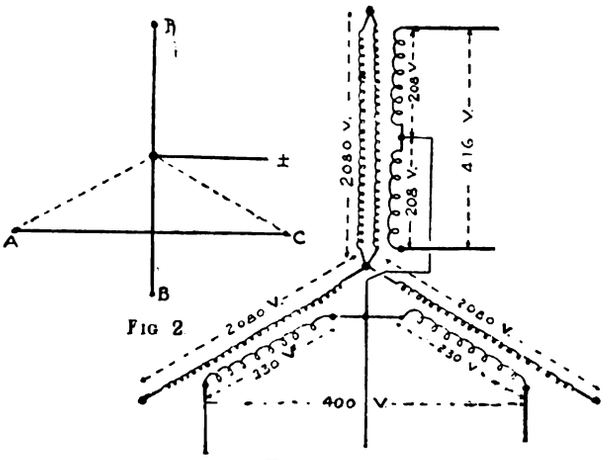

FIG 2

FIG 1.

reproduce from the *Western Electrician* of Chicago. The two 10-to-1 transformers were connected in parallel from the intermediate phase to the neutral wire of the four-wire line, and the two 9 to-1 transformers were connected from the two outer phases respectively to the neutral. The secondaries of the intermediate phase transformers were put in series to obtain 400 volts, and the 230 volt secondaries of the other two were combined in a similar manner. This scheme, however, unbalanced the three phase line, for while the current in the two outer phases showed 57 7 amperes, that in the intermediate one showed 100 amperes. Meters for 440-volt service not being available, the mid-points of the two-phase windings were tied together, as shown in Fig. 2, and the secondary neutral thus formed was used as a pressure wire for the meters. Two sets, consisting of four 50-kw. transformers each, were connected as shown in Fig. 2 to carry the load, and thus the desired result was accomplished.

Electricity Supply as a Business—There is no doubt that the reason why a considerable number of electrical undertakings in this country have not been more successful financially is the want of business-like management on the part of the engineers. They have failed to recognise that it is useless to spend all their time in increasing the economy of the generating plant if the load is not at the same time an increasing one. It is the engineer who is able to induce the consumer to take a supply of power and light, and at the same time keep his works properly equipped to meet the demand, who will succeed in the electrical supply business. Quite a number of the corporation undertakings now issue useful information to intending consumers. From Ipswich we recently received samples of literature which Mr. Frank Ayton, the engineer of the undertaking, is circulating. One of these gives nine good reasons "why you should use the electric light." The first three read as follows: "(1) Because it is the only method of lighting which makes it possible for you to always maintain fresh air in your rooms. It does not consume any of the oxygen in the air, neither does it heat the latter. It does not give off any fumes. These advantages, from the health point of view, are of enormous value. (2) Because it is the safest form of illuminant known. Its use greatly reduces the risk of fire, and there is no danger to life by leakage. The Phœnix Fire Office says: 'The electric light is, in the opinion of the Phœnix Fire Office, the safest of all illuminants, and preferable to any other, when the installation has been thoroughly well put up to its satisfaction, and the particular system employed has its approval.' (3) Because it is so extremely convenient. Directly you open the door you can light up the room by mere turn of the switch. There is no waste as with gas, since the lamps, being so easily lighted, are always turned off when leaving the room. When desired, as for instance, in nurseries, sick rooms and bedrooms, special turn-down lamps can be used." The remaining six reasons are also valid ones quite apart from the question of cost. Such a pamphlet will do much to popularise electric lighting. The second one, on electric power and what it costs, is equally serviceable. For instance, some actual results are given as to what has been attained by the adoption of electrical driving. At the National Arms Factory at Liége all the main lines of shafting are done away with, and instead short straight lengths of shafting driven by independent electric motors. As a result the power required per rifle turned out is less than half that in any similar factory using mechanical transmission from steam-engines—viz, 1½ h.p. per rifle against 3½ h.p. The wording of the result leaves something to be desired, as the statement that it takes 1½ h.p. per rifle neglects the important element of time. Again, it is shown that the coal bill at the Royal Arms Factory at Liége was reduced to one-third by the adoption of electric motors throughout the factory. Several other instances are given, and the pamphlet ends as follows: "What is the reasonable deduction to be made from the above statements? It is this: if these large firms, previously producing power on a large scale by steam and gas engines, could make such considerable savings by adopting electric driving, then you — working on a much smaller scale—will derive, in proportion, a much greater benefit, simply because it now costs you considerably more to produce a unit of power by your present methods than it cost them with their previous methods, the general rule being that the larger the scale of operations the lower the cost of producing the unit of power. If you change to electric driving you can buy power from the Corporation supply at prices which are among the lowest and most favourable in the country—2d. down to 1½d. per unit, which works out at 1½d. down to $1\frac{1}{10}$d. per electrical horse-power per hour. Let us have the opportunity of going into the matter with you—it won't be a waste of your time, and we can put absolutely convincing figures before you.' Ipswich is to be congratulated on the clear way in which the advantages of their municipal electrical supply is being put before the inhabitants. The idea of publishing the actual yearly accounts which users of electric motors have had to pay at Ipswich is also a good one, and will convince certain classes who do not trouble to read literature for which they have not to pay.

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THE YORKSHIRE ELECTRIC POWER COMPANY.

This company, as mentioned in a recent issue, has commenced the supply of power from its Thornhill generating station, and organised an electrical exhibition to show intending users of power what could be done by electric motors. The powers of the company to distribute electrical energy date from the 1901 session, and cover a very wide area (about 1,800 square miles) in the West Riding of the county of York. The chief manufacturing districts of the county are included, in which it is estimated that over 2,000,000 h.p. is actually employed, so that there is ample scope for electrification. Mr. Horace F. Parshall has designed the equipment of the power station, and acts as consulting engineer to the company. Mr. W. B. Woodhouse is the resident engineer, and to him we are indebted for the following facts as to the power station and the development of the demand for power. This last and most important branch of the scheme has been energetically pushed, and already a large number of consumers have been obtained. The diversity of uses helps the station to obtain an economical load, and hence we propose to describe in detail the various classes of consumers already secured. Thus the company are authorised to supply local authorities in bulk, and to make other agreements with them. Where the local authorities hold a provisional order for their district, the company may not supply in that district without the consent of the local authority. A number of local authorities have, however, realised that it is greatly to the advantage of the district to let the power company supply all large consumers direct, and in the cases of the Mirfield District Council and the

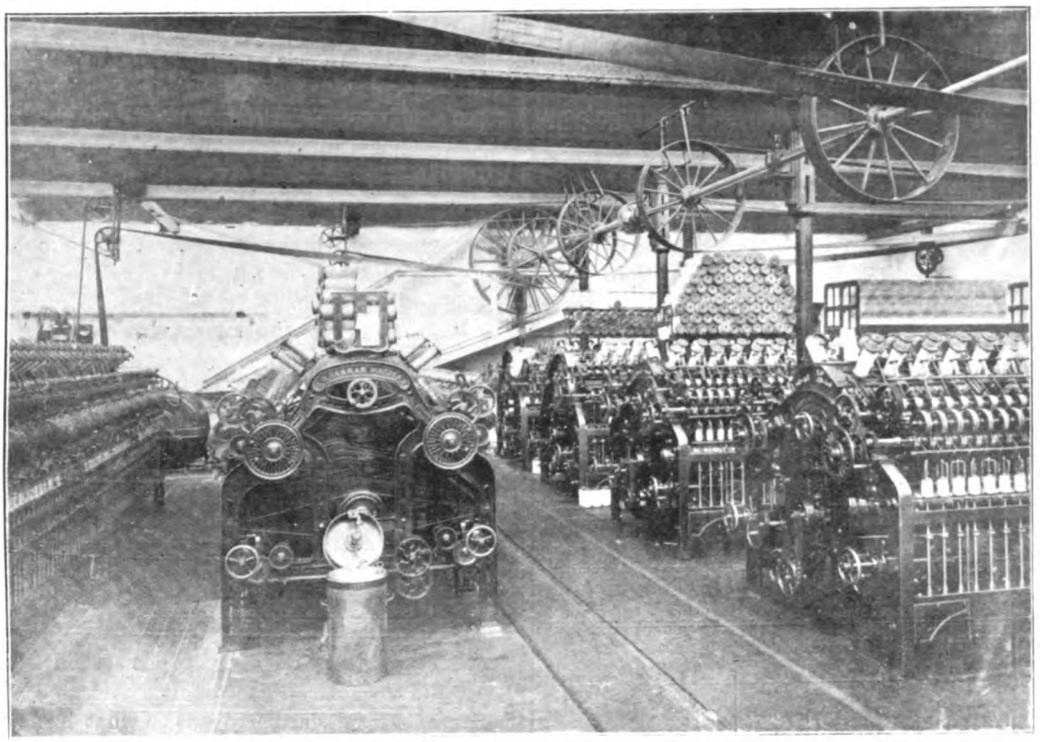

FIG. 1.—Electrically-Driven Roving Frames.

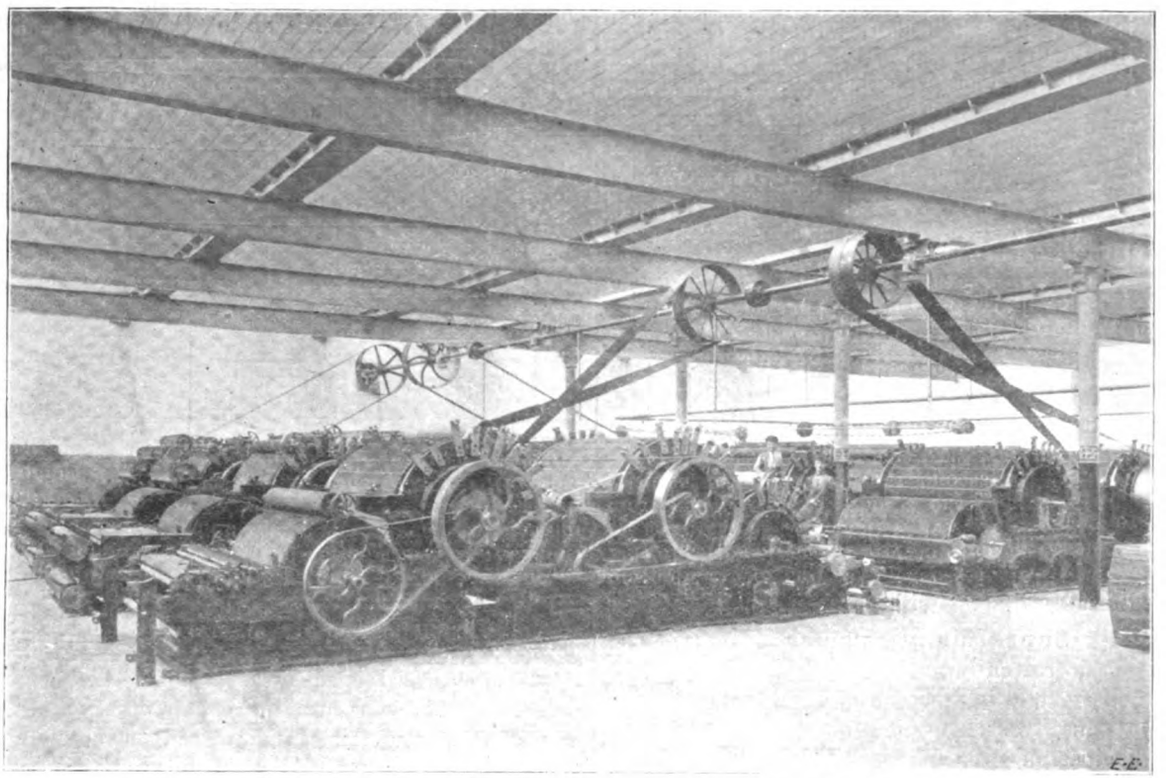

FIG. 2.—Carding Engines driven from the Yorkshire Power Company's mains.

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Liversedge District Council, who are taking a bulk supply for distribution for lighting and small power users, the company are supplying the large users direct. The Pudsey Corporation, who are taking a bulk supply for lighting, power, and tramways, have also consented to the company supplying in the case of one large user—namely, the woollen mills of Messrs. Wm. Lupton and Co.—they preferring to give consent for each individual case on its merits.

At Liversedge it is interesting to note that the Council have already a refuse destructor in existence, but after a

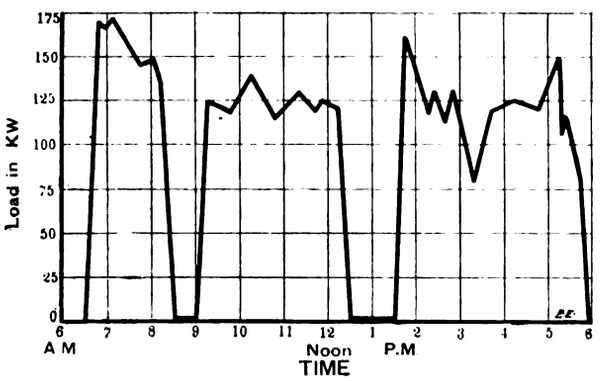

FIG. 3.—Day Load Curve from a Textile Mill supplied by the Yorkshire Power Company.

very lengthy consideration of the matter they decided not to use this for the purpose of generating electricity, being somewhat guided in their decision by the report of the committee of the Corporation of Leeds, who recently considered this matter and decided that in Leeds also this principle should be upheld. The Liversedge Council have made an agreement to take a bulk supply for 25 years, and they propose to distribute three-phase current for power and single-phase for lighting. The system of tramways in their area will, of course, be supplied by direct current.

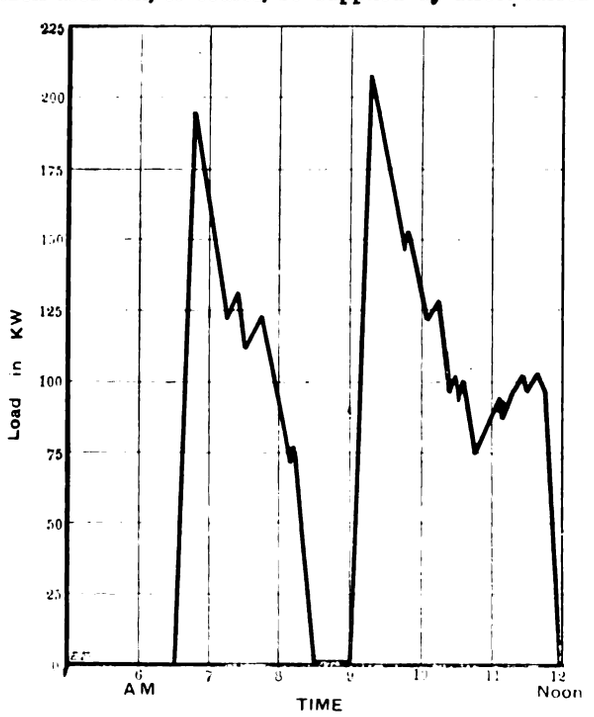

FIG. 4.—Saturday Morning Load Curve from the same mill.

The consulting engineers of the Council are Messrs. Charles Gott and Sons, of Bradford.

The Birstall District Council own their own gasworks, and were thus naturally inclined to consider favourably the driving of an electrical generating plant by gas-engines. The extremely disappointing results obtained in small gas-driven stations, when set against the terms on which the power company offer bulk supply, decided in favour of making an agreement with the power company. The consulting engineer to this Council (Mr. J. E. Ellis, of Morley) has decided on a single-phase distribution for lighting.

The Mirfield Council were the first to take a bulk supply from the company. This supply has now been given since the beginning of July, and connections to the Council's mains are increasing rapidly. The consulting engineer to the Council (Mr. A. B. Mountain, of Huddersfield) decided on an alternating-current supply, and lighting is given at 200 volts single-phase. The power company are supplying large power users direct with three-phase current.

The limitations of small generating stations and the cost of management of small undertakings is leading local authorities who have their own generating stations to consider favourably the company's proposals for a bulk supply, and the company is now negotiating with several local authorities who are in a position of having generating stations, and it is confidently anticipated that additional requirements will be met by a bulk supply from the company. In large districts such a supply is of great advantage, as the company can give a supply at outlying points, and so save considerable expenditure on feeders.

Power Consumers.—A large load is anticipated from collieries, as within a radius of eight miles from Thornhill power station there are 174 collieries. The company have

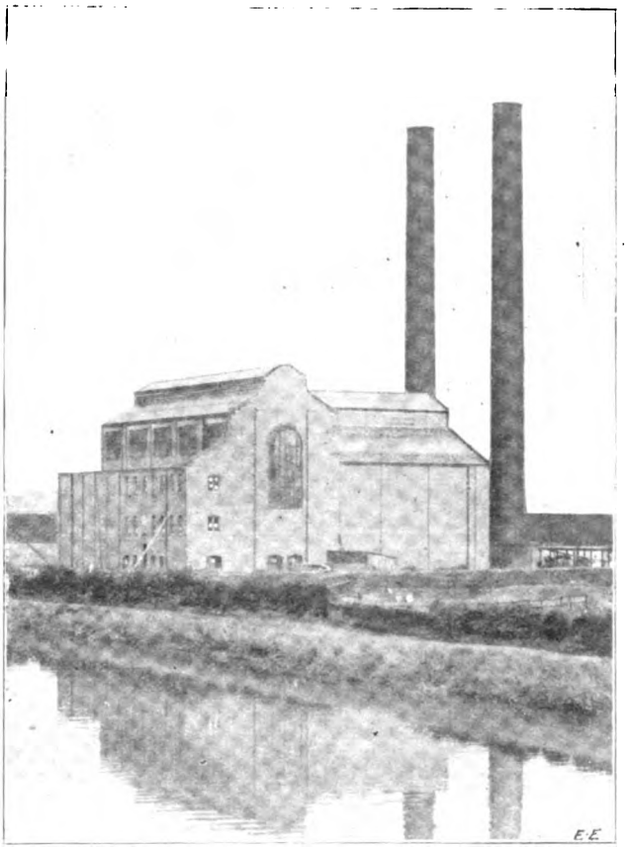

FIG. 5.—The Thornhill Power Station.

already made agreements with five collieries, and negotiations are proceeding with many more. The last few years have shown interesting and rapid developments in the application of electricity in mining work. The advent of the high-lift centrifugal pump has proved of great benefit to the collieries. These pumps are admirably suited for electrical driving, and their first cost is low compared to that of ram pumps. The Low Moor Company (one of the power company's consumers) is installing at their Three Nuns pit a centrifugal pump to lift water 175 yards. Coal-cutting by electricity is increasing year by year. From the point of view of safety, there is no doubt that the three-phase current from the company's mains should be used in collieries without conversion into direct current wherever possible. Where oil-break switches are used there is no risk of explosion when switching on and off. The makers of coal-cutting machinery are now nearly all prepared to supply cutters driven by three-phase motors, and it is anticipated that the future will see a much larger proportion of these machines in operation. The company, however, are prepared to supply direct current to collieries who have existing plants, and this is being done in the case of the Calder pit of the Mirfield Coal Company, where coal-cutting, pumping, and hauling are being performed

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electrically. The company have a special tariff for supplying collieries, or to any consumer who is prepared to take a limited supply—that is to say, any consumer who is prepared to guarantee that a certain percentage of his consumption shall be at night-time, that his maximum demand will be reduced between the hours of 4 and 8 p m., so as not to interfere with the lighting load.

of Gomersal. Other textile manufacturers taking a supply are Messrs Wm. Lupton and Co., of Pudsey, and Messrs. Booth Bros, of Drighlington. Figs. 1 and 2 show respectively some electrically-driven departments in the above mills.

The advantages of electrical driving of textile machinery are becoming more widely known, and the company expect to derive a large portion of their load from this source. It is often considered that the load of a mill engine is perfectly steady, but the actual records taken from a

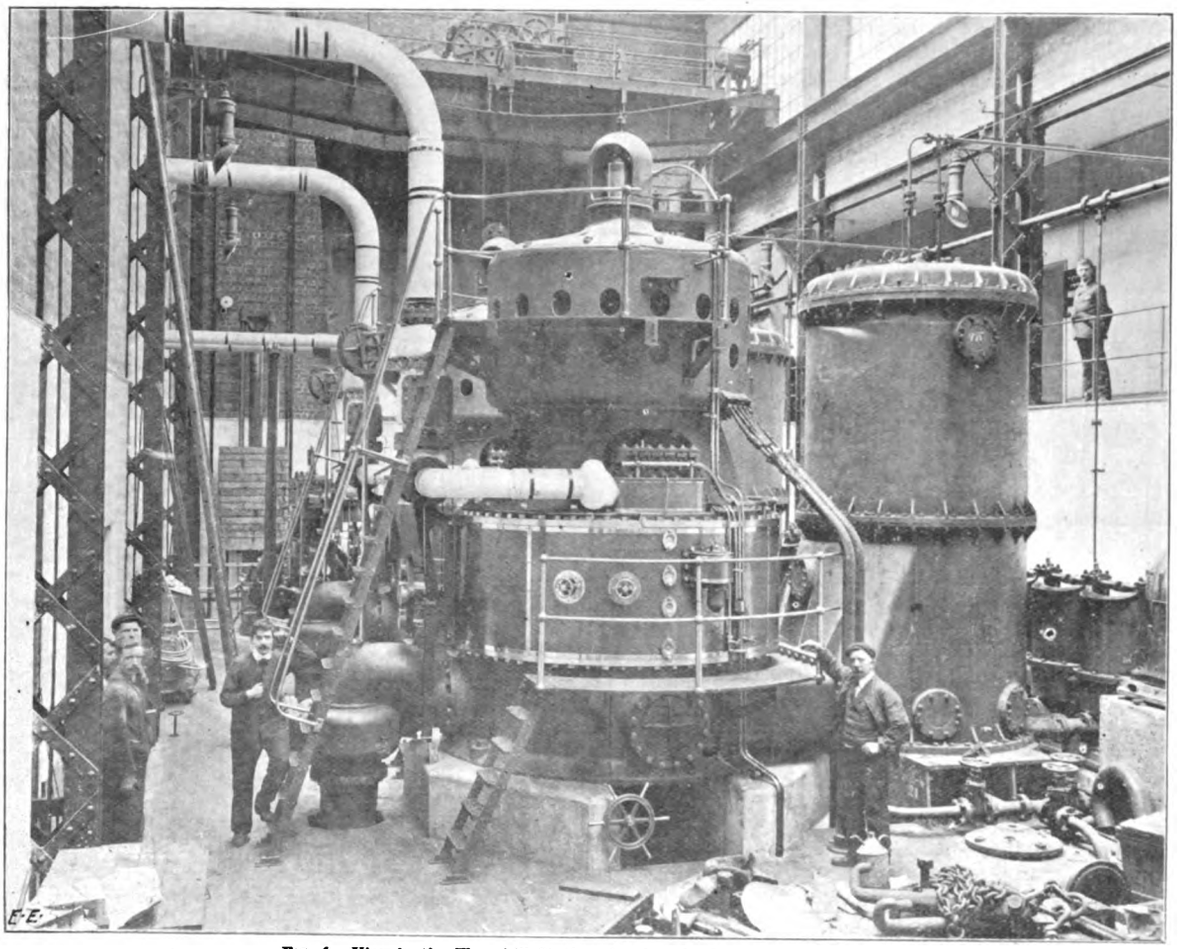

FIG. 6.—View in the Thornhill Station showing the 2,000-kw. Curtis Turbines.

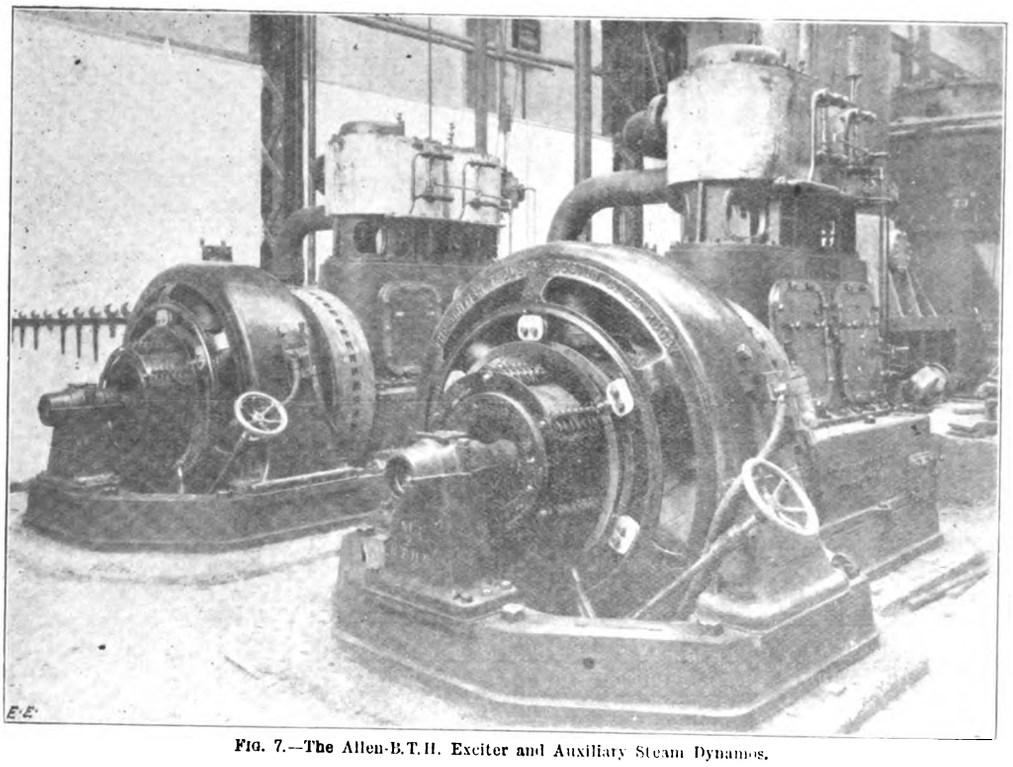

FIG. 7.—The Allen-B.T.H. Exciter and Auxiliary Steam Dynamos.

The company has the distinction of being the first to drive from public mains a complete textile mill—namely, the worsted spinning mill of Messrs. T. Burnley and Sons,

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textile mill, reproduced in Fig. 3 and 4, are interesting, showing how the load varies. The increased power needed to start again after a meal hour is remarkable.

It is particularly interesting to note how the load dwindles on Saturday, the human element anticipating stopping time by some hours. It is of little value to give a list of the company's consumers, as this is being added to daily, but it may be mentioned that already four local authorities have made agreements—five collieries, three textile mills, two railway companies, and a number of other power users. The diversity factor of the company's consumption will be very large, and the load factor on the station correspondingly high.

The Thornhill power station (Fig. 5), from which these will be supplied, is situated between the L. and N.W. Railway Company's Ravensthorpe Station and the River Calder, the position being chosen with due regard to its proximity to a railway and water supply, as tending to keep the cost of working as low as possible. The station, as can be seen from the illustration, is a steel and brick structure divided into two parts—the boiler-house (70ft. by 80ft.), the engine-house (100ft. by 50ft.). The design of the station is such that the capital cost per kilowatt is reduced to a low figure without sacrificing security or efficiency in any way. Extensions will be made, as required, by adding to the present station (which is in itself two complete unit stations) similar "units" until a total capacity of some 60,000 h.p. is reached. Coal may reach the power station by road, rail, and river; by road the coal is delivered to a hopper outside the boiler-house, and is raised from there to the boiler-house bunkers by means of a bucket conveyor; the railway siding (not yet constructed) will feed the same conveyor, which will raise 25 tons of coal an hour.

The coal bunkers at the top of the boiler-house are of steel, and from these coal is delivered through automatic measuring shoots to each boiler. Provision is made for six boilers, of which four are already installed. They are of the water-tube type, made by Babcock and Wilcox, each

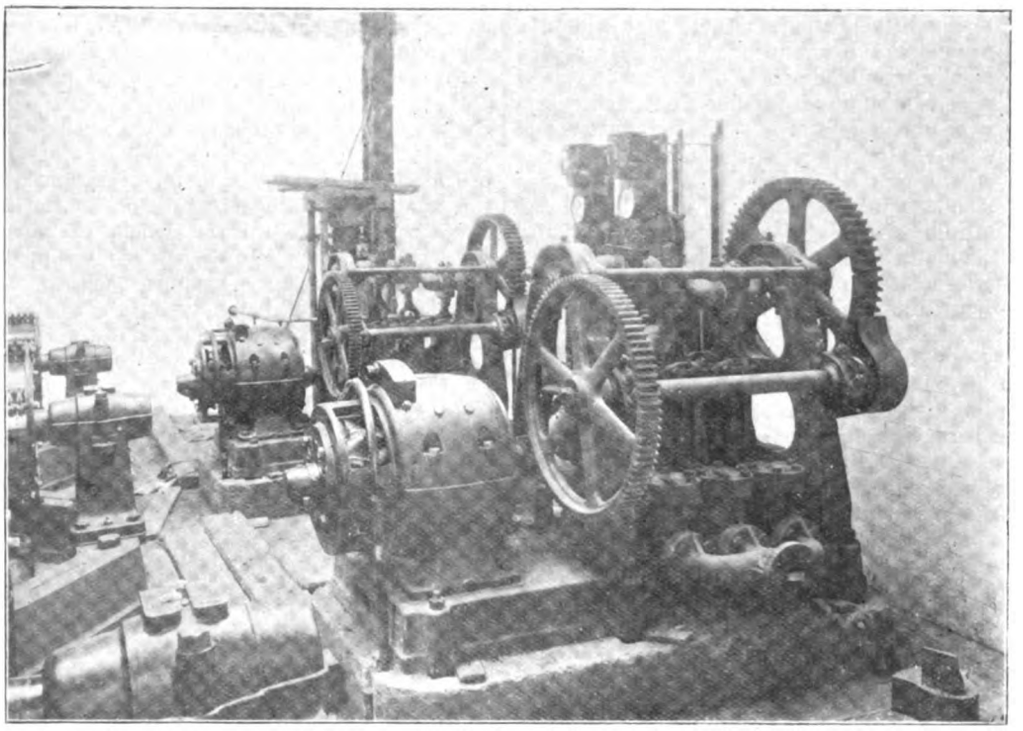

FIG. 8.—The Three-Throw Pumps supplying the water to the footstep bearing of the Curtis Turbines.

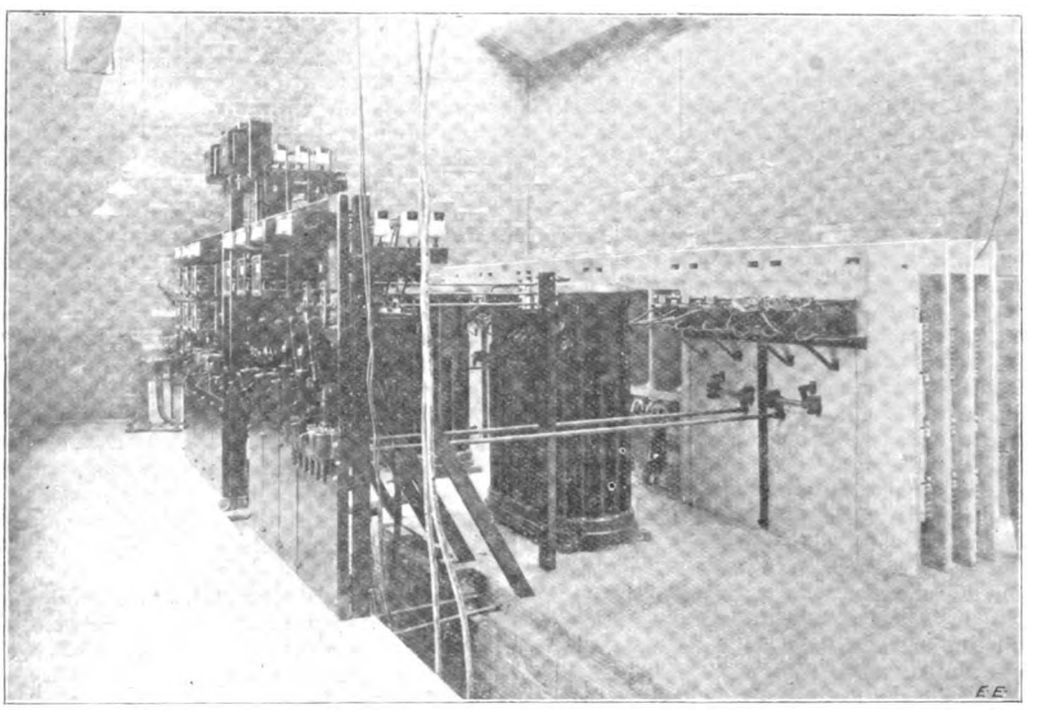

FIG. 9.—Interior of the Mirfield Sub-Station.

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capable of evaporating 20,000lb. of water per hour from a temperature of 60deg. F. to steam at 160lb. per square inch pressure, and 150deg. F. superheat. Each boiler has a heating surface of 5,730 square feet and a grate area of 100 square feet. The chain grates and stoker gear are worked by electric motors. The ashes fall by gravity to the basement, and are delivered into trucks. The main flues, of which there are two, are beneath the boilers, and lead to two brick-lined steel chimneys 150ft. high and 10ft. diameter. The economical combustion of coal is watched with great care, daily tests being made of the heat value of the coal used, the composition of the flue gases, and everything bearing on the boiler efficiency. The arrangement of the steam and feed-water piping is designed so that one half of the boiler-house can be completely isolated from the other. At the end of the boiler-house are situated the feed pumps, hot-wells, and water-tank, immediately under the control of the boiler-house staff. These feed pumps are the only auxiliaries which are not electrically driven.

The engine-house, like the boiler-house, has a main floor and basement; it is designed to contain generating plant of 8,450 kw. (11,000 h.p.) capacity. Two turbo-alternators, each of 2,000 kw. (Fig. 6), are already installed, and a third is being erected. Three high-speed Allen engines direct connected to direct-current dynamos of 150 kw (Fig. 7) each are installed at the end of the engine-room; these machines provide the current necessary to operate the station motors and for a local supply. The main generating sets are Curtis turbo-alternators made by the British Thomson-Houston Company, of Rugby; they are unique amongst steam-turbines in having vertical shafts with the alternators mounted on top, an arrangement which enables a large amount of power to be housed in a small building. The shaft and all rotating parts are carried by a hydraulic footstep bearing. Water at a pressure of 400lb. to the square inch is supplied by three-throw motor-driven pumps (Fig. 8), and the shaft floats on a film of water. The top and centre bearings of these machines are lubricated by the gravity system, with oil at a pressure of 10lb. per square inch pumped from a settling tank in the basement into a tank at the top of the engine-house, from which it gravitates to the bearings and returns to the settling tank. These pumps, and, indeed, all the auxiliary machinery in the station, are excellent examples of the adaptability of electrical driving to varied uses. The turbine runs at a speed of 1,000 r.p.m., and is controlled by a centrifugal governor; this governor by an electrical controller operates small steam-valves opening or closing the passages to the steam nozzles as the load varies.

A separate surface condenser is provided for each turbine, and the general arrangement presents some novel points; the condenser tubes are vertical, the air-pump running at 160 r.p.m. is direct coupled to a motor, and the circulating water discharge pipe being submerged at its end in the river allows the siphon action of the arrangement to be taken advantage of, and thus reduces very considerably the head against which the water is pumped. The siphon action is maintained by means of a dry-air pump which prevents an accumulation of air in the pipes and condensers. The centrifugal circulating pumps in the basement are controlled from the main floor; each pump is rated to lift 160,000 gallons per hour against a head of 28ft.

The proportionately large size of the condensing plant is on account of the benefits to be obtained by working with a high degree of vacuum in connection with steam-turbines; the results obtained with the present plant point to an extremely low consumption of steam per kilowatt-hour. Thus a steam-consumption test of one of the turbo-alternators was taken on April 26 and 27 this year, when the following results were obtained: With dry steam at 150lb. pressure and 28in. vacuum—full load, steam consumption 19lb. per kilowatt-hour; three-quarter load, 19·8lb.; half load, 21·8lb.; and quarter load, 25·6lb. per kilowatt-hour. With the higher superheat of 200deg. F. and 28in. vacuum, the above figures were reduced as follows: full load, steam consumption 16lb. per kilowatt-hour; three-quarter load, 16·6lb.; half load, 18·2lb.; and quarter load, 21·2lb. per kilowatt-hour.

An electrically-operated travelling crane travels the whole length of the engine-house; it is equipped with three motors, one for each motion. The alternators attached to the turbines generate three-phase alternating current at 10,000 volts, at which pressure it is transmitted to the various sub-stations. The switchgear controlling the machines and transmission mains, which is constructed by the British Thomson-Houston Company, is of a type that experience has proved suitable to controlling large powers at high voltages. It occupies three floors of one side of the engine-house, and is thoroughly fireproof. Each part is separated from the remainder by a brickwork partition, and can be disconnected when required without affecting the working of the other parts. The large amount of space occupied by the switchgear and considerations of safety call for a central control of all operations; there is, therefore, a control switchboard situated on the switch gallery. From this switchboard the whole of the main switchgear is operated by means of low-pressure current. All the high-pressure gear is enclosed, and the main switches, of the oil-break type, are worked by means of small motors. The switchboard attendant, on closing a small switch, causes the motor to open or close the main switch; directly the operation is performed the motor stops automatically, and a lamp lights up, informing the attendant of the fact. The paralleling of the alternators is also performed on the control board, the speed of the turbines being regulated by a small switch operating a motor attached to the governing gear of the turbine. The general type of the switchgear and control is similar to that used in the Lots-road station of the District Railway, and described in detail in our issue for Feb. 10, 1905. No high-pressure current is brought near the control board, the instruments showing the pressure and current in each feeder are all controlled by low-pressure current, and the maximum of convenience and safety is obtained. The switchgear for the direct-current machinery is also on the switch gallery.

System of Mains and Distribution.—The company's system of extra high-pressure mains is laid out with a view to giving a duplicate supply to every large consumer. This supply is at 10,000 volts, and the company's system is notable for the extreme simplicity of the switching arrangements. The protective devices are fitted to the cables in the power station; such complications as time-limit and reverse-current relays have been avoided. The system of mains is practically equivalent to a low-tension distribution network, except that it is in duplicate. Sub stations have been erected every four miles, and from these sub-stations distribution is effected at 2,000 volts within a radius of two miles. The majority of the company's power users are supplied at 2,000 volts, but in any extremely dense districts the company propose putting down a small amount of 400-volt distribution. Sub-stations are now erected and in operation at the following places: Thornhill, Mirfield, Gomersal, and Pudsey; other sub-stations are in course of construction at Birstall, Soothill, and Liversedge. The high-pressure cables, which were supplied and laid by Callender's Cable and Construction Company, are led from the power station in earthenware ducts for a considerable distance until they diverge in different directions, when they are laid in wooden troughs. Each cable is covered by a lead sheath and steel wire armouring, and contains three copper conductors insulated from one another and from the sheath by paper insulation. The cables are tested to three times the working pressure, or 30,000 volts, before being laid.

Fig. 9 shows the equipment of the Mirfield sub-station, which is typical of those stations from which direct current has not to be distributed. In the other sub-stations, like those at Thornhill and Ravensthorpe, rotary converters are also installed. Where low-voltage three-phase distribution is arranged, the voltage is 400.

Mains are now laid in the following districts: Thornhill, Dewsbury, Soothill Nether, Ravensthorpe, Mirfield, Kirkheaton, Liversedge, Gomersal, Birkenshaw, Drighlington, Leeds, Pudsey, and they are being extended in every direction. A supply can be given in any district within 15 miles of Thornhill in a few months, and the company will be pleased to deal with inquiries from any part of their area.

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The company through their resident engineer are advising intending consumers as to what can be done to secure the best economy from electric power. They have also arranged for the supply of motor and other electrical apparatus on the hire-purchase system.

ELECTRIC DRIVING OF TEXTILE MILLS.*

BY W. B. WOODHOUSE, ASSOC. MEMBER.

1. *Introductory.*—The reasons for the slow rate of adoption of the use of electrical machinery in textile factories in this country are not far to seek. The first is the lack of accurate knowledge as to the results to be obtained from electrical driving; the second, the absence, until recently, of a public supply of electrical energy at a reasonable price. The object of this paper is to state briefly the advantages of electrical driving, and to show that a clear knowledge of the advantages will modify very considerably the prevalent ideas as to the relative cost of driving by individual steam plants and by motors taking a supply from the mains of a power company or electricity works. That the advantages are truly existent may be realised from the extent of the adoption of electrical driving in other countries. On the Continent it is largely used in the woollen, cotton, and silk industries; in the United States, at the census of 1900, over 140,000 h.p. of electrical machinery was in use in cotton mills alone, and a considerable proportion are supplied with current from public mains.

2. *Variation of Load.*—The preparation of animal or vegetable fibres involves a very large number of operations, and owing to the delicate structure of the fibre the amount of work done on it in each machine is small. It is, therefore, readily understood that the power required to drive the machines unloaded is a large percentage of the total required. Mechanical transmission of power from a main engine to the various machines by means of ropes, belts, gearing, and shafting involves a steady loss of power, which

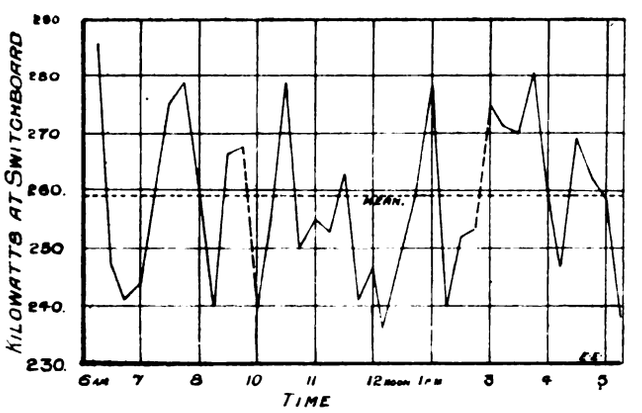

FIG 1. LOAD CURVE OF A FLAX MILL.

is very little reduced by the stoppage of individual machines. These facts have led many power users to believe that the load on the main engine is quite steady, and in comparing the cost of electrical with mechanical driving, on the basis of "horse-power hours," they are apt to find an advantage in mechanical driving that does not exist.

The efficiency of mechanical transmission in textile mills varies with each mill, depending as it does on the original design, the nature of any extensions which have been made, and the state in which the gearing is maintained. In a number of mills which the writer has tested, the average efficiency at full load is 50 per cent., the lowest 34 per cent., and the highest 70 per cent.; in all these cases the loss of power in the main engine being included. These losses, serious enough at full load, are practically constant, and so the efficiency rapidly decreases as the load becomes less. This steady loss in transmission has an important bearing on the variation of load on the main engine or source of power supply; in discussing this variation it will be convenient to speak of the ratio of the average power required to the maximum required during working hours as the working load factor—*i.e.*,

$$\frac{\text{Average power}}{\text{Maximum power}} = \text{working load factor.}$$

When the source of supply is electrical, this is equal to

$$\frac{\text{Units consumed}}{\text{Maximum demand in kilowatts} \times \text{working hours}}$$

Fig. 1 is an actual record showing how the load varies through the day in a flax mill of the British Linen Thread Company. The mill is electrically driven and the transmission loss small. The maximum power demanded is 285 kw. and the average 259 kw., giving a working load factor of 91 per cent. Had the various machines been driven by mechanical transmission from one main engine a steady extra loss would have been incurred, on account of the friction of extra shafting and gearing; assume this as only 20 per cent. of full load, then the maximum power would be raised to 342 kw., and the load factor increased to 92·5 per cent. That is to say, the more inefficient the

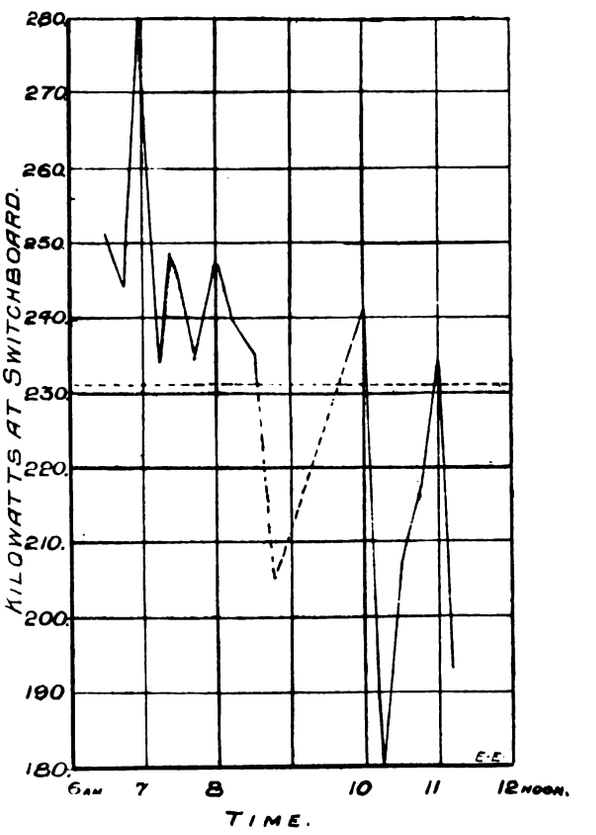

FIG 2:-LOAD CURVE OF A FLAX MILL.-SATURDAY.

system of power transmission in a mill, the steadier is the load on the main engine, and, though the useful power required varies in every mill, yet, with mechanical driving, the variation is masked by the steady loss in transmission. Fig. 2 shows the variation of load, of the same mill, on Saturday morning; the load factor here is only 82 per cent. In a large cotton mill the following variations of load were noted*: morning—maximum load 1,685 h.p. and minimum load 1,640 h.p.; afternoon—maximum load 1,635 h.p. and minimum load 1,575 h.p. Millowners usually reckon their costs in pounds per indicated horse-power per annum, and the figure is usually based on the maximum horse-power indicated; it is not possible to compare such a figure with the cost of electrically driving the same mill without knowing the electrical or brake horse-power taken to drive each machine, or group of machines, and the working load factor of the machines.

3. *Load Factor of Various Machines.*—In nearly every textile machine the starting effort is considerable—due to the inertia of the moving parts. In the "mechanical" mill starting a machine is usually accompanied by a slipping

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

* "Centralisation of Power," by S. B. Paine.—British Association of Textile Managers, 1904.

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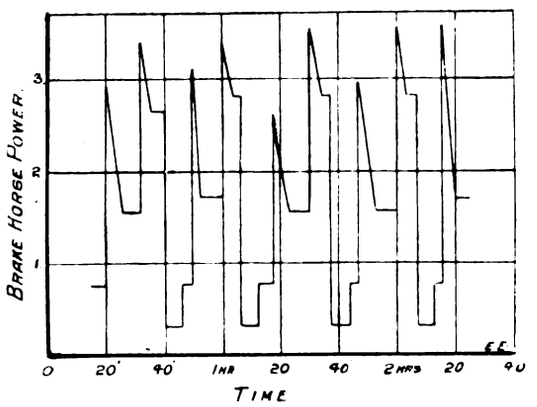
of several belts and a general loss of speed. For each particular class of machines there are peculiarities of working which determine the working load factor, such as frequent stops of short duration, in the case of looms; a periodical stoppage of part of the machine, as in spinning; intermittent running, with long stops, as in milling or printing machines. A particularly irregular load is met with in the case of self-acting mules. Fig. 3 shows the power taken by a mule as it goes the various operations of drawing, twisting, backing off, and winding on. The working load factor is 46 per cent. on one machine. When a group of mules are driven from one motor a heavy fly-wheel on the motor tends to steady the demand for current; despite this, however, the fluctuation of load is more extreme than in the main engine of a mechanical



SELF-ACTING MULE-120 SPINDLES

FIG 3.—VARIATION OF LOAD—SELF ACTING MULE.

mill. Fig. 4 is part of a record showing the power taken by a motor driving four self-acting cotton mules. The maximum horse-power required was 32 b.h.p., and the average 19 b.h.p., or a working load factor of 59 per cent.

The variation in the amount of power taken by machines having many bearings, with temperature, is brought out in Fig. 5, which shows the power required to drive a cap spinning frame. It will be seen that as the bearings and the oil warm up the power steadily decreases. This is, of course, true for all machines, and may be described as the "Monday morning effect." The advantage of being able to see just what power a machine is taking under different conditions of working is a great point in favour of electrical driving. The following figures were obtained from a worsted spinning frame when two different qualities of spindle oil were used: oil A, 4·4 b.b.p average; oil B,

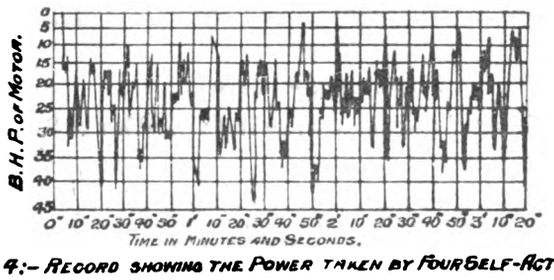


FIG 4.—RECORD SHOWING THE POWER TAKEN BY FOUR SELF-ACTING COTTON MULES WORKING TOGETHER.

4·19 b.h.p. average—or a difference of nearly 5 per cent. Where looms are driven in large groups the load is fairly constant, despite the frequent starting and stopping of individual looms, due to the large amount of shafting involved and the small power taken by each loom. In an "electrical" mill, however, a recording wattmeter will show the variations, and, more particularly, the tendency of the workers to start late and finish early.

The milling or fulling of woollen cloths is a process in which the power required varies from piece to piece, depending on the amount of milling required; the working load factor is very low. Fig. 6 is an actual record of a day's work of milling and washing machines; the working load factor is only 63 per cent. Tests made on carding machines show a fairly steady load during the time of running (Fig. 7). Rag-grinding machines often show a considerable variation, depending on the material they are being fed with. Fig. 8 is the load curve of two balling boxes, which are, normally, being repeatedly started and stopped.

4. *Power Absorbed by Various Machines.*—There is a lack of information as to the power taken by textile machines. The particulars of some tests are given below:

Spinning.—* Test made of a motor driving 38 ring spinning frames of 10,032 spindles, running at 9,000 r.p.m., spinning No. 35 cotton yarn:

Number of frames running	38	28	18	8
Power in kilowatts	140	107	76	44
Spindles per kilowatt	81·2	83 8	82·5	78·2

Or an average of 62 spindles per electrical horse-power.

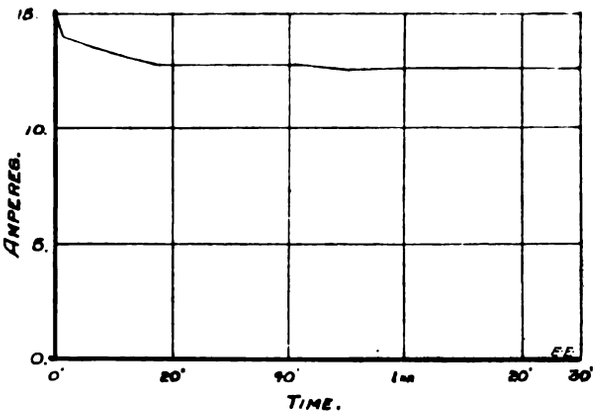
Tests made on worsted spinning frame of 200 spindles, running at 5,800 r.p.m.: First test—average brake horse-power, 4·45; second test—average brake horse-power, 4·19, the difference, as explained above, being due to the quality of oil used.

Self Acting Mules—Cotton.—† Test made on motor driving line shaft and four mules:

Mules running.	Spindles. Number.	R.P.M.	Maximum horse-power.	Average horse-power.
All	2 712	—	32	19
No. 1 only	672	7,600	20	13
No. 2 ,,	672	7,600	18	9
No. 3 ,,	684	7,800	15	9
No. 4 ,,	684	7,800	15	9

The result of tests made to determine the power taken by spindles at various speeds is shown in Fig. 9. It will be seen that the spindle friction and windage varies directly as the speed.

Roving Boxes—Worsted.—Dimensions of bobbins, 6in. by 3in.; number of spindles, 12; revolutions per minute, 1,000; brake horse-power, 0 4.



CAP SPINNING FRAME—NORMAL LOAD.

FIG 5.—SPINDLES AT 7,000 R.P.M.

Weaving.—The amount of power taken by looms varies with the class of work and dimensions of the looms. Silk looms—small loom, power taken 0·25 b.h.p. (authority, A. C. Eborall); jacquard, 0·5 b.h.p. Cotton looms—draper loom, 160 picks per minute, 0·25 (authority, de Wolf). Woollen looms—various, 0·3 to 0·5.

C. *Carding Machines.*—Woollen, carding botany—48in. swift: power at starting, 7 e.h.p.; running, average, 3·2. 60in. swift: running at 96 r.p.m.; average power, 5 e h p.

D. *Scouring Machine, or Leviathan.*—The dimensions of these machines vary considerably, and figures of horse-power taken are not of much value. The following figures of relative power taken are from a test of one machine: maximum running horse-power, 100 per cent.; when changing liquor, 38; working load factor, 86. The changing and heating of liquor reduces this to about 70 per cent.

Milling Woollen Cloths.—Test on motor driving milling machine, washing machine, and mangle: maximum electrical horse-power, 11; working load factor, 63 per cent. The amount of power taken in milling varies from day to day, depending on the nature and amount of milling required by the various cloths.

5. *Advantages of Electrical Driving.*—The advantages

* "An Electrically-Driven Cotton Mill," J. O' de Wolf.—New England Cotton Manufacturers' Association, 1902.

† "The Application of Three-Phase Motor to Electrical Driving," A. C. Eborall.—Society of Arts, 1903.

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attendant on electrical driving are but partly gained if electrical transmission is adopted in the mill and the main engine or engines retained. The addition of a dynamo to the steam plant, and the replacement of mechanical transmission by electrical, in no way lessens the responsibility attached to the use of steam plant, nor does it relieve the manufacturer from keeping his eye on the coal market as well as on the textile. Now that a public supply of electrical energy is available throughout the manufacturing districts of Yorkshire and Lancashire at reasonable rates, manufacturers should not be slow to take advantage of it when once they realise the consequent benefits. Many of the advantages of a public supply are difficult to give an exact cash value to, but they are, nevertheless, very real. Briefly enumerated they are: (1) A saving in space, buildings, and capital expenditure. The manufacturer can employ his capital to greater advantage on productive machinery, and he is not compelled to decide beforehand what his requirements will be for 10 years ahead. (2) A reduction in fire risk, insurance, rents, rates and taxes, wages, repairs, and maintenance. (3) An absolute freedom from worry as to spare plant in case of a breakdown, or as to extensions or alterations. If an extra 100 h.p. is required temporarily, it can be drawn from the mains. If slack times come, the manufacturer can shut down any part of the mill without affecting the remainder; or overtime can be worked in any one section at, usually, a less cost than for ordinary working hours. (4) An accurate knowledge of the power taken in each department, and, by means of indicating or recording instruments, a check on the efficiency.

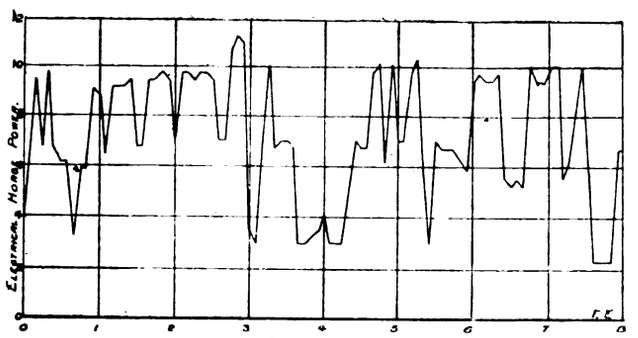

FIG 6.—MILLING SHED LOAD

6. *The Application of Electrical Driving.*—The effect of electrical driving on the general arrangement of a mill is to allow the various machines to be arranged in the natural order of the processes without reference to the position or direction of shafting. In a steam-driven mill the arrangement is decided by the main driving, and in a new mill it is not difficult to lay out a good arrangement; extensions and alterations are, however, nearly always made at the expense of efficiency. The sub-division of the driving accompanying the use of motors may be carried to its full extent, and a motor provided for each machine, doing away thereby with all line shafting. It has found its most successful application in the driving of silk looms, the valuable material worked on making the risk of damage from oil or dirt thrown from a shaft or belt a serious one. The motors, rated at $\frac{1}{3}$ h.p., either drive the looms by gearing or by a single belt, and, to enable the tension of the belt to be adjusted, the motor is swung on an arm and supported by springs; the weight of the motor tends to keep the belt tight, and the tension may be adjusted at will (Fig. 10). Such extreme sub-division is, however, rarely advisable on account of first cost, and group driving must be nearly always adopted. In arranging such driving a considerable saving on the cost of equipment can be effected by increasing the speed of the line shafts, and thereby reducing the size of shafts, pulleys, and hangers—a standard diameter of shaft may often be adopted throughout.

Certain machines have their driving shafts running at a sufficiently high speed to be direct coupled to a motor; doubtless, as electrical driving spreads, textile machine makers will modify their designs so that this will be possible in a larger number of cases. Group driving of from two to four machines without line shafting may be accomplished by fitting the motor with two pulleys. Where a greater number of small machines makes a line shaft a necessity the motor may often be coupled direct to the shaft, being bolted to the wall or ceiling. A reduction of shafting may also be effected by driving the machines on two floors from the one shaft, holes being made in the intervening floor for the belts of the upper machines. Vertical shafts, when necessary, can also be driven by direct-coupled motors—the centrifugal hydro-extractor is an excellent example of the adaptability to this need.

A word of warning may be given as to the installation of motors too large for their work on account of the lessened efficiency and increased cost. Unless the variation of load is extreme, the continuous rating of the motor should correspond with the average load. The small loom induction motors above referred to are designed with a considerable slip and a consequent wide range of efficiency.

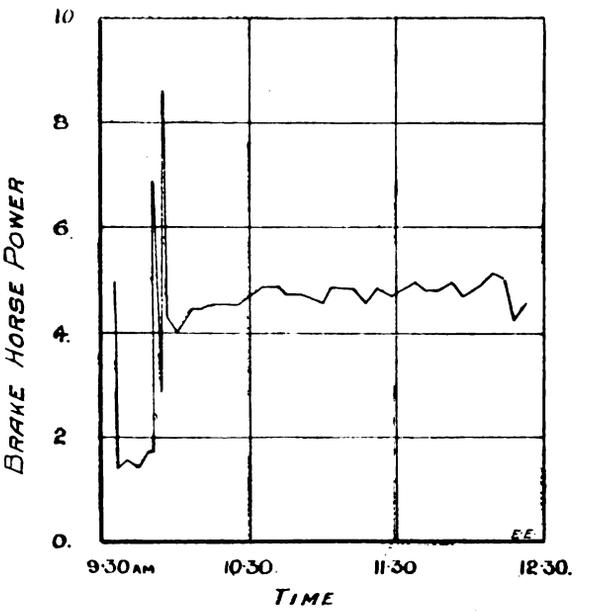

FIG 7 NORMAL RUNNING 65 R.P.M.

7. *Constancy of Speed as Determining the Nature of the Equipment.*—In the majority of textile operations constant speed is of vital importance; the output of a mill depends on the maximum speed at which the thread can be safely run, and any variation below this results in a decreased output. That regularity of speed at the machines in a "mechanical" mill is never obtained may be realised when one considers that there are often four or five belts between the engine and a machine, the bright surface of the pulleys indicating only too clearly that slipping is never absent. A quotation from a paper by Mr. S. B. Paine, whose experience in electrical driving is unique, bears this out. Referring to a large cotton mill in South Carolina, where the motors were coupled direct to the spinning frames, he says: "The increase in quality and production has been very marked over mechanically-driven frames. I find that there is a very large loss in speed on the frames, due to the slipping of the various belts. In one case the speed on the front rolls in one room varied from 103 r.p.m. to 120 r.p.m. A direct-connected motor showed a range in speed on the front rolls during a week's run of from 120 to 122."

The provision of any speed regulation on motors driving the large majority of textile machines is unnecessary, for the reason that, although different qualities of fibre and different counts of thread require different speeds, yet the manufacturer finds it most economical to keep each machine on a particular class of work. This necessity of constant speed points clearly to the use of polyphase motors in preference to direct-current machines. The advantages of squirrel-cage motors are many; the constancy of speed, the simplicity due to the absence of commutators and sliding contracts, their low cost and the lessened fire risk due to the absence of exposed live metal, are all points in their favour. Their advantages have been

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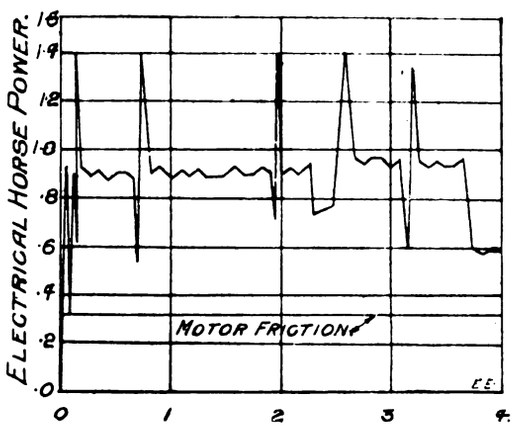
recognised by the Fire Offices Committee, and doubtless further concessions will be made as time goes on. With a direct-current equipment more attention is required, and the motor must be completely enclosed. The great objection is, however, the variation of speed at different loads and temperatures. In a case brought before the writer's notice, where shunt motors were used, the complaint was made that on Monday mornings the machinery ran slow, with a consequent reduction of the output of the mill, and the same fault was noticed in a less degree on other mornings; this was, of course, due to the field windings being cold, and to some extent to the extra stiffness of the machinery. The polyphase induction motor under similar conditions would vary in speed by an inappreciable amount.

8. *Variable-Speed Machines.*—The only important class of variable-speed machines is found in textile printing. A detailed consideration of the various equipments which may be adopted are beyond the range of this paper. Multi-voltage direct-current systems, with shunt motors, have much to recommend them in the case of isolated plants, but excellent results have been obtained by the use of a single-supply voltage and motors with double-wound armatures and two commutators. In the latter case a high efficiency is obtained over a wide range of speed. Mention may be made of an equipment adopted in a large printing works in America, where each printing-machine motor was driven from a separate shunt generator, the generators being coupled together and driven at constant speed by a large induction motor. The printing-machine speed was altered by regulating the field of its generator. Such an equipment is, however, too costly for ordinary purposes. The writer's opinion is that almost any known system of speed regulation will meet the case, the determining factors being simplicity and first cost, and the wound rotor induction motor or the direct-current series motor are from this point of view as good as any others.



FIGS:-SINGLE AND DOUBLE HEADBALLING BOXES.

Centrifugal Hydro-Extractors.—The steam-driven centrifugal machine is exceedingly wasteful and messy; the belt or rope driven machine involves a considerable amount of gear in the neighbourhood of the basket, and is very severe on the belts; the direct-coupled electrically-driven machine is compact, simple, and reliable, and can be placed anywhere. Either series direct-current or induction motors motors may be used for this work; the induction motor has an important advantage in that it can never "run away." In practice the motor is completely enclosed and flexibly supported beneath the basket. The time taken to accelerate depends on the maximum torque of the motor at various speeds. Hence, if a squirrel-cage motor is adopted it should be built with a high-resistance rotor, so that the current may be kept down during acceleration. The time taken to accelerate is then practically constant, and the machine needs no attention beyond switching on the motor, which runs up to speed and stays there until switched off. Table A gives the power required for two standard makes of machine

TABLE A.—Power Required to Drive Centrifugals.

Dia. of basket. Inches.	Units per hour.	Revs. per min.	Time to accelerate. Min.	Pott, Cassel's and Williamson type. Watts—Starting.	Pott, Cassel's and Williamson type. Watts—Running.	Broadbent and Sons' type. Watts—Starting.	Broadbent and Sons' type. Watts—Running.	Broadbent and Sons' type. Time to accelerate. Min.	Broadbent and Sons' type. Max. speed
24 ...	0·75	1,500	0·75	2,530	690	—	—	—	—
30 ...	1·02	1,200	1·0	3,100	1,260	5,400	2,700	1·5	1,100
36 ...	1 28	1,000	1·5	3,200	1,370	5,800	2,900	1·5	1,000
42 ...	—	—	—	—	—	6,400	3,200	1·5	950
48 ...	3·19	750	2·5	5,950	2,070	7,200	3,600	1·5	900
54 ...	—	—	—	—	—	8,400	4,200	1·5	800
60 ...	—	—	—	—	—	10,000	5,000	1·5	700
72 ...	—	—	—	—	—	17,600	8,800	1·5	600

9. *Other Applications of Electricity—Lighting.*—Brief reference may be made to the subject of electric lighting. The matching of colour can only be done satisfactorily by sun or arc light, and in some smoky Yorkshire valleys the sunlight cannot be depended on as a correct source of light. The use of enclosed arc lamps in mills gives excellent results for general illumination; for local lighting the incandescent lamp has the great merit of safety. The greater purity of the air, due to the absence of gas, has an important effect on the health of the workers.

Heating.—Where steady temperatures are required, as in calenders, electrical heating has much to recommend it. Steam joints have a way of giving trouble, and, where higher temperatures are required, gas is found somewhat unreliable. Where current is taken from the public mains the electrical heating of the mill is not out of the question. If the warming up be done at night time, a moderate consumption only is necessary by day.

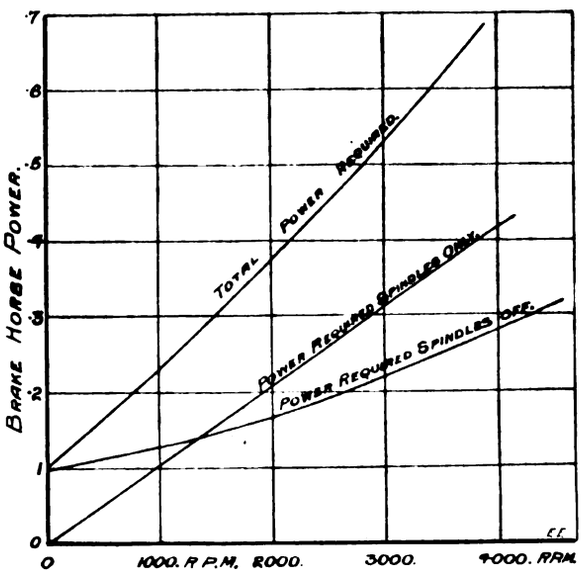


FIG 9:- POWER REQUIRED TO DRIVE RING TWISTING FRAME AT VARIOUS SPEEDS.

Fans.—In addition to the use of electrically-driven fans for ventilating and removing dust, they are finding extended application as a means of transporting wool from the washing machines to the carders, by way of an air-shute connecting the rooms.

NOTES ON AERIAL POWER LINES.—IV.

BY CHE.

(Continued from page 269.)

In designing the supports for aerial power lines the engineer must exercise sound judgment in deciding upon several factors, the values of which can only be obtained by a knowledge of all the local circumstances, and, as in other branches of engineering, experience is the only sure guide. In the remaining paragraphs of these articles the method of applying the mechanical principles already given to the three-phase transmission system (the electrical details of which were deduced in the *Electrical Engineer*, Aug. 18, 1905) will be explained:

Poles are required to carry three copper wires 0·2294in

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in diameter, and the following particulars respecting copper wires will be found useful in dealing with this problem :

Diameter of wire	0·2294in.
Area of wire	0·04133 square inch.
Weight of copper wire per mile one square inch section	20371·878lb.
Weight of copper wire used per mile	842lb.
Weight of copper wire used per foot length	0·15947lb.
Tensile strength of copper wire per square inch	64,000lb.
Wind pressure per square foot	40lb.
Coefficient of expansion per degree Centigrade	·0000172
Maximum variation of temperature	50deg. C.
Modulus of elasticity of copper wire	16,000,000
Factor of safety for suspended wire	6
„ „ „ the poles	10

It will not be unreasonable to assume 40 poles per mile as the number of poles to employ, so that $\frac{1}{l} = 40$ and $l = 132$ft. = span, and as a first approximation it will be convenient to take one-sixth the breaking strain as the tension to put upon the stretched conductors; consequently

$$F = \frac{\text{weight per mile}}{6} \times c_1 \text{ pounds.}$$

But $$842 \times c_1 = 0{\cdot}04133 \times 64{,}000$$

and $$c_1 = 3{\cdot}142$$

$$\therefore F = \frac{842 \times 3{\cdot}142}{6}$$

$$= 441\text{lb.}$$

The sag is obtained from the formula

$$s = \frac{l^2 w}{8 F},$$

in which w is the resultant of the weight, p_1, of the wire and the wind pressure, p_2, in pounds per foot of wire.

$$\therefore w = \sqrt{p_1^2 + p_2^2}.$$

p_1 is 0·15947lb.

and $$p_2 = \frac{2}{3} \times \frac{12 \times 0{\cdot}2294}{144} \times 40$$

$$= 0{\cdot}51\text{lb.}$$

$$\therefore w = \sqrt{(\cdot 15947)^2 + (\cdot 51)^2}$$

$$= 0{\cdot}534\text{lb.}$$

And by substitution

$$s = \frac{(132)^2 \times 0{\cdot}534}{8 \times 441}$$

$$= 2{\cdot}637\text{ft.}$$

The actual length of wire between the supports is given by

$$L = l + \frac{8}{3}\frac{s^2}{l}$$

$$= 132 + \frac{8}{3} \times \frac{2{\cdot}637}{132}$$

$$= 132{\cdot}0533\text{ft.}$$

So far we have not taken into consideration elastic extension, and to simplify matters let us assume that the wind has ceased, and that hypothetically the weight of the wire has been reduced to an indefinitely small quantity. In such a case the wire will not be stressed, but will contract elastically to a position of zero extension. The contraction is given by the well-known formula

$$l' = \frac{F \times L}{M \times A},$$

in which l' is the change in length, F the applied tension, M the modulus of elasticity of the wire, and A is its area of cross-section in square inches, and

$$l' = \frac{441 \times 132{\cdot}0533}{16{,}000{,}000 \times 0{\cdot}04133}$$

$$= 0{\cdot}088\text{ft.}$$

At the minimum temperature, therefore, the length of wire unstretched will be

$$L_0 = 132{\cdot}0533 - 0{\cdot}088$$

$$= 131{\cdot}9653\text{ft.}$$

Having fixed the maximum variation of temperature as 50deg., C., the length of the wire in consequence of thermal expansion will be

$$L_{50} = 131{\cdot}9653\,(1 + {\cdot}0000172 \times 50)$$

$$= 132{\cdot}0788\text{ft.}$$

The sag corresponding to this unstretched length at the maximum temperature is obtained from the formula

$$L_{50} = l + \frac{8}{3}\frac{s^2}{l}.$$

Thus $$132{\cdot}0788 = 132 + \frac{8}{3} \times \frac{s_1^2}{132}$$

and $$s_1 = 1{\cdot}9745\text{ft.}$$

It must next be assumed hypothetically that the wire has its normal weight restored, in which case the sag will be increased until the tendency to elongate, due to gravity stress, is just balanced by the elastic tendency to contract, but as the connection between the resultant sag and the factors, which take into account the temperature and elastic effects, is a cubic equation, a graphical solution will be given instead of the analytical one.

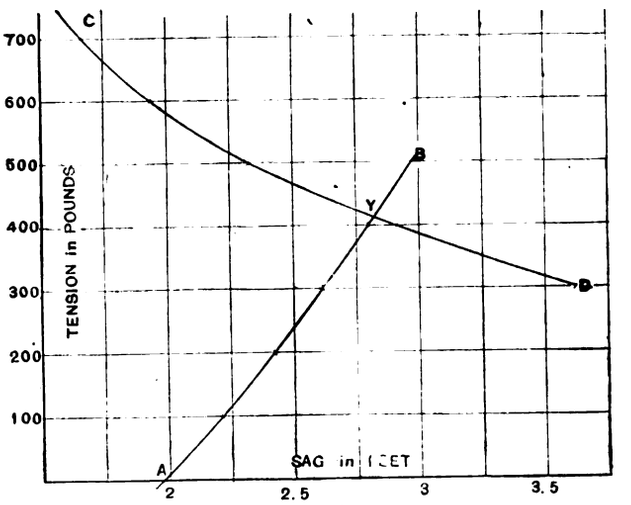

FIG. 10.

In the first place, we require a curve representing the relation between the tension and corresponding sag in the wire, as the wire sags under gravity stress from its hppothetical position of zero tension, and this is plotted from the results calculated on the assumption that the tension is increased from zero by applying the formulæ

$$l' = \frac{F \times L}{M \times A} \text{ and } L = l + \frac{8}{3}\frac{s^2}{l}.$$

Commencing with the sag at maximum temperature and zero tension—*i.e.*, 1·9745ft.—assume certain increasing tensions in the wire, and from the increased length given by the former equation obtain the corresponding sag by means of the latter, which when plotted give the curve A B in Fig. 10. Thus—

When F is lb.	l is ft.	L is ft.	s is ft.
0	0	132·0788	1·9745
100	0·01997	132·0988	2·211
200	0·03995	132·1188	2·42
300	0·0599	132·1387	2·62
400	0·0799	132·1587	2·80
500	0·0999	132·1787	2·97

Another curve is also required showing the relation between the tension and the sag in the wire at various tensions, when the wire is assumed to have its normal weight per foot, and this curve—*i.e.*, C D in Fig. 10—is found by taking different values of F in the equation $s = \frac{l^2 w}{8 F}$, when w is the weight of the wire per foot. Thus—

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When F is lb.	s is ft.
700	1·661
600	1·937
500	2·325
400	2 907
300	3·876

In this case the two curves A B and C D intersect at the point Y, giving the sag as 2·82ft. at the maximum temperature, and as this is the point of equilibrium at which the force of elastic contraction is balanced by the gravity stress, it gives the condition in which the wire is strung, so that at minimum temperature it will be stressed at one-sixth its breaking strength, corresponding to its factor of safety of 6.

As regards the dimensions of the poles for supporting the wires, the following notes afford an example of applying the principles already given. The conditions of the problem are: Three wires of diameter 0·2294in. have to be supported at the corners of an equilateral triangle of 62in. side, the apex being at the top. The maximum sag is 2·82ft. Distance between poles 132ft.

Assuming the free height of the lower wires to be 40ft. as the minimum, the height of the pole above the ground must be 40 + 2·82 + 4·5, or 47·32ft., since the top insulator is approximately 4·5ft. above the bottom ones. Allowing 5ft. as the depth of setting the poles in the ground, the actual length of the pole must be 52·32ft., and as poles of pine may be obtained in suitable lengths, we may assume, as an example, that the poles are of pine. The tendency to bend the poles is due to the wind pressure upon the wires and the pole. If T_1 is the resistance to rupture at the bottom of the poles, then, as we have already shown,

$$\frac{\pi d_2^3 T_1}{32} = F' h',$$

where $F' h'$ is the summation of the bending moments due to the wind, and this equation enables us to determine d_2, the diameter of the pole at the bottom close to the ground. Now, since the wind pressure upon each wire is 0·51lb. per foot length, the stress due to the wind pressure on each line wire will be $p_2' = 132 \times 0{\cdot}51 = 67{\cdot}32$lb.; therefore,

Bending moment of the top wire

$$= M_1 = F_1 h_1 = 67{\cdot}32 \times 47{\cdot}32 = 3{,}186 \text{ pound-feet.}$$

Bending moment of each lower wire

$$= M_2 = F_2 h_2 = 67{\cdot}32 \times 42{\cdot}82 = 2{,}882 \text{ pound-feet.}$$

Bending moment of wind upon the pole

$$= -\left[\frac{2}{3} \times 40 \times h \times \frac{d_1 + d_2}{12 \times 2}\right] \times \frac{h}{2}$$

$$= \frac{2}{3} \times 40 \times h \times \frac{5}{72} d_2 \times \frac{h}{2}$$

$$= \frac{80}{3} \times \frac{(47{\cdot}32)^2}{2} \times \frac{5}{72} d_2$$

$$= 2{,}074\ d_2.$$

Note $d_1 = \frac{2}{3} d_2$.

Now, $F' h' = F_1 h_1 + 2 F_2 h_2 + 2{,}074\ d_2$

$$= 3{,}186 + 5{,}764 + 2{,}074\ d_2.$$

$$\therefore\ 0{\cdot}0982\ d_2^3\ T_1 = 8{,}950 + 2{,}074\ d_2.$$

With a factor of safety of 10, $T_1 = \frac{1}{10}$ of 5,000 = 500lb

$$\therefore\ 0{\cdot}0982\ d_2^3 \times 500 = 8{,}950 + 2{,}074\ d_2,$$

and

$$d_2^3 - 42{\cdot}24\ d_2 - 182{\cdot}25 = 0.$$

To solve this equation, let $y = d_2^3$ and $y_1 = (42{\cdot}24\ d_2 + 182{\cdot}25)$, then

$$y - y_1 = 0,$$

which is a convenient form for solving the equation graphically, by assuming several values of d_2 and calculating the corresponding values of y and y_1, which when plotted will give two curves which intersect, and the point of intersection will give the value of d_2 required. Thus

When x is	0	2	4	6	7	8	9
y	0	8	64	216	343	512	729
y_1	182·25	266·73	351·21	435·7	478	520	562

The equation $y = d_2^3$ is represented by Curve I. in Fig. 11, and the equation $y_1 = (42{\cdot}24\ d_2 + 182\ 25)$ by Curve II. The point of intersection, Y, gives the value of d_2 as 8·1in. This means that if the pole has a diameter of 8·1in. at the bottom close to the ground, the pole offers a factor of safety of 10 against a wind pressure of 40lb. to the square inch. In practice, however, it is unusual to employ poles for power transmission work with a diameter less than 8in. at the top, and since $d_2 = \frac{3}{2} d_1$, this gives the diameter at the bottom as 12in, consequently with the thicker pole

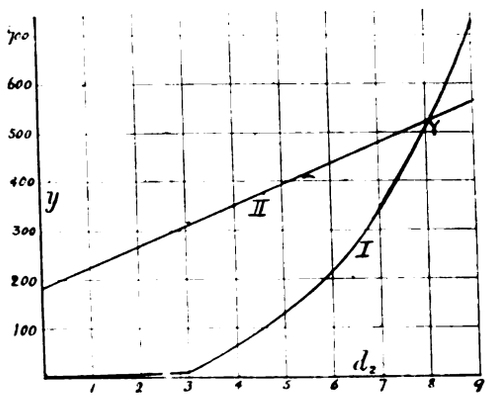

FIG. 11.

the factor of safety would be greater than 10. It may be remarked that the high voltage and the comparatively small amount of power dealt with in this example accounts for the somewhat small poles required.

HORN LIGHTNING ARRESTERS.

In his paper read before the Electric Club of Pittsburg, Mr. N. J. Neall gave a *résumé* of the present American practice in lightning arresters for high-voltage transmission circuits. The information is of special value to those engineers putting up power transmission lines overhead in this country. We propose to confine our extracts from the paper to the type of arrester known as the "horn," which was invented in Germany by Oelschlaeger, and developed by the Allgemeine Elektricitäts-Gesellschaft. The feature of the arrester is that the short-circuit arc once started by lightning at the narrow gap between the horns (Fig. 1), is caused by the heat of the arc to travel upwards along the horns and break by reason of its attenuation. Of course, a certain amount of time is required to do this. The author states that this time may be something like two seconds, and that on large plants the resulting short-circuits would not only be objectionable, but in many cases where synchronous apparatus could fall out of step it would be prohibitive. At the International Electrical Congress at St. Louis, Mr. F. G. Baum, of the San Francisco Gas and Electric Corporation, stated that on their system (formerly the Bay Counties and Standard Electric Companies, now working in parallel) this type of arrester had been known to operate frequently without affecting the service, and no effect was felt at distant points. At another plant of the company a horn arrester has been known to operate without blowing the fuse in series with it. In the following will be found a description of typical and important high-tension installations using these arresters.

The arrester used by the Standard Electric Company is illustrated in Fig. 2. The three legs of the main line pass from the transformer and high-tension switch-room, A, directly through the building, B, emerging at *c c c*, and thence to the transmission line, D D D. The horn arrester, or the "Dutchman," as it is generally called, is connected to the line at *c c c*. As the picture shows, the apparatus is very simple—in fact, its cheapness is strongly in its favour. As used at Electra it consists of an air-gap at F in series with a water resistance, and an iron wire resistance and a choke coil, H, from which it is connected to the ground. The knee-shaped spark terminals are formed of about No. 0000 copper wire, supported on the regular line insulator; the water resistance consists of copper strips immersed in a salt solution contained in the jars, G, which

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are of about 15 gallons capacity each. The salt water is covered with about ⅛in. of oil to prevent evaporation. The resistance choke coils consist of about 18 turns of iron wire wound on a 6in. cylinder, the cylinder being removed before mounting. The arrangement is shown diagrammatically in Fig. 3. The gap, F, is adjustable. While operating at 40,000 volts the distance was 3in. to 3¼in. The protector as described was installed by Mr. A. C. Bunker in 1902, while he was in charge, and the same device is now in use

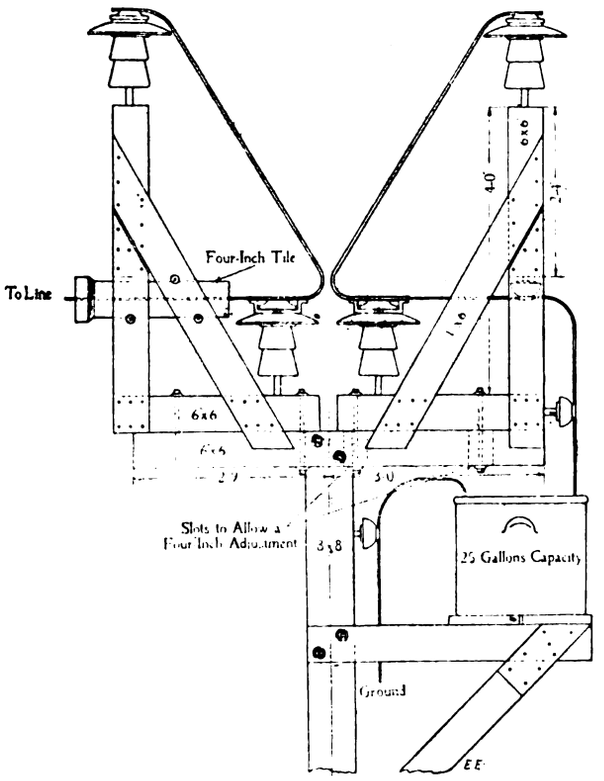

FIG. 1.—Horn Lightning Arresters as constructed by the American River Electric Co.

on the lines of the California Gas and Electric Corporation, which now owns and operates the Standard plant. Mr. Bunker lays great stress on the curve of the knees, and the form shown in Fig. 3 was adopted after considerable experimenting. If the wires separate too abruptly above the gap, the arc will not follow up and extinguish itself; if the crook in the knee is too sharp, the arc will either hold on

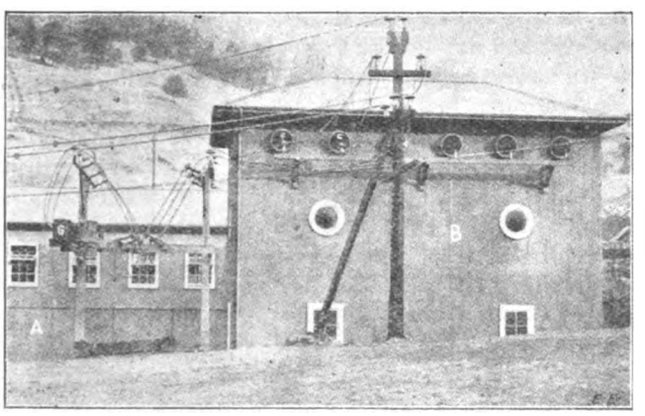

FIG. 2.—Horn Arrester outside Transformer Station of the Standard Electric Co.

or rise and extinguish itself and immediately strike back again at F. Further, the curve of the knee depended on the value of the line constants at the point protected, for a curve that gave the best satisfaction at one point on the line was not the best at another.

In California, the lightning storms lack the severity and frequency of those further east, but as an instance of the value of the protection afforded against line surges, Mr. N. A. Eckert mentions some switching experiments carried on at Mission San Jose, 100 miles from Electra. These experiments or tests were for the purpose of establishing the value of a certain type of switch, and consisted of closing and opening the switch with 10,000 kw. at 40,000 volts behind it. As a rise in the line voltage was expected, the gap, F, at the power-house was increased to 4¼in. About the fourth time the switch was opened the arrester discharged and the arc extinguished itself. The test was repeated and the arrester again discharged, but so violently as to blow all the water out of the resistance jars. No damage was sustained by any of the transformers or instru-

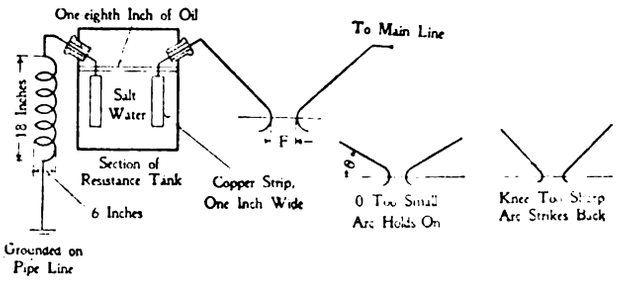

FIG. 3.—Details of Connections and as to Best Shape of Horns.

ments. He does not know of any transformer being broken down by lightning or similar disturbances where protected by this apparatus. The chief objection offered to it is the length of time the arc or short holds on after the discharge to ground. This may be as long as a second or a second and a half. However, the arrester does not discharge very frequently.

The American River Electric Company use the arrester, as shown in Fig. 1. The horns are of galvanised iron gas-pipe, and for the voltage of about 40,000 they are separated about 2¼in. A jar of water, covered with oil, is used for a resistance in the ground wire. The oil, of course, is simply to reduce the evaporation. The company have used both pure water and water with salt added, but find the pure water more satisfactory. These arresters have been in operation for about 18 months, and have gone through several lightning storms. Several of the employés have witnessed their action during the storms. In one instance they discharged several times in succession, the arc travelling about half-way up the horn before breaking. Every discharge had the same effect as a temporary short-circuit, causing the voltmeters to swing entirely across the scale, and the lights to dip to perhaps ½ c.p. Mr. B. C. Condit writes that they have had no trouble from these arresters, no damage done by lightning, and consider the arrester as satisfactory for high voltages as any now in use.

APPOINTMENTS VACANT.

Draughtsman for works in North of England. Apply to Box O 8, *Electrical Engineer* office. See advertisement in last issue.

Canvasser, wages 25s. per week and commission. Letters only, Midland Electric Corporation for Power Distribution, Limited, 73, Lichfield-street, Wolverhampton. See advertisement in last issue.

Engineers in charge of a H.T. generating station. Salary from £27 to £29.—Apply to X 55, *Electrical Engineer* office. See advertisement in last issue.

District Representative for firm of manufacturing electrical engineers. Apply to "Electric," care of Hart's Advertising Offices, 6, Arundel-street, Strand, W.C. See advertisement in last issue.

Junior Engineer, Erith Urban District Council electricity works. Applications by Sept. 18. See advertisement.

PERSONAL.

The marriage of Mr. O. L. Falconar, A.M.I.E.E., senior partner of the firm Falconar, Cross, and Co., 4, St. Nicholas-buildings, Newcastle-on-Tyne, and Miss Elizabeth Bell took place at North Shields on the 2nd inst.

The Johannesburg Council has confirmed the appointment of Mr. J. F. I. Thomas as general manager of the lighting and tramways undertaking. Mr. Thomas has been the resident engineer for Messrs. Mordey and Dawbarn, the consulting engineers to the Council.

FORTHCOMING EVENTS.

SATURDAY, SEPT. 9.

Birmingham Electric Club.—At 7.30 p.m., social evening.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE OXFORD TRAMWAYS.

The expiration of the authorised life of the horse tramways of the city of Oxford gives the Corporation a chance to purchase the system on the well-known tramway terms. This is to be done, and the question then arose as to what should be the future policy of the Council as to the transport facilities within its area. The two courses open were either to re-equip the tramways for electric traction, which will necessitate new permanent way, or to replace the same by a service of motor 'buses. Before deciding on the first course, as has been done this week, two reports were obtained from the leading exponents of the rival systems. Mr. Stephen Sellon was selected to advise as to the results which could be obtained by electric tramways, and Mr. W. Worby Beaumont's opinion as to motor omnibuses was taken. As it is the first time that a large town has thoroughly gone into the matter, we reproduce these two reports in full so that our readers may have before them the complete evidence as to the rival systems. In the table following these reports are the figures as to the service proposed in each case, the cost of equipment, and the estimates as to the results to be attained. To these figures we shall presently refer, but at once it must be remembered that Oxford is not on a par with most towns in the United Kingdom. As Mr. Beaumont says, "It is a city with a character all its own; a city which has not yet lost its charm and its distinctiveness through accretions and adaptations of things incongruous. In considering for it, then, a system of public passenger conveyances, it must be remembered that a system which would be permissible in a striving manufacturing town would not necessarily be expedient or desirable in Oxford." This consideration, coupled with the narrowness of several of the streets to be traversed, is greatly in favour of the motor 'buses, which are not confined to one definite part of the street. Mr. Beaumont also presented some attractive figures as to the probable receipts and expenditure. In the latter item he included 20 per cent. for depreciation, which is equivalent to allowing only a five years' life to the motorcars. It will be noted, however, that the carrying capacity of the seventeen motor vehicles is thirty-four as against the seating accommodation of forty-eight in the electric cars and forty in the existing horse cars. Thus a comparison between the working expenses per mile run, which are 8·7d. for the motorcar and sixpence for the electric car, is too favourable to the former vehicle. Adjusted for the carrying capacity, the figure for the motorcar to transport forty-eight passengers would be in the neighbourhood of a shilling, or double the cost with electric traction. This is a very large difference, and it no doubt led to the decision above mentioned. The chief reason for the increased cost is an essential one, which cannot be removed by experience in design. A metal wheel running on a well-laid steel rail reduces the tractive effort required to a point which cannot be approached by any type of tyre traversing the ordinary surface of a road. The nearest approach to tramway conditions as far as smooth running is concerned is obtained with rubber tyres, and at the expense of the same. Figures as high as twopence to twopence-halfpenny per mile run are common for the upkeep of rubber tyres on motor 'buses. Such a cost is practically double the six per cent charge required at Oxford to cover the interest and sinking fund instalment on the capital to be spent on the new permanent way and the electrical equipment of the routes. With internal-combustion engines placed in tramcars, and driving the same, the charges for tyre repairs and for increased tractive effort would be eliminated, but there is still enough margin between the figures of cost to warrant electric transmission of the power required on the car from

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an economical central station. A careful perusal of the two reports leaves the impression that motor vehicles have not yet reached a stage at which they can be considered as strong rivals of electric tramways. There are, however, other uses to which they can be put which may make them valuable adjuncts to electric lines. Thus the marked difference between the two systems lies in the low first cost of the motorcar as compared with a tramway system needing permanent way. On routes, therefore, with a very infrequent service—say three or four cars a day each way—it may be found that the extra cost of running motor 'buses is less than the capital charges for permanent way. In such cases the motor 'bus will serve to develop a district which may ultimately need a light railway or tramway to connect it to the nearest town. Returning to Oxford, we note that the incongruity of overhead wires in its principal and historic streets is to be avoided by a surface-contact system of electric traction.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE LINE CALCULATION.

SIR,—The writer wishes to thank "Newcastle" for his lucid remarks *re* the $C^2 R$ loss and its relation to the load factor in last week's correspondence column. I find that "Alternator" in his answer to the question under discussion makes the same mistake as did the writer; for his solution is based on "the lost energy being proportional to the load factor," which "Newcastle" points out is not correct.

Re "Newcastle's" formula for lost volts, the writer sees nothing wrong with it, yet at the same time it does not seem to me to agree with Ohm's law. Can "Newcastle" say what is wrong with the following formulæ, which the author uses, but which give a different result to "Newcastle's"?

Taking a 40-mile line, three wires No. 8 S.W.G., with 50,000 volts between any two wires:

(*a*) By Ohm's law $E = C R$, where E = lost volts in any two wires, C = current = 14·5 amperes, R = resistance of 40 miles lead and return = 80 miles 8 S.W.G. = 171·32 ohms. ∴ volts lost = 2,484.

(*b*) My formula is evolved as follows from Ohm's law, where E = volts lost in *one* wire, C = current = 14·5 amperes, R = resistance of one line = 40 miles of 8 S.W.G. = 85·66 ohms.

$$E = C R$$
$$= C R \times \frac{3C}{3C} = \frac{3C^2 R}{3C}.$$

∴ lost volts in *two* wires lead and return

$$= \frac{3C^2 R}{3C} \times \frac{2}{1} = \frac{3C^2 R}{1{\cdot}5\,C} = \frac{\text{total energy loss}}{1{\cdot}5 \times C} = 2{,}484 \text{ volts}$$

By "Newcastle's" formula $C R \sqrt{3}$ lost volts = 14·5 × 85·66 × $\sqrt{3}$ = 2,152 volts.—Yours, etc.,

DUPLICATOR

["Duplicator's" formula does not take into account the difference of phase between the currents and E.M.F.'s in the three line wires. Thus, with a loss of 1,242 volts in each line wire, the algebraic sum of the losses in two wires is not 2,484 volts, but 1,242 + (1,242 × cos 60) = 2,152 volts.—ED. *E. E.*]

REVIEWS.

Modern Lightning Conductors. By KILLINGWORTH HEDGES, M.I.C.E. Crosby Lockwood and Sons, London. 6s.

The author of this volume is the hon. secretary of the Lightning Research Committee, whose report was recently issued and commented upon in our columns. This report was the result of four years' work, and had of necessity to give only an abstract of the information collected. In the book before us much additional information is published as to the details of the damage done by lightning to various buildings throughout the country. This is accompanied by sketches and photographs which make the path of the lightning clear in most cases. Such detailed information is most valuable. Elsewhere in the book will be found the suggestions and rules of the Research Committee, which were drawn up after a consideration of the reports on a large number of lightning strokes. These are commented on by the author, who gives also some specifications which will guide surveyors and architects in the right direction. To the electrical engineer, the reports as to standard practice in foreign countries will be most interesting, and the experience obtained from some districts where storms are very prevalent is most valuable. The chapter dealing with this part of the subject includes reports from Germany, Holland, and Hungary, and notes on special systems used in Belgium, France, and Italy. The Melsen system used in Belgium seems to be a step towards the network system of protection advised by the English committee. It is used on the Hotel de Ville at Brussels, and the only damage recorded was proved to be due to the neglect to connect an horizontal bar of metal to the network of copper conductors. The information given in the volume is most valuable, but we are somewhat surprised to see some of the daily paper cuttings reproduced in chapter ix. This deals with "Fulgurites and Other Vagaries of Lightning," but some of the matter is more concerned with the vagaries of the newspaper reporters. In records of lightning accidents it is not easy to get a scientific statement of what occurs, and on such occasions the local reporter is apt to draw on his natural store of legends. It is for this very reason that the reports of the observers of the Lightning Research Committee are so valuable. The volume is one which will be appreciated both by the electrical engineer and by those who, having no electrical knowledge, have to protect buildings from lightning.

ELECTRIC TRAMWAYS v. MOTOR OMNIBUSES.

Oxford Reports.

The Corporation of Oxford have this week decided to purchase the existing horse tramways and to reorganise the system for electric traction. The decision has been arrived at after a careful consideration of the two following reports from Mr. Stephen Sellon and Mr. W. Worby Beaumont respectively. Additional information was also supplied by these engineers, amongst which was a tabulated comparison of the results expected from the rival system. This table we also reproduce. Mr. Sellon's report, dated Aug. 5, 1905, to the town clerk reads:

To the Town Clerk, Oxford.

Sir,—In response to the request contained in your letter of July 14, and availing myself of the further information received at the meeting of your committee and my subsequent visit, I now have the honour to present for your Council's consideration the conclusions to which I have come.

To deal with the instructions in the letter quoted in the order stated, first, "the form of traction most suitable for Oxford, taking into account the interests of passengers, ratepayers, all classes of road users, and residents on the routes involved." Considering, in the first place, the routes covered by the existing tramways, I have no hesitation in stating that the interests of all concerned will be best met by a tramway service constructed and worked on modern lines. The fact that the existing tramways with the present service carry so large a traffic as that shown by the annual reports of the company proves conclusively that no other than a tramway method can give such good results.

The general argument in favour of tramways as against other systems of traction is that the additional capital expenditure results in a large economy in working expenses, from which it follows that, if the traffic is sufficiently great, the total of capital charges and of working expenses will be lower on a tramway than if carried by other methods of road traction. That this is the case in regard to the routes I am now considering is quite clear, because the passengers

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carried and the traffic receipts shown with horse traction are quite sufficient to justify the capital expenditure on an electric tramway of the best modern construction. This opinion is the result of my experience of 20 years over some 60 different undertakings, some new and some converted, representing about 600 miles in all, and an expenditure of £6,000,000. Assuming for the moment that the receipts would remain at the same figure, the economy in working would more than off-set the capital charges involved. Therefore, I have no hesitation in recommending the Council that electric tramways will best meet the requirements.

The assumption that the receipts from the traffic will remain the same, is one not justified by experience. The reasonable presumption is that these figures will increase considerably, and to provide the necessary accommodation for such increase it will, in my opinion, be prudent to construct a greater length of double line than that which is found on the existing tramway routes. This is particularly the case as regards the main routes crossing at Carfax, where the lines in both directions should be doubled. On the north and south route this should be from the corner of Beaumont-street and St Giles to the south end of the town hall buildings in St. Aldate's-street, and on the east and west route from the western end of Queen-street to the corner of Turl-street and High-street.

In view of the construction in parts of these streets, I propose to so construct the double lines there that whilst the cars are kept on their proper side of the road they will not be able to pass each other, thus leaving ample room for the other traffic on either side. In my view the doubling of the lines near Carfax is eminently desirable, not only for the purposes of the tramway traffic, but for the better regulation of the other road traffic, the observance by the tramcars of the rule of the road in such places being decidedly beneficial.

I have carefully considered the instructions of the committee, "that the Council will not entertain any scheme involving the erection of posts and wires between the east end of Magdalen Bridge and the west end of Queen-street, nor between the north end of St. Giles's-street and Folly Bridge, and will regard with special favour any scheme which dispenses entirely with posts and wires within the city." The effect of this decision is that within the limits prescribed either a conduit system or one of the surface-contact systems can alone be considered. I have gone closely into this matter, and it appears to me that on the ground of expense a surface-contact system is the only one which can be adopted. Now the track mileage within the area from which posts and wires are barred is 2·434, and the electrical equipment of this position on the surface-contact system will cost about £3,000 per track mile, or £7,300 within the area mentioned. This figure is one which the scheme can bear, whilst the cost of a conduit would, in my opinion, make the annual capital charges assume an excessive proportion of the gross receipts.

I have to point out that both the surface-contact and the conduit systems involve an additional expense outside their own cost, because there is interference with pipes and other works in the street. The amount of this is quite impossible to estimate without a detailed knowledge of the subterranean works along the routes, and I have not allowed any particular amount for such work. The conduit system requiring excavation and construction to a depth of nearly 3ft., and the surface-contact systems to a depth not exceeding 2ft. from the street surface, it will be obvious that the conduit is the more expensive in this respect. The city engineer, who is thoroughly acquainted with the local conditions, can give your committee a much closer estimate of the amount and cost of such work than I can venture to offer. It is claimed that the working expenses on a surface-contact system are not greatly, if at all, in excess of those with an overhead equipment.

The question of safety is, of course, of the greatest importance. The surface contact presents a greater potential danger than either the overhead or the conduit, because the live conductors from which the car derives its supply of power are, in the former case, on a level of the street surface. All the systems which have been brought forward provide, as a matter of course, that these live conductors or studs shall be alive only while a car is passing over and taking current from them, and that the onward passage of the car shall automatically disconnect and leave them dead. It will be obvious that the failure of this automatic disconnection will leave on the street surface a charged conductor, capable of giving extremely severe shocks to any foot passengers or animal which may tread upon it. The great endeavour of all inventors in this field has, therefore, been to render the automatic action absolutely reliable.

With one exception, the motive power of all the practicable surface-contact systems now on the market is derived from magnets carried below the car body. These magnets act upon movable iron pieces in the box under the stud and actuate switches connecting the stud surface to the supply cable. As soon as the car with its magnet moves on, the moving parts under the stud resume their normal position and the stud is disconnected. The exception has a mechanically-actuated switch worked by strikers carried on the car. One of the running rails is slotted, the strikers project downwards into the slot and there meet the actuating mechanism of the switch. A front striker turns current on to the stud, and a rear striker turns it off. The only remark I would make about this method is that it seems to involve the disadvantages of a conduit slot in the street and a more expensive track construction. In this country there is only one town, as the committee are probably aware, in which a surface-contact system has been in practical use—viz, Wolverhampton. There were some initial troubles during the first months of operation in that town, some cases of animals being killed and injured, but the greater part of the trouble was due to the interruption of service in consequence of failures of this kind. It is claimed that these troubles have now disappeared and that the surface-contact system in Wolverhampton works with as much reliability and with no more danger to the public than the overhead trolley system. Clearly, in selecting a system for adoption in Oxford the committee and their advisors will have to look very closely into the reliability of the various devices offered in this respect, and the Council will be well advised not to decide to adopt any particular system excepting after consideration of tenders, accompanied with a satisfactory guarantee providing for the continuous reliable action and maintenance expenses, and, what is more important, the continuous approval of the Board of Trade. Full details for the consideration of the Council's technical advisers will, of course, be necessary.

Outside the limits mentioned I recommend the adoption of the overhead system. From the point of view of commercial success, of economical maintenance, and of general reliability and safety, no other method can compete with the overhead system. It has had the advantage of the experience of many years under very varying conditions, and has shown itself capable of serving the very heaviest traffic with the greatest reliability, and the smallest traffic on which a tramway can pay with great economy. This is of the greatest importance, as enabling the maximum profitable extensions to outlying districts.

The cost of the overhead electrical equipment need not exceed £1,300 per route mile. This expenditure does not compare accurately with the cost per track mile for the surface-contact or the conduit system, for the reason that the overhead work costs no more for a double line than for a single line, whereas either the conduit or the surface-contact system costs practically twice as much for double line as for single, so that contrasting a mile of double line the surface-contact work would cost £6,000 and the overhead work £1,300, whilst with single line in both cases the surface-contact work would cost £3,000 and the overhead work £1,300 as before, so that in considering the relative cost the amount of single and double line has to be taken into account.

As regards instruction No. 2, I recommend the Council, when it has been duly considered and decided what lines it is advisable to construct with such estimates as it may see fit to obtain, to call for tenders for the construction and equipment of these tramways upon proper specifications. These specifications should, as in ordinary course, be so divided up as to enable the Council to place the contracts for the various parts of the work in the most

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advantageous manner. As above stated, particular attention will have to be given to any portions of the lines which will be constructed with the surface-contact equipment to ensure that the specification calls for substantial guarantees and safeguards in respect to this comparatively untried form of construction.

It appears to me that the best course to meet instruction No. 3 is to lay before your Council my views as to the expenditure and the probable gross and net receipts to be derived from tramways constructed in a modern way. The first point to be considered is the gauge, and here I am clearly of opinion that the standard gauge of 4ft. 8½in. is the most suitable. Other gauges have been adopted in some towns for a variety of reasons; none of these operate in Oxford, while the advantages of the standard gauge as regards more comfortable rolling-stock, more convenient disposition of the electrical equipment, and the possibilities of future intercommunication, all seem to me to have full force, and to call for the adoption of the gauge 4ft. 8½in.

Single and Double Line.—In the centre of the town, on either side of the crossing of the main routes at Carfax, the lines should be doubled, as above stated. There should also be an extension of double line in St. Aldate's-street north of Folly Bridge. Elsewhere a sufficient number of loops to provide for a five minutes' service appear to me to meet the requirements, and the remainder of the line should be single track. In the estimate of construction costs which follows I have taken into account this proposed proportion of single and double line, which gives me the route mileage at 5·375 and the track mileage at 7·291 miles. The track mileage on which posts and lines cannot be entertained amounts to 2·434 miles, and that on which posts and wires are permissible to 4·857 miles, the route mileage being 3·87.

Generating Station.—There are suitable sites for a generating station to be found either in Twenty Pound Meadow, or adjacent property, well situated for economical power generation and distribution.

Car-Shed.—The site now used for the tramway company's depôt is very suitable for housing the proposed rolling-stock, and my estimate covers its adaptation for the purpose.

I estimate that the capital expenditure in constructing and electrically equipping this suggested system will be as follows:

Permanent way—7·291 miles single track	£40,106
Overhead work—3 87 route miles	5,031
Surface-contact work—2 434 track miles	7,302
Feeder cables—5·375 route miles	5,375
Rolling-stock—20 cars	14,000
Generating station, including machinery, with a capacity of 400 kw.	10,000
Car-shed building and equipments	3,000
	84,814
Promotion, engineering, and contingencies	8,481
Total	£93,295

Traffic Estimate.—The traffic returns of the tramway company show that during the year 1903 the tramcars carried 2,716,500 passengers, and that the total receipts were £13,190. Experience has taught me that a very safe basis is that an electric tramway service will carry traffic of 40 per cent. greater value than a horse tramway on the same ground and the same population. There are many cases in which the increase has been much larger. I am not aware of any where it has been less, and from what I have seen of Oxford, I feel sure that 40 per cent. is quite a moderate increase to allot. On this basis the receipts of the electrified tramways will amount to £18,360 per annum, which, it will be observed, works out at a rate of £3,416 per route mile. The working expenses should not exceed 60 per cent. of the receipts, so that the revenue account will stand thus:

Gross receipts	£18 360
Working expenses, 60 per cent.	11,016
Net revenue	£7,344

From this net revenue has to be met the interest and sinking fund upon the capital expenditure. Assuming this to be as high as 61 per cent., it will be seen that there is a substantial credit balance to be anticipated. I am therefore confident that the tramways suggested will be financially successful, as well as a great improvement and convenience to the inhabitants and visitors of Oxford.

I have given separate consideration to the extension from the present tramway termini to the suburban and outlying districts, and I am of opinion that it would be financially advantageous to the tramway system as a whole, and necessarily a great benefit to the population of the city and outlying districts, to make the following extensions, which the committee will find indicated upon the enclosed map.

Extensions, etc.	Length, miles.	Cost of construction and equipment, including share of rolling-stock.
Headington	1·75	£14,000
Iffley	1·3375	10,700
Cowley	·6125	4,900
Hinksey	·4375	3,500
Walton-street and Kingston-road line	·275	2,200
Banbury-road	·194	1,552
	4·6065	£36,852

Considering very carefully the amount and distribution of the population on these extensions, I have come to the conclusion that the amount of traffic receipts to be anticipated in consequence of their construction, including the mutual feeding effects between this and the central system, will be fairly proportional to the length of individual extensions, and that the gross receipts thereon will have a value of not less than

(annually)	£9,213
Deducting therefrom working expenses of	5,528
Leaves a balance of net receipts of	3,685
Interest and sinking fund on the capital expenditure of £36,852 amounts to	2,211
	£1,474

So that a balance of between £1,400 and £1,500 will remain after satisfying these charges.

Summarising the whole financial results, I put forward the following figures:

Capital expenditure—central system	£93,295
Ditto branches	36,852
Total	£130,147
Gross receipts—central	£18 360
Ditto branches	9,123
Total	27 573
Working expenses	16,544
Net receipts	11,029
Interest and sinking fund	7,809
Net balance	£3,220

I strongly recommend your committee and Council to give their fullest consideration to a complete scheme, and it is for this reason that I have outlined the whole of the extensions described. I would point out that in any application for powers to carry out these works the Council can ask for such a period for construction as will leave the order and date of execution within the discretion of the Council. In my opinion, looking at the character of the districts to be served, the extension along the Iffley-road will be the most immediately remunerative of those mentioned, whilst those to Cowley and Headington seem to promise the greatest ultimate development.

I have for the convenience of the committee put into the form of appendices a statement showing what I think will be the value to the whole system of each extension, including its feeding effects. It will be noted that in the above estimates no allowance is made in any way for the acquisition of the existing tramways.

I trust that the above information will enable your Council to decide upon the next steps to be taken, and I shall be pleased to supplement this report with any details on which the Council would like further explanation.—I am, sir, yours faithfully, STEPHEN SELLON.

Mr. W. Worby Beaumont's report is dated Aug. 9, and read as follows:

Outer Temple, 222, Strand, London, W.C.

Richard Bacon, Esq., Town Clerk, Oxford.

Dear Sir,—In the following I beg leave to submit to the Corporation of Oxford my report in accordance with the instructions received from you and the further instructions

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received at the time of my visit on the 22nd ult. from the Tramways Committee. On that occasion I made a general inspection of the whole of the routes now traversed by tramways, those of proposed extensions, and those of the present omnibuses. I have previously visited and stayed in Oxford on several occasions, and have thus made myself acquainted with the city, and the streets and roads of the city and suburbs, and the traffic to be provided for.

In your letter of the 14th ult. you inform me that "the committee have decided that the Council will not entertain any scheme which involves the erection of posts and wires between the east end of Magdalen Bridge and the west end of Queen-street, nor between the north end of St. Giles and Folly Bridge." The same letter instructs me "(1) to advise the Council as to the form of traction most suitable for Oxford, taking into account the interest of passengers, ratepayers, all classes of road users, and residents on the routes involved." I have been provided by Mr. White, M.I.C.E, with particulars as to the lengths of the several Oxford city tramways at present existing, and of those which have been proposed, and I have received from you particulars of the tramway and omnibus traffic of the past 4½ years in the six directions and districts served. I have fully considered the existing accommodation with regard to Oxford, and the "form of traction most suitable in the future, taking into account the interest of passengers, ratepayers, all classes of road users, and residents on the routes involved." All the roads and streets of Oxford and the connected districts are, from a transport point of view, practically level, or have but slight gradients. Comparatively small maximum power per vehicle will be thus required, the power needed for acceleration or quick getting away being the chief determining demand.

The Oxford city tramways comprise a total length of 6⅞ miles single horse-car line, including a total length of 1⅜ miles of turn-out loops. In 1904 they carried 2,841,315 passengers. The greatest length of line is that of the Cowley-road to the station, which is a little over 2½ miles of single line in all, and this carried in 1904 1,614,302 passengers, or 51·65 per cent. of the whole of those carried by the tramways, and is about 645,000 passengers per mile of single line. The next tramway in length is the Banbury-road line, 2¼ miles in length total of single line with the extensions, and this carried 734,094 passengers in 1904, or 30·7 per cent. of the whole, and about 322,000 passengers per mile. The Hinksey line is the next in length, 1$\frac{1}{17}$ miles, carried only 190,594 passengers, or only 6·7 per cent. of the whole, and 180,000 per mile. The Walton-street lines, under one mile of single line in length, carried 302,335 passengers, or only 10·5 per cent. of the whole, or 350,000 per mile of line. The Iffley-road omnibuses carried 335,310 passengers in the year. The Woodstock-road omnibuses carried 95,305 passengers in the year.

The variation in the number of passengers carried during the past six years has been almost negligible by both tramways and omnibuses; the total by trams, for instance, in 1899 being 2,730,274, as against 2,841,315 in 1904, or a growth of less than 1 per cent. per year. In the same time the passengers by omnibuses have grown in numbers from 341,900 in 1899 to 430,615 in 1904, or a growth of 21 per cent. in the years following 1899, or over 4 per cent. per year. Examination of these figures and of the populations of the several wards shows that the passengers carried by the tramcars and by the omnibuses differed enormously, as would be expected. The number of journeys per head of the respective populations being, as near as it is possible to allocate them, as follows: East Ward, Central, and University, 70 journeys per head; St. Giles, 70; St. Thomas, 35; and St. Aldate, 49. This, of course, does not necessarily show that the inhabitants of St. Thomas and St. Aldate travel so much, as appears, less than those of the other wards, but that the tram and omnibus traffic on the roads of those wards is and will be the greatest. These figures, as a total, give less than the total of 62 journeys per year made by the whole population of 52,836 on the whole of the lines, showing that the populations overlap in relation to the services, as they would, for instance, in the use of the St. Thomas's service. These figures give some idea of the quantity and distribution of the traffic at present and of the probable distribution in future with somewhat increased facilities.

At present 13 tramcars are in use and three omnibuses. The tramcars have thus carried about 218,000 passengers per car per year. The omnibuses have carried per 'bus 143,538 passengers. Taking the population of the central and five surrounding districts as 52,800, the total journeys by tram and 'bus represent 62 journeys per head per year, which is equal to or exceeds that of more than one-third of the towns and cities in the United Kingdom in which the tramways are electrically operated (about one-sixth of which, as shown by the returns of 1903-4, are worked at a loss). This large number of apparent journeys per head per year—large considering the facilities—must be taken in considerable degree as due to large numbers of visitors.

The disproportion in the number of journeys made per head of the population of the several Oxford districts would, there can be little doubt, be modified to some extent if a quicker, and by a quicker a more frequent, service were established. There is not, however, in my opinion any necessity for a system of very large carrying capacity in Oxford city and districts. At an outside estimate it is possible that about 100 journeys per head of population per year might be made if a sufficient system were established.

I assume that it is wished to provide ample accommodation, that this accommodation should at least be self-supporting, and that it is not thought desirable or expedient in such a city as Oxford to make a tramway trade. I also assume that the amenities of Oxford should be considered as precedent of any question of assumed profit, or trading returns, which may be possible from any system of cheap popular public conveyance.

Although Oxford has increased and is increasing in population, its general character and distinction as a great university city have remained without changes which would have affected its dignity and unique attractiveness. It has remained true to its attributes and ancient and lofty associations, yet has encouraged that progress which does not militate against the preservation of the spirit of its ideals—ideals which have made it in the eyes of the world the city of history, learning, and repose. It is a city with a character all its own; a city which has not yet lost its charm and its distinctiveness through accretions and adaptations of things incongruous. In considering for it, then, a system of public passenger conveyance, it must be remembered that a system which would be permissible in a striving manufacturing town would not necessarily be expedient or desirable in Oxford.

With regard, then, to a system of traction most suitable for Oxford, and the paragraph before quoted in the instructions given me. At the time of expiry of the present ownership of the existing horse tramways the tramways will in great part be useless for any other than horse traction. They might be extended now in several directions, but no material improvement in the service could be made where the possible traffic most requires it firstly, because almost the whole of the lines are single way; secondly, because in several parts the streets are not wide enough to permit the construction and use of double lines; thirdly, because their use if constructed would cause great inconvenience to every other kind of traffic, and in many cases cause congestion. Most of these objections refer equally to any system of tramway traction.

The existing tramways, then, will have no more than the value of their material when the time comes for making a change. I am of opinion that, when that change is made and the existing permanent way removed, no more rails should be put down. I do not even think that the traffic of any part of the city or the connected districts would be benefited by the establishment of any system of electric tramway, but distinct advantages would result from the reconversion, now that the opportunity will arise, of all streets and roads at present laid with rails, into well-made and well-maintained ordinary paved, macadam, wood, or other of the best clear surface roadways suitable for every kind of vehicle.

Oxford, as before remarked, is mainly a level-road city, and the traffic density is not and will not be great. It will be well suited for, and well suited by, a public service

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—	Present company, 1904.	Mr. Beaumont's scheme.	Mr. Sellon's complete scheme.	Mr. Sellon's scheme without Headington.
Length of road served. (Give to nearest quarter of mile. No distance to be counted more than once)	Tram and 'buses about eight miles.	About nine miles.	10 miles	8¼ miles
Number of vehicles: (*a*) cars	16	—	25	23
" " (*b*) 'buses	—	17	—	—
Seating capacity of vehicle	40	34	48	48
Number of passengers	3,271 930	4,580,000	5 294,016	4 734 016
Number of miles run: (*a*) cars	320 407	—	661,752	577,752
" " (*b*) 'buses	58,050	490,000	—	—
Traffic receipts per mile run	10d.	11d.	10d.	10d.
Working expenses per mile run	8 44d.	8·70d.	6d.	6d.
Capital expenditure	£60,000	£20,000	£130 147	£116,147
Traffic receipts—total	£15,705 8s.	£22 520	£27,573	£24,073
Working expenses	£13 280*	£17,750	£16,544	£14,444
Loan charges at 6 per cent.	£3 000	£1,200	£7 809	£6 969
Balance	£1,786. 19s. 7d.†	£3,570	£3,220	£2,660

* This is £13,580. 3s. 6d. less cost of working brakes. † This is £2,703 3s. 6d. less receipts for advertisements and for brakes.

of motor omnibuses; the working of which does not interfere with any other traffic, requires no special roadway not equally required by every other class of vehicle, is the system best suited for narrow streets, requires no special installation or new establishments, and with a moderate maximum speed will give a higher average speed than can be obtained by any system of tramway. The motor omnibus system requires no overhead wires or posts and cross-wires to carry them, and requires not only no rails in the streets, but no conduits or no surface contacts. The reasons which have decided your committee to refuse to entertain any scheme which involves the erection of posts and wires along certain routes should equally obtain with respect to other routes, as these things are not now necessary to the desired end in any places where the traffic density is not extremely heavy, and they certainly should hold good in the narrower and the narrow streets not included in the routes excluded. The motor omnibus would be suited for the traffic of all the streets and roads in which tramways are not at present laid, and they would provide, without the laying of any lines, for the service of any street or roads not now served, such as Woodstock-road, without any expenditure except for the omnibuses themselves. The motor omnibus requiring no special roadway can at any time be put to work on any route to suit special circumstances or changed conditions. A new route may be tried and served, or one not requiring or paying for a service may be abandoned temporarily or permanently without any loss at any time.

I am, therefore, of opinion that: (1) "The form of traction most suited for Oxford" is the motor omnibus. (2) "The interest of passengers" would be best met by the motor omnibus, as (*a*) with equal maximum speed being quicker than any other system; (*b*) as being more flexible and lending itself without extra cost to change of route on special occasions, to the opening up of new routes, and to the minimum of delay in narrow streets; (*c*) convenience of access or of alighting at the pavement instead of the middle of the street. (3) That "the interest of the ratepayers" is best met by the motor omnibus, as (*a*) involving much less capital outlay at first or for extensions; (*b*) because they could be worked at a profit; (*c*) because with comparatively small expenditure the present tramway depôts can be converted into motor-'bus depôts and workshops; (*d*) because their road requirements are those of every user, and well made and maintained roads are the most economical. (4) "The interest of all classes of road users" is best met by the motor omnibus because they do not interfere with other users (*a*) by appropriating a definite part of the highway; (*b*) because they can accommodate themselves to any circumstances of the traffic; (*c*) because they do not require any rails in the roadway; (*d*) because for their use they only require the ordinary road, and their use encourages the making and maintenance of good roads and surfaces, which are more economical in the end than cheaply-made and inefficiently maintained roads. (5) "The interests and convenience of the residents on the routes served" are best met by motor omnibuses, because (*a*) they do not involve road obstruction for tramway lines construction; (*b*) they do not require the ringing of bells to clear every other kind of traffic off their fixed routes; (*c*) they do not interfere with the carriages stopping at shops or private houses at the road or street side; and (*d*) because they enable the passenger to enter or alight from them at the pathway.

Experience has now shown that motor omnibuses can be run profitably; great improvements have been made in them in the past two years, and the very wide experience now being obtained will lead rapidly to further improvements, and they will, there can be no doubt, in every way meet the requirements of the service, every month now adding to their development and their durability.

For use in Oxford, which is now served by 13 tramcars and three omnibuses, I would recommend the installation of 16 or 18 motor omnibuses, 10 or 12 of them to carry 34 passengers and six to carry 16 passengers, their selection as to make and maker to be decided hereafter, but to be of the internal-combustion motor type. These could be put to work as obtained and without waiting for the removal of the tramways. Addition to this number of omnibuses could be made if and as required. The total cost of the number first to be put in service would be about £14,000, and the expenditure on the depôt and workshops about £6,000, or a total of £20,000. Powers for this expenditure and for running this service would have to be obtained.

In coming to the conclusion herein set forth, I wish to say that I am not averse to the use of tramways where they are most suited, and as a member of the council of the Tramways and Light Railways Association I would encourage their use in wide roads where traffic is very heavy, and along roadsides in some cases; but I am convinced that for Oxford the electric tramway, either of the overhead, the conduit, or any surface-contact system, is not the best, is not required, and that the motor omnibus does meet the requirements.—I am, faithfully yours,

W. Worby Beaumont.

At the request of the Council these two engineers each supplied the figures in the table herewith given in the columns under their names. With these figures before them the Corporation of Oxford passed a resolution in favour of electric tramways, which, we believe, will include the extensions mentioned in Mr. Sellon's report as well as the conversion of the existing lines.

DIAMONDS.

The following is a condensation of a lecture on "Diamonds" delivered by Sir William Crookes, F.R.S., before a meeting of the British Association at Kimberley this week. The lecture was most appropriate to the place of delivery, and seats to hear it were at a premium.

Sir William Crookes said it was recorded in "Sprat's History of the Royal Society" (1667) that among the questions sent by order of the society to Sir Philiberto Vernatti, resident in Batavia, was one inquiring "Whether diamonds grow again after three or four years in the same places where they have been digged out?" The answer sent back was "Never, or at least as the memory of man can attain to." South Africa was the favourite haunt of diamonds on this planet; it ranked with Australia and California as one of the three great gold-yielding regions

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But the wealth of South Africa was not limited to gold and diamonds. It was also the illimitable home of coal—"the black diamond" of the universe. The province of Natal alone contained more coal than Britain ever owned before a single bucket had been raised; and the coal beds extended into the Orange River Colony. Valuable iron ores existed also in large quantities. In addition to these lavish natural riches the high grounds above Cape Town abounded in medicinal health-giving waters. He had studied diamonds scientifically for 30 years. In 1896 he spent nearly a month at Kimberley, when Mr. Gardner Williams, general manager of the De Beers Consolidated Mines, and the managers of neighbouring mines, did their utmost to aid him with valuable information. The most famous diamond mines were Kimberley, De Beers, Dutoitspan, Bultfontein, and Wesselton. Kimberley was practically in the centre of the present diamond-producing area. The mines were situated in latitude 28° 43′ south and longitude 24° 46′ east. There were also river washings in the neighbourhood of the Vaal River, where the work was conducted in somewhat primitive fashion. When he was at Klipdam miners had congregated at a spot called "New Rush," where some good finds of diamonds had been reported. At one of the claims the proprietor said he had not seen a diamond for a fortnight! But then he had picked out one worth £300, "and that," he said, "will pay for several weeks' wages of my boys." This was the kind of speculative gambling that went on at the river diggings.

The surface of the country round Kimberley was covered with a ferruginous red, adhesive, sandy soil, which made traffic heavy. Below the red soil was a basalt, much decomposed, and highly ferruginous, from 20ft. to 90ft. thick, and lower still from 200ft. to 250ft. of black slaty shale containing carbon and iron pyrites. There was no water nearer than the Vaal River, about 14 miles away; formerly the miners were dependent on rain-water and a few springs and pools. Now, however, a constant and abundant supply of excellent water was served to the town. Good brick houses, with gardens and orchards, had sprung up on all sides. The five diamond mines were all contained in a precious circle 3½ miles in diameter. They were irregular shaped round or oval pipes, extending vertically downwards to unknown depths, retaining about the same diameter throughout. They were considered to be volcanic necks, filled from below with a heterogeneous mixture of fragments of surrounding rock, and of older rocks such as granite, mingled and cemented with a bluish-coloured hard clayey mass, in which famous blue clay the embedded diamonds were hidden. The areas of the mines were: Kimberley, 33 acres; De Beers, 22 acres; Dutoitspan, 45 acres; Bultfontein, 36 acres. How the great pipes were originally formed was hard to say. They were certainly not burst through in the ordinary manner of volcanic eruption, since the surrounding and enclosing walls showed no signs of igneous action, and were not shattered or broken up even when touching the "blue ground." It was pretty certain these pipes were filled from below after they were pierced, and the diamonds were formed at some previous time and mixed with a mud volcano, together with all kinds of *débris* eroded from the rocks through which it erupted, forming a geological "plum pudding" There were many such pipes in the immediate neighbourhood of Kimberley. It might be that each volcanic pipe was the vent for its own special laboratory—a laboratory buried at vastly greater depths than we had yet reached—where the temperature was comparable with that of the electric furnace, where the pressure was fiercer than in our puny laboratories, and the melting point higher, where no oxygen was present, and where masses of liquid carbon had taken centuries, perhaps thousands of years, to cool to the solidifying point. This hypothesis of the origin of diamonds was in many ways corroborated. The ash left after burning a diamond invariably contained iron as its chief constituent; and the most common colours of diamonds, when not perfectly pellucid, showed various shades of brown and yellow, from the palest "off colour" to almost black. They were also green, blue, pink, yellow, and orange. These variations gave support to the theory advanced by Moissan that the diamond had separated from molten iron, and also explained how it happened that stones from different mines, and even from different parts of the same mine, differed from each other. Further confirmation was given by the fact that the country round Kimberley was remarkable for its ferruginous character, and iron-saturated soil was popularly regarded as one of the indications of the near presence of diamonds. Along with carbon, molten iron dissolved other bodies which possessed tinctorial powers. One batch of iron might contain an impurity colouring the stones blue, another lot would tend towards the formation of pink stones, another green, and so on. Cobalt, nickel, chromium, and manganese, all metals present in the blue ground, would produce these colours.

The blue ground varied in its yield of diamonds in different mines. According to tables furnished by the De Beers Company, the yield of the De Beers and Kimberley mines had declined as the depth increased. At the same time the value of the stones had risen, and diamonds were more expensive to-day than at any previous time. The number of carats per load (about 1,600lb.), a carat being 3⅕th troy grains, or rather less, had fallen from 1·283 in 1889 to ·54 in 1904; but in the same period the value per carat had risen from 19s. 8·75d. to 48s. 11·8d. The diamonds from each mine had a distinctive character, and so uniform were the characteristics that an experienced buyer could tell at once the locality of any particular parcel of stones. De Beers and Kimberley mines were distinguished by the yield of large yellowish crystals with curved edges; Dutoitspan yielded mainly coloured stones; while Bultfontein, half a mile off, produced small white octahedral crystals, occasionally speckled and flawed, but rarely coloured. The diamonds from the Wesselton mine were characterised by the large number of perfect octahedra of pure water amongst them. The diamonds from the Leicester mine had a frosted, etched appearance; they were white, the crystallisation irregular ("cross-grained"), and they were hard and expensive to cut. Stones from Jagersfontein, in the Orange River Colony, displayed great purity of colour and brilliancy, and they had the so-called "steely" lustre characteristic of old Indian gems.

Sir William Crookes then gave a description of the diamond mines 30 years, and compared the method of working individual claims then with the present system now that the work is carried out under one management. Speculations as to the probable origin of the diamond had been greatly forwarded by patient research, and particularly by improved means of obtaining high temperatures, an advance we owed principally to the researches of Prof. Moissan. Until recent years carbon was considered absolutely non-volatile and infusible; but the enormous temperatures at the disposal of experimentalists—by the introduction of electricity—showed that, instead of breaking rules, carbon obeyed the same laws that governed other bodies. It volatilised at the ordinary pressure at a temperature of about 3,600deg. C, and passed from the solid to the gaseous state without liquefying. It had been found that other bodies, such as arsenic, which volatilised without liquefying at the ordinary pressure would easily liquefy if pressure were added to temperature.

It naturally followed that if, along with the requisite temperature, sufficient pressure were applied, liquefaction of carbon would take place, when on cooling it would crystallise. But carbon at high temperatures was a most energetic chemical agent, and if it could get hold of oxygen from the atmosphere or any compound containing it, it would oxidise and fly off in the form of carbonic acid. Heat and pressure, therefore, were of no avail unless the carbon could be kept inert. For the manufacture of an infinitesimal diamond, the first necessity was to select pure iron—free from sulphur, silicon, phosphorus, etc.—and to pack it in a carbon crucible with pure charcoal from sugar. The lecturer then described the process, which was, he said, in parts extremely tedious. In the result along with numerous pieces of black diamond were seen transparent colourless pieces, some amorphous, others with a crystalline appearance. All appear shattered, as if, on being liberated from the intense pressure under which they were formed, they burst asunder. A fine piece of artificial diamond, carefully

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mounted by him on a microscopic slide, exploded during the night and covered the slide with fragments. Moissan's crystals of artificial diamond sometimes broke a few weeks after their preparation, and some of the diamonds which cracked weeks or even months after their preparation showed fissures covered with minute cubes. This bursting paroxysm was not unknown at the Kimberley mines. The largest artificial diamond was less than 1mm. across. In lustre, crystalline form, optical properties, density, and hardness, they were identical with the natural stone. In several cases Moissan separated 10 to 15 microscopic diamonds from a single ingot. The larger of these were about 0·75mm. long, the octahedra being 0·2mm.

Intermediate between soft carbon and diamond came the graphites. The name graphite was given to a variety of carbon, generally crystalline, which in an oxidising mixture of chlorate of potassium and nitric acid formed graphitic oxide. This varied in colour from green to brown or yellow, or it was almost without colour, according to the completeness of the reaction. Graphites were of varying densities, from 2·0 to 3·0, and generally of crystalline aspect. Graphite and diamond passed insensibly into one another. Hard graphite and soft diamond were near the same specific gravity. The difference appeared to be one of pressure at the time of formation. Some forms of graphite exhibit the remarkable property by which it was possible to ascertain approximately the temperature at which they were formed, or to which they had subsequently been exposed. Sprouting graphite was a form frequently met with in nature which on moderate heating swelled up to a bulky, very light mass of amorphous carbon. Moissan had found it in blue ground from Kimberley; his own results verified his. The resistance of a graphite to oxidising agents was greater the higher the temperature to which it had previously been exposed. Graphites which were easily attacked by a mixture of fuming nitric acid and potassium chlorate were rendered more resistant by strong heat in the electric furnace. After dealing with the boiling and melting point of carbon and a new formation of diamond, Sir W. Crookes said that, sensational as was the story of the diamond industry in South Africa, quite another aspect fixed the attention of the chemist. The diamonds came out of the mines, but how did they get in? How were they formed? What was their origin? Gardner Williams, who knew more about diamonds than any man living, was little inclined to indulge in speculation. In his fascinating book ("The Diamond Mines of South Africa," p. 510: Macmillans. 1902) he frankly said: "I have been frequently asked, 'What is your theory of the original crystallisation of the diamond?' And the answer has always been, 'I have none; for after 17 years of thoughtful study, coupled with practical research, I find that it is easier to "drive a coach and four" through most theories that have been propounded than to suggest one which would be based on any non-assailable data.' All that can be said is that in some unknown manner carbon, which existed deep down in the internal regions of the earth, was changed from its black and uninviting appearance to the most beautiful gem which ever saw the light of day."

Another diamond theory appealed to the fancy. It was said the diamond was a gift from Heaven, conveyed to earth in meteoric showers The suggestion was first broached by A. Meydenbauer (*Chemical News*, vol. lxi., p. 209. 1890), who said: "The diamond can only be of cosmic origin, having fallen as a meteorite at later periods of the earth's formation. The available localities of the diamond contain the residues of not very compact meteoric masses which may, perhaps, have fallen in prehistoric ages, and which have penetrated more or less deeply, according to the more or less resistant character of the surface where they fell. Their remains are crumbling away on exposure to the air and sun, and the rain has long ago washed away all prominent masses. The enclosed diamonds have remained scattered in the river-beds, while the fine light matrix has been swept away." According to this hypothesis, the so-called volcanic pipes were simply holes bored in the solid earth by the impact of monstrous meteors — the larger masses boring the holes, while the smaller masses, disintegrating in their fall, distributed diamonds broadcast. Bizarre as such a theory appeared, he was bound to say there were many circumstances which showed that the notion of the heavens raining diamonds was not impossible. The most striking confirmation of the meteoric theory came from Arizona. Here, on a broad open plain, over an area of about five miles in diameter, had been scattered one or two thousand masses of metallic iron, the fragments varying in weight from half a ton to a fraction of an ounce. There was little doubt these masses formed part of a meteoric shower, although no record existed as to when the fall took place. Curiously enough, near the centre, where most of the meteorites had been found, was a crater with raised edges three-quarters of a mile in diameter and about 600ft. deep, bearing exactly the appearance which would be produced had a mighty mass of iron struck the ground and buried itself deep under the surface. Altogether 10 tons of this iron have been collected, and specimens of the Canyon Diablo meteorite were in most collectors' cabinets. An ardent mineralogist—the late Dr. Foote—cutting a section of this meteorite, found the tools were injured by something vastly harder than metallic iron. He examined the specimen chemically, and soon after announced to the scientific world that the Canyon Diablo meteorite contained black and transparent diamonds. This startling discovery was afterwards verified by Profs. Moissan and Friedel, and Moissan, working on 183 kg. of the Canyon Diablo meteorite, had recently found smooth black diamonds and transparent diamonds in the form of octahedra with rounded edges, together with green hexagonal crystals of carbon silicide. The presence of carbon silicide in the meteorite showed that it must, at some time, have experienced the temperature of the electric furnace. Since this revelation, the search for diamonds in meteorites had occupied the attention of chemists all over the world. He was enabled to show his hearers photographs of true diamonds he himself had extracted from the Canyon Diablo meteorite.

Diamonds varied considerably in hardness, and even different parts of the same crystal differed in their resistance to cutting and grinding. Beautifully white diamonds had been found at Inverel, New South Wales, and from the rich yield of the mine and the white colour of the stones great things were expected. In the first parcel which came to England the stones were found to be so much harder than South African diamonds that it was at first feared they would be useless except for rock-boring purposes. The difficulty of cutting them disappeared with improved appliances, and they now were highly prized. The famous Koh-i-noor, when cut into its present form, showed a notable variation in hardness. In cutting one of the facets near a yellow flaw, the crystal became harder and harder the further it was cut, and after working the mill for six hours at the usual speed of 2,400 revolutions a minute little impression was made. The speed was increased to more than 3,000, when the work slowly proceeded. Other portions of the stone were found to be comparatively soft, and hardened as the outside was cut away. Although not directly bearing on the subject, he would introduce the only serious rival of the diamond as regards hardness. It was the metal tantalum, a fine specimen of which he owed to Messrs. Siemens Bros. A hole had to be bored through a plate of this metal, and a diamond drill was used revolving at the rate of 5,000 revolutions per minute. This whirling force was continued ceaselessly for three days and nights, when it was found that only a small depression ¼mm. deep had been drilled, and it was a moot point which had suffered most damage—the diamond or the tantalum. In another respect tantalum was likely to rival graphitic carbon, as it had rivalled adamantine carbon. Its thin wire was extensively used for filaments of incandescent electric lamps; it showed a much higher efficiency than did the old carbon filament. The melting point of tantalum was about 2,300deg. C., a temperature seldom or never reached in an ordinary lamp.

After exposure for some time to the sun many diamonds glowed in a dark room. Some diamonds were fluorescent, appearing milky in sunlight. In a vacuum, exposed to a high-tension current of electricity, diamonds phosphoresced of different colours, most South African diamonds shining with a bluish light. Diamonds from other localities emitted

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bright blue, apricot, pale blue, red, yellowish green, orange, and pale green light. The most phosphorescent diamonds were those which were fluorescent in the sun. One beautiful green diamond in his collection, when phosphorescing in a good vacuum, gave almost as much light as a candle, and you could easily read by its rays. But the time had hardly come when diamonds could be used as domestic illuminants! Diamonds which phosphoresced red generally showed the yellow sodium line superposing on a continuous spectrum. In one Brazilian diamond phosphorescing a reddish-yellow colour, he detected the citron line characteristic of yttrium. By permission of Mrs. Kunz, wife of the well-known New York mineralogist, he would show, perhaps, the most remarkable of all phosphorescing diamonds. This prodigy diamond would phosphoresce in the dark for some minutes after being exposed to a small pocket electric light, and if rubbed on a piece of cloth a long streak of phosphorescence appeared. The rays which made the diamond phosphoresce were high in the ultra-violet. A thin sheet of glass cut them all off.

The β-rays from radium having like properties to the stream of negative electrons in a radiant matter tube, it was of interest to ascertain if they would exert a like difference on diamonds. The diamond glowed under the influence of the β-radiations, and crushed diamond cemented to a piece of card or metal made an excellent screen in a spinthariscope — almost as good as zinc sulphide. Some fine colourless crystals of diamond were embedded in radium bromide, and kept undisturbed for more than 12 months. At the end of that time they were examined. The radium had caused them to assume a beautiful blue colour, and their value as "fancy stones" had been materially increased. Sir W. Crookes showed his audience a couple of diamonds originally of the same purity of water. One had been coloured by radium, the other was in its natural state. The colour of the radium-tinted stone was very pronounced. This blue colour was persistent, and penetrated below the surface. It was unaffected by long continued heating in strong nitric acid and potassium chlorate, and was not discharged by heating to redness. To find out if this prolonged contact with radium had communicated to the diamond any radioactive properties, six diamonds were put on a photographic plate and kept in the dark for a few hours. He would project the image of the result after development. The three on the upper row were the diamonds which had had a prolonged sojourn with radium, the three below were similar diamonds picked out for comparison, which had not been near radium. It would be seen how strangely the upper ones had acted. They would notice also that by mere contiguity to the others the lower diamonds also shone with an induced factitious radioactivity. He would throw on the screen a magnified image of one of the blue crystals, and they would see in how regular and geometrical a pattern the radioactive emanations radiated from the crystal. This observation had only been made a short time, and was still under investigation. Like the blue tint, the radio activity persisted after drastic treatment. A diamond that had been coloured blue by radium, and had acquired strong radioactive properties, was slowly heated to dull redness in a dark room. Just before visibility a faint phosphorescence spread over the stone. On cooling and examining the diamond it was found that neither the colour nor the radioactivity had suffered appreciably. The diamond was remarkable in another respect. It was extremely transparent to the Röntgen rays, whereas highly refracting glass, used in imitation diamonds, was almost perfectly opaque to the rays. He exposed for a few seconds over a photographic plate to the X-rays the large Delhi diamond, of a rose-pink colour, weighing 31½ carats, a black diamond weighing 23 carats, and a glass imitation of the pink diamond. On development, the impression where the diamond obscured the rays was found to be strong, showing that most rays passed though, while the glass was practically opaque. By this means imitation diamonds could readily be distinguished from true gems.

We are indebted to the *Times* for the text from which the above condensation has been prepared.

TRADE NOTICES AND NOVELTIES

Lundberg Specialities.

The accompanying diagrams (Figs. 1 and 2) illustrate two useful adaptations of the "Pivot" combined tumbler switch and wall connection manufactured by A. P. Lundberg, Pioneer Electrical Works, London, N. Several other adaptations are shown in a pamphlet just issued by Mr. Lundberg. As for the

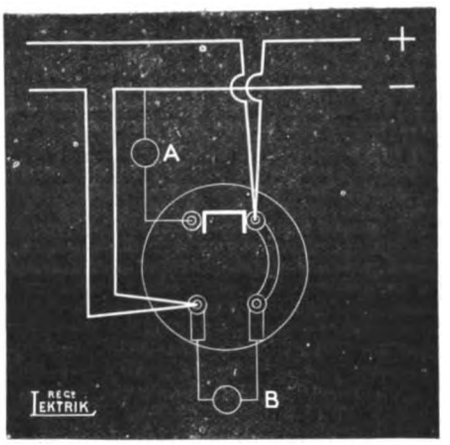

FIG. 1.—Switch and Plug controlling independent circuits.

combination itself, this has been already described in our columns. Suffice it here to say that the variable spring leverage action produces a very definite and easy movement, with both on and off positions, effectively locking the contact arm in the former. Four substantial terminals are provided, and the connecting strap may be readily removed. By the use of such

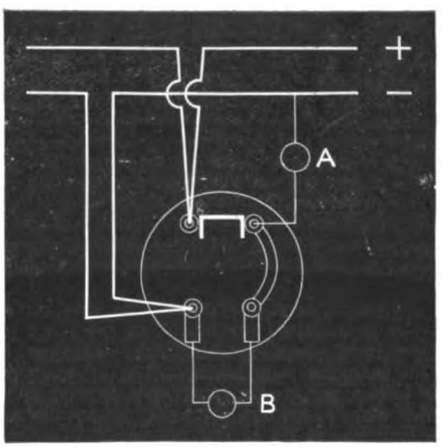

FIG. 2.—Switch controlling both plug and switch circuits.

combination fittings considerable economy may be effected both in material and labour, quite apart from the convenience obtained. The "Pivot Intermediate" switch is another useful type, of which we have particulars from the same source. This switch is especially suitable for corridor and staircase lighting, also for drawing, dining, and bed room lights,

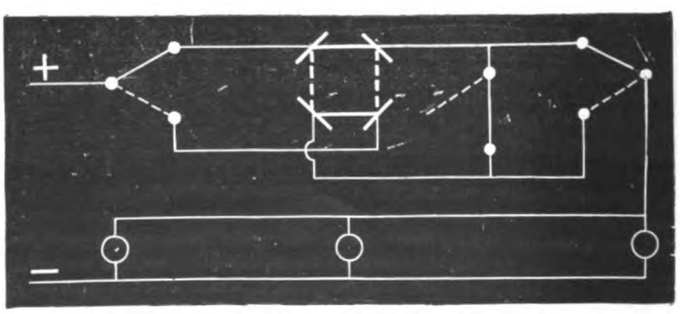

FIG. 3.—Master Switch in combination with "Pivot Intermediate" Switches.

enabling such to be controlled from any number of positions desired. The diagram (Fig. 3) illustrates one method of wiring it up in combination with "Pivot" two-way switches. It will be noticed that all the switches are arranged on one pole only, consequently safe working is ensured. The master switch may be introduced as shown anywhere in the circuit, so that,

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when turned on during legitimate hours of lighting, no movement of any of the other switches will extinguish the lamps and cause annoyance to the users. Take a typical case as used in flats. Up to 11 p.m. it is desired that the corridor and staircase lights shall be illuminated continuously, and that no movement of any of the other switches shall extinguish them. After that hour the switch knob is thrown over on to one of the other contacts to extinguish the lamps. These may be again illuminated or extinguished by any of the other switches in circuit, during the night, as desired. Following are suggestions for the application of the "Pivot Intermediate" switch: (1) a long corridor may have a number of doors opening into it, and it is desirable to control the lamps illuminating it from either end or intermediate door; (2) in a house of several floors it is undoubtedly an advantage to be able to turn off the staircase lights from either ground, top, or intermediate floor or landing; (3) a large room with, say, three or four doors may have the lamps illuminating it similarly controlled from any door or other desirable position.

Small Rotary Converter Set.

We understand that the Rhodes Electrical Manufacturing Company, Limited, Bradford, are standardising a small rotary converter set suitable for charging motorcar accumulators. It consists of a double-wound machine suitable for 110 or 230 volts at one end and 4 to 25 volts at the other, this latter voltage being regulated by the rocking of the brushes only. Where electric power is available the set is used as a rotary converter to convert to low voltage for cell charging, and in this case requires no foundation whatever, but will stow away in a corner or under a bench, or will hang from the ceiling. Where electric power is not installed, the machine is belted to the line shaft, and when driven in this manner will supply the necessary high-tension current for the pit inspection lamps, and also the low voltage necessary for accumulator charging. Where electric power is installed, it can be used to drive any small machine tool using not more than ½ h.p. at the same time as it is being used for charging purposes. Twelve cells can be charged at once, and the set is found to be very useful in automobile garages. There should be an increasing demand for this machine; it seems to us to be just the thing that is wanted.

Catalogues, etc, Received.

E.P.S. Batteries.—From the Electrical Power Storage Company, Limited, 4, Great Winchester-street, E.C., we have a copy of a neat little pamphlet which they have just brought out giving illustrations and particulars of a few central-station batteries they have supplied. Some of these batteries are of very large capacity, and the numerous repeat orders obtained by the firm tell a satisfactory tale of their reliability in working. It is worthy of note that the Liverpool Corporation have no less than 13 E P.S. batteries installed. At the General Post Office, London, a battery of 700 K type E.P.S. cells has been installed for telegraphic purposes. These cells replace 30,000 primary batteries. Similar type batteries are also in use, we gather, in the post offices at Liverpool, Manchester, Leeds, Birmingham, Glasgow, Newcastle, Cardiff, etc. The manufacturers would, therefore, seem to supply a large proportion of the orders given out by the Post Office Department for batteries, due no doubt to the proved excellence of their speciality. The firm's special motorcar and electric launch cells are dealt with in another publication.

Measuring Instruments.—The latest *brochure* from Messrs. Ferranti Limited, Hollinwood, Lancs., deals with the firm's switchboard measuring instruments in a very entertaining manner. It is excellently printed, and contains numerous illustrations of an instructive character. The reader of this paragraph is recommended to apply for a copy.

TUNBRIDGE WELLS ELECTRICITY ACCOUNTS.

The accounts of the Tunbridge Wells electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £80,949. Abstracts of the revenue account, balance-sheet, etc., are appended.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5,330	13	3
Distribution of electricity	708	17	4
Attending and repairs to public lamps	510	5	3
Repairs to buildings	12	0	10
Rents, rates, taxes, and insurance	401	17	11
Management expenses, salaries, etc.	1,328	5	0
Special charges, etc.	78	5	1
	8,370	4	8
Balance to revenue account	5,413	14	11
	£13,783	19	7

Cr. Income.	£	s.	d.
By sale of current to private consumers by meter	10,661	9	3
Ditto for public lighting	2,589	18	10
Rental of meters	430	18	2
Fees for tests, miscellaneous, etc.	158	8	8
	13,840	14	11
Less allowances and bad debts	56	15	4
	£13,783	19	7

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Corporation stock and redemption, etc.	80,949	7	8
Sundry creditors on revenue account	986	8	11
Profit appropriation account—surplus	4,005	13	8
	£85,941	10	3

Cr. Assets.	£	s.	d.
Amount expended for works	75,583	1	10
Discounts on stock issued	5,366	5	10
Deposit account	16	5	0
Stores on hand	275	13	1
Sundry debtors for current supplied, etc.	4,212	5	8
Cash with treasurer and in hand	487	18	10
	£85,941	10	3

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.		1,035,470
Quantity sold { Private consumers by meter	555,846	883,184
Quantity sold { Public lamps	325,338	
Quantity used on works		11,893
Total quantity accounted for		895,077
Quantity not accounted for		140,393
Maximum supply demanded (kilowatts)		620

Number of public lamps: 81 arcs, 1,236 16 c.p. incandescents.

BELFAST ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., by the Belfast Corporation electricity department for the year ending March 31, 1905. The total capital expenditure to end of past year was £259,973.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	7,255	2	5
Distribution of electricity	1,261	1	4
Attending and repairs to public lamps	79	0	5
Rents, rates, and taxes	525	1	5
Management expenses, salaries, etc.	1,785	11	8
Insurance	204	8	6
Special charges	157	7	9
	11,267	13	6
Amount carried to net revenue account	16,984	9	11
	£28,252	3	5

Cr. Income.	£	s.	d.
By sale of current per meter	27,427	18	10
Public lighting	184	17	6
Motor rents	488	17	1
Rent from Gas Committee, etc.	150	10	0
	£28,252	3	5

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Corporation redeemable stock	213,500	0	0
Grant from Gas Committee	32,500	0	0
Sundry creditors	4,413	19	4
Surplus accounts	12,001	14	8
	£262,415	14	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	254,163	12	9
Sundry debtors for current supplied, etc.	10,800	15	11
Stores on hand	1,741	15	8
Balance in bank	4,709	9	8
	£262,415	4	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.		2,556,742
Quantity sold { Private consumers	2,263,798	2,290,872
Quantity sold { Public lamps	27,074	
Quantity used on works, etc.		148,604
Total quantity accounted for		2,439,476
Quantity not accounted for		117,266
Number of public lamps (incandescents)		29
Maximum supply demanded (kilowatts)		

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TONBRIDGE ELECTRICITY ACCOUNTS.

From the accounts of the Tonbridge electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounts to £21,866. Appended are abstracts of the revenue account and general balance-sheet.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	856	6	5
Distribution of electricity	39	4	11
Attending and repairs to public lamps	86	19	8
Management expenses, salaries, etc.	229	0	3
Rents, rates, taxes, and insurance	104	10	2
Bad and doubtful debts	2	10	9
	1,318	12	0
Balance carried to net revenue account	603	11	9
	£1,922	3	11

Cr. Income.	£	s.	d.
By sale of current by meter	1,239	9	8
Public lighting	615	5	3
Rental of meters and other apparatus	33	5	0
Sale and repairs of apparatus	3	17	6
Miscellaneous receipts	30	6	6
	£1,922	3	11

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	19,532	15	4
Sundry creditors	352	12	4
Due to treasurer on revenue account	644	2	1
Due to treasurer on capital account	470	6	1
Electrical engineer's account	2	3	1
	£21,001	18	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works, less repaid	20,223	16	4
Sundry debtors for current supplied	561	2	1
Stores on hand	217	0	6
	£21,001	8	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		156,582
Quantity sold { Private consumers by meter 60,476 / Public lamps 47,525 }		108,001
Quantity used on works		48 581
Total quantity accounted for		156 582
Number of public lamps		59
Total maximum supply demanded (kilowatts)		69

DEVONPORT ELECTRICITY ACCOUNTS.

The accounts of the Devonport electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £94,964 (exclusive of £8,632 for depreciation). Abstracts of the revenue account, etc., are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5,176	15	4
Distribution of electricity	396	19	4
Attending and repairs to public lamps	81	18	8
Rents, rates, and taxes	295	7	1
Management expenses, salaries, etc.	972	1	0
Special charges, insurance, etc.	170	10	11
Balance, being gross profit for year	8,684	11	11
	£15,778	4	2

Cr. Income.	£	s.	d.
By sale of current, etc.	15,223	5	11
Generation—compensation and repairs	24	6	11
Distribution—meter rents, sale of fittings, etc.	462	1	11
Rents	68	9	4
	£15,778	4	2

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Mortgage debt	110,296	12	3
Floating liabilities	1,147	5	10
Reserve fund	320	0	4
	£111,762	18	5

Cr. Assets.	£	s.	d.
Capital expenditure (after depreciation)	94 964	8	8
Discounts on stock, and issue expenses	5 926	3	5
Stock redemption fund	6 352	11	1
Floating assets	4 520	15	3
	£111,763	18	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,857,740
Quantity sold { Private lighting 294,807 / Public lighting 26,742 / Traction 1,315,401 / Motors 5,296 }			1,542,246
Quantity used on works			52,858
Total quantity accounted for			1,595,104
Quantity not accounted for			162,636
Number of public lamps			18
Maximum supply demanded (kilowatts)			850

LEGAL INTELLIGENCE.

OBSTRUCTION OF CARS.

At the Wigan Police Court last week Robert Morris was charged with obstructing a Corporation car, by refusing to move his lorry. The case for the prosecution was that as the car approached the loop the driver rang the bell so that the lorry might clear the loop before the car overtook it, the road being somewhat narrow at this point. In consequence of the lorry continuing to move slowly the two vehicles came into contact.

Corroborative evidence was given by a passenger.

The defendant stated that he did not hear the bell, and that there was time for the car to pull up.

After arguments by counsel, the Bench decided that there was not sufficient evidence to convict.

At the Bradford City Police Court, R. Bracewell, the driver of a laundry van, was fined 5s. and 11s. costs for obstructing an electric car on the Manningham route.

The evidence of the car driver showed that although he rang the gong repeatedly defendant refused to leave the track, and the car was delayed seven minutes.

Defendant denied having heard the gong, and said he was riding inside the van.

In answer to the stipendiary magistrate, defendant said that when riding inside the van he could not hear people shouting in the street.

The stipendiary magistrate pointed out that if he could not hear when inside the van he could not be aware of any danger, and it was very dangerous for a driver to be boxed up in a van, unable to hear or see what was going on.

LONG-FIRM PROSECUTION.

The charge against George Webber and Richard T. Rozenberg, reported in our last week's issue, was proceeded with at the Guildhall on Monday, when the case was again adjourned.

TRAMWAY AND TELEPHONE WIRES.

In the Court of Session Lord Ardwell had before him in the Bill Chamber a note of suspension and interdict at the instance of the National Telephone Co., having their chief office at Telephone House, Victoria-embankment, London, and a district office at Royal Exchange-buildings, Glasgow, against the Falkirk and District Tramways Co., having its principal office at 37, Castle-street, Edinburgh. The complainers asked interdict against the respondents erecting poles and wires and other apparatus in connection with their electric tramways within such distance as would endanger the complainers' wires and apparatus, or interfere with or impede the telephonic communication along or by means of the same, and also from turning on electric current within such distance as would endanger the complainers' wires and apparatus. The complainers relied on certain sections of the Tramways Act of 1870, incorporated in respondents' special Act, as affording protection against interference with their telephone wires, while respondents contended that these provisions were not applicable, in respect that tramways worked on the trolley system of electric traction were not in contemplation by the Legislature when the Act of 1870 was passed, and they founded upon certain sections in their special Act and regulations made by the Board of Trade in pursuance thereof as defining the measure of protection afforded to the complainers. His Lordship, in respect of an arrangement between the parties, whereby the alterations on the complainers' wires are to be carried out by them under reservation of their claims against the respondents if liability therefor should ultimately be established, refused the note.

TRAMWAY FARES.

A test case of considerable interest was tried at Liverpool on Wednesday, when Colonel John Pilkington was summoned for non-payment of 1d. excess fare while riding on a Corporation car.

Defendant took a 1½d. ticket, but continued to travel beyond that stage, tendering the conductor an additional ½d. There are no ½d. stages on the system, and the conductor asked for 1d., which defendant refused to pay, contending that he was only travelling to a point for which the fare was 2d.

The magistrate dismissed the summons, taking the view that the regulation was only designed to prevent wilful avoidance of payment. He added that "the mere fact that the undertaking did not possess a ½d. ticket was not defendant's fault."

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COMPANIES' MEETINGS AND REPORTS

WHITECHAPEL AND BOW RAILWAY.

A special meeting of this Company was held last week for the purpose of raising fresh capital.

Mr. A. L. STRIDE presided, and announced that the proxies of the London, Tilbury, and Southend Railway Co. and of the Metropolitan District Railway, who jointly owned the line, were in favour of the increase of capital. He thereupon moved that, under the powers of the Whitechapel and Bow Railway Act, 1905, there should be created additional capital to the amount of £150,000 by the issue of 15,000 new ordinary shares of the Company of £10 each, and that the directors should be at liberty, with the consent of the London, Tilbury, and Southend Railway Co. and of the Metropolitan District Co., to attach to 6,000 of the said shares—in lieu of the rights attached to ordinary shares—a dividend in priority to the ordinary shares of the Company, at such rate not exceeding £4 per annum as the directors might determine.

Mr. GRIFFITH MURRAY seconded the resolution, which was carried unanimously.

A resolution was then passed authorising the issue of the shares at such times, on such terms, and in such manner as the directors might think advantageous to the Company.

A third resolution sanctioned the exercise by the Company of their borrowing powers to the extent of £50,000, by the creation and issue of debenture stock as the directors should think fit, and at an interest not exceeding £4 per annum.

This resolution was moved by the CHAIRMAN, seconded by Mr. J. R. HOARE, and carried unanimously.

YORKSHIRE ELECTRIC POWER.

The half-yearly report, to be submitted at the meeting of the Company on the 26th inst., states that since the last report the first two turbo-generators have been erected in the Thornhill power station, and are now working. It is expected that the third turbo-generator, which will complete the present order for generating machinery, will be installed during the autumn. The equipment for sub-stations at Thornhill, Mirfield, Gomersal, and Pudsey is practically completed and is now in use. The transmission mains referred to in the January report have been laid, and the distribution mains and service equipment necessary to connect consumers are being proceeded with. A supply of energy was given to the Mirfield Urban District Council on July 7, and to the Pudsey Corporation on Aug. 23, and the supply to other consumers is being given as their installations are ready. It is satisfactory to report that it has been possible, without serious opposition, to arrange clauses in the parliamentary Bills affecting the Company, by which the interests of the Company have been protected.

At the conclusion of the general business an extraordinary meeting will be held to consider the desirability of passing, and, if deemed expedient, to pass necessary resolutions to obtain further moneys to develop the Company, and carry the transmission mains into other districts in which a good demand for power is anticipated.

The meetings will be held in Ravensthorpe to give shareholders the opportunity to visit the power station and other works of the Company in the neighbourhood.

LANCASHIRE ELECTRIC POWER.

The tenth ordinary meeting of the Company was held at Broad Sanctuary-chambers, Westminster, on Thursday, the 31st ult., Mr. F. E. Gripper presiding.

The CHAIRMAN said he was pleased to be able to state that they were on the eve of the commencement of supply. Their main cables were practically laid to Swinton and Pendlebury and Westhoughton, and the Company would be in a position to supply those urban districts during the coming month. A provisional order had been obtained for the urban district of Tottington, and the laying of their main cable through that district and on to Bacup was well in hand, and by the end of this, or early in the coming year, it was expected that the Company would be fully working.

UNITED ELECTRIC CAR.

The report for the year ending June 30, to be submitted at the general meeting on the 21st inst., states that the works have been efficiently maintained as regards buildings and machinery, the cost of which has been charged against revenue. After paying debenture interest, amounting to £2,500, and charging £4,315. 6s. 2d. for depreciation, the profit for the year is £15,188. 18s. 9d., to which is added £2,873. 1s. 11d. brought from last year, making a total of £18,062. 0s. 8d. The directors recommend that this amount be dealt with as follows: dividend of 6 per cent., less income tax, for the year ending June 30, 1905, £12,000; carry to general reserve, £2,000; and carry forward to next year, £4,062. 0s. 8d.

NEW COMPANIES REGISTERED.

Burgess Hill and District Electric Supply Co.—Registered Aug. 29. Capital, £5,000 in £1 shares (2,000 5 per cent. non-cumulative preference). Object: to adopt an agreement with W. Simms, trading as Simms and Co., electrical engineers, of Hamilton-road, Felixstowe, and to carry on at Burgess Hill and elsewhere in Sussex the business of an electric light and power company, and that of electrical and general engineers, electricians, manufacturers of and dealers in all kinds of electrical apparatus and accessories, etc. The first directors (to number not less than four nor more than seven) are W. H. de la Tour d'Auvergne Findlay, H. Aldrich, W. B. Welch, and A. G. Davey. Registered office: Mr. Thomas Sinnock's Offices, Railway-approach, Burgess Hill, Sussex.

Kapar Para Rubber Estates Co., Limited—Capital, £50,000, in £1 shares. Object: to carry on the business of rubber and general produce planters, growers, manufacturers, and merchants, etc. Registered office: 81, Gracechurch-street, E.C.

Lancashire Rubber Co., Limited.—Registered Aug. 30. Capital, £3,000, in £1 shares. Object: to carry on the business of buyers and sellers of old and new rubber or similar substances, manufacturers of and dealers in rubber articles of all kinds, and of chemical and scientific apparatus and appliances. Registered office: 86, Cross-street, Manchester.

Liens Registered.

Fife Electric Power Co., Limited.—A trust deed, dated Aug. 15, securing £15,000 debentures, created by resolutions of June 6 and Aug. 15, 1905, has been registered. Property charged: the company's general assets, present and future, including uncalled capital, with certain collateral security. Trustees: R. E. Walker, Lieut.-General Sir Richard H. Sankey, and H. Mungall.

Scottish House-to-House Electricity Co., Limited.—Charge registered Aug. 31 for £1,600 and 6 per cent. interest to the County of London Electric Supply Co.; charged on the undertakings and all the property and assets, present and future, including the uncalled capital.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Stockport—Tenders are required for supply and laying of cables. Tenders by Sept. 14.

Oban—Tenders are required for supply and laying of feeders and mains. Tenders by Sept. 11.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Plasencia (Spain)—The municipal authorities require tenders for an electric lighting installation. Tenders by Sept. 15.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct coupled steam set.

Madrid.—The Public Works Department require tenders for the construction and working of an electric tramway in Zaragoza. Tenders by Sept. 12.

Pontypridd.—The Urban District Council invite tenders for (Section B) overhead equipment for tramways; (C) cables for tramways. Tenders by noon on Sept. 30. See advertisement.

Salford.—The Corporation invite tenders for the wiring of the new Council Schools, Devonshire-street, Broughton. Tenders to the Director of Education, Chapel-street, Salford, by 14th inst.

Bishop's Stortford.—The Urban District Council invite tenders for lighting such of the public streets as are at present lighted, for two or three years from Sept. 30. Tenders by 4 p.m. on Sept. 25.

Edinburgh.—Tenders are invited for the electric lighting installation at the mortuary buildings, High School Yards, Edinburgh, for the Lord Provost, Magistrates, and Council. Tenders by Sept. 11.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of feeder cables, conduits, and other works in connection therewith. Tenders by noon on Sept. 25. See advertisement.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10,000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Chelmsford.—The Town Council invite tenders for lighting the public streets and public clock within the borough with electricity, gas, or other illuminating power for three or five years from March 25, 1906. Tenders by Sept. 8.

Paris—The Waterworks Department of the Municipality require tenders for supply and erection of motors, pumps, and generators for the proposed waterworks at Chantilly. For particulars apply to above authority. Tenders by Oct. 12.

Ipswich.—The Guardians invite tenders for supply and erection of a dynamo and motor (to be made by Crompton and Co.), a battery booster, and alterations and additions to the main switchboard at the workhouse. Tenders by 10 a.m. on Sept. 14.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Pembroke (Ireland).—The U.D.C. invite tenders for electricity supply mains, arc lamps and pillars, house meters, and switchboard panels. Tenders to Mr. J. C. Manly, Town Hall, Ball's Bridge, Co. Dublin, by 10.30 a.m. on Sept. 22. See advertisement in last issue.

Dublin.—The Lighting Committee invite tenders for the supply of (*a*) sub station switchboards, transformers, etc.; (*b*) extra high-tension and low-tension mains. Tenders to Chairman of the Lighting Committee, 3, Cork-hill, Dublin, by Sept. 18. See advertisement in last issue.

Linlithgow (Scotland).—The Uphall and Broxburn District Lighting Committee invite tenders for the supply and erection of one suction gas-producer plant of 80 b.h.p. capacity; one 80-b.h.p. gas-engine; one 52-kw. dynamo; one automatically-reversing motor booster, two 280-ampere-hour storage batteries, switchboard, cables, meters, etc. Tenders to Mr. J. G. B. Henderson, county clerk, Linlithgow, by 12 noon on 18th inst.

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London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of 34 steel single-deck tramcar bodies; maximum traction swing bolster trucks for 34 electric cars; complete electrical equipments for 34 cars; or, alternatively, 34 steel single-deck cars, with trucks and equipments complete. Tenders by 10 a.m. on 29th inst.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2¼ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23.

RESULTS OF TENDERS.

Warrington.—The Council have accepted the tender of Johnson and Phillips for 12 months' supply of paper-insulated lead-covered cables.

Ilford.—The Urban District Council have accepted the tender of W. T. Henleys Limited, London-wall (per schedule), for supply of ·4in. and ·25in. concentric cable.

Luton.—The tender of Triumph Stoker, Limited, of 39, Victoria-street, London, S.W., has been accepted for mechanical stokers for the Corporation electricity works.

Pekin.—The tender of Bruce Peebles and Co. has been accepted for 1,500-h.p. electrical plant for the complete equipment of the railway shops of the Imperial Chinese Railway, Pekin.

Dover.—The Town Council have accepted the tender of W. Cory and Son, Mark-lane, E.C., for large Welsh coal at 16s. 11d. per ton, and small at 11s 6d., for their electricity works for 12 months.

Neath.—The Rural District Council have accepted the tender of Johnson and Phillips, Old Charlton, Kent, for low-tension cables and street-lighting for the districts of Skewen, Melincrythan, Cadoxton, and Aberdulais.

South Shields.—The Town Council have accepted the tender of W. Underwood and Bro., Hope-street and Railway-street, Dukinfield, at £1,070, for the laying of the permanent way for the service line to the car-sheds at Dean-road.

Oakeley Quarries (North Wales).—Messrs. Bruce Peebles and Co have secured the contract for supplying motors for the Oakeley Quarries, North Wales, for 2,000 h.p., ranging from 25 h.p. to 125 h.p., for hauling, compressing, winding, etc., the power to be taken from the North Wales Power and Traction Co.'s mains.

Limerick — the Technical Education Committee have received the following tenders for electric lighting of the municipal technical schools, 69 and 70, George-street, Limerick:

69 and 70, George-street.

Ampere Co., 44, Fleet-street, Dublin	£97	10	0

69, George-street.

Coates, Dublin (accepted)	35	10	0
Portley Bros., Limerick	39	0	0

70, George-street.

Coates	45	0	0
Portley Bros. (accepted)	41	0	0

Fulham.—The Borough Council have received the following tenders for the erection of a boiler-house, cable-shed, and stores at the electricity works, Townmead-road:

Borough Surveyor*	£4,000	0	0
Perry and Co.	4,656	0	0
A. Hudson and Co.	3,550	0	0
S. E. Moss and Co.	4,300	0	0
A. Lawrence and Son	4,545	0	0
H. Windsor and Co.	5,083	7	2
Higgs and Outhwaite	4,613	0	0
W. H. Hyde	3,810	0	0
W. J. Fryer and Co.	5,190	0	0
B. E. Nightingale	4,077	0	0
Leslie and Co.	4,495	0	0
F. and G. Foster	4,278	0	0

* Recommended for acceptance.

The Establishment Committee also recommend for acceptance the following tenders for the supply and delivery of steam coal to the electricity department during the year ending June 30, 1906: Charrington, Sells, Dale, and Co., 2,000 tons of Albert nuts, 11s. 11d. per ton; Crynant Colliery, Limited, 1,000 tons Crynant nuts, 14s. 4d. per ton; Cory Bros. and Co., 1,000 tons Monmouthshire washed beans, 14s. 1d. per ton.

Motor 'Buses.—The trial trip by motor 'bus to Brighton, referred to in our last week's issue, is considered satisfactory, and further runs will be made. If these prove satisfactory, there will be a regular service next year.

BUSINESS NOTES.

TRACTION.

Perth.—A special meeting of the Town Council was held in private last week upon the question of liability for the cost of heightening the cars.

Blackburn.—The Corporation tramways show a net profit of £800 on the past quarter, as compared with a loss of £400 on the corresponding three months last year.

Carshalton.—The Urban District Council have received from the British Electric Traction Co. several plans regarding street widenings, which have been referred to committee.

Doncaster.—At the meeting of the Town Council it was reported that the receipts from the Oxford-street route for a fortnight were 1s. 2d.! The service will probably be discontinued.

Manchester.—At Wednesday's meeting of the Corporation, a resolution that a scale of reduced fares for workmen be formulated with a view to relieving congested areas was formulated.

Electrical Signalling.—The installation of an electrical system of working points and signals has been adopted at Didcot, this being the first installation of the kind on the Great Western system.

Oxford.—The City Council decided on Wednesday to purchase and electrify the tramways, a surface-contact system to be used in the High-street and in the centre of the city for æsthetic reasons.

Motorcars and Westrumite.—The Automobile Club intend to have the whole of the course (over 40 miles) in the Isle of Man for the Touring Trophy Race on the 14th inst. treated with Westrumite.

Broughty Ferry.—The work of reconstruction is being rapidly pushed forward by Messrs. J. G. White and Co., and it is expected that the system will be completed by the first week in December. There is some talk of the erection of a garden city *en route*.

Newcastle.—The Corporation have decided to apply for a provisional order for an extension from Pilgrim-street to New Bridge-street. In reply to a question, the Chairman of the Tramways Committee thought the present time inopportune for the adoption of ½d. fares.

American Methods.—A new railway training school has been established at Elmira, N.Y., on distinctly practical lines. Railway telegraphy is part of the training, and in this department a switch-line enables the school to cut in on the regular dispatchers' wire on the Erie main line, allowing advanced pupils to have the practice of copying real business.

Rochdale.—The traffic receipts on the Corporation system for the week ended on Saturday are the highest yet reached, being £80 in excess of the previous week, the takings for which were the largest returned up to that date. The passengers carried numbered 13,758 more than for the previous week, the total being 194,772, and the receipts £1,083 against £1,002.

Erith.—The new cars are meeting with excellent support, the takings for the first five days being: Saturday, £71. 2s. 8d.; Sunday, £61. 5s.; Monday, £29. 4s. 9d.; Tuesday, £25. 4s. 1½d.; Wednesday, £25. 18s. There have been complaints as to the irregularity of the service, this being attributable to the narrowness of some of the roads, which will probably be widened.

Bath.—A trial trip was made last week with the motor 'buses with which the Bath Electric Tramways Co. propose to link up their system with the outlying districts of Box, Corsham, Bradford-on-Avon, etc. The Milnes-Daimler Co. have supplied the first of six 'buses. The trial proved satisfactory, and it is expected that the service will be inaugurated in a fortnight's time.

Glasgow.—An accident occurred on the Corporation system on Saturday, when a lorry and car collided. The road was narrow, with a steep incline, and greasy through showers. The lorry pulled up in front of the car, which there was not time to stop. The two drivers and several passengers were injured, and the car penetrated an advertisement hoarding and fell into a field.

Tourist Cars.—The Brighton tourist tramcars appear to have proved a profitable venture. Since July 3 6,512 passengers have been carried round the town on these cars. The fares have amounted to £312, which gives an average of 34·34d. per car mile. The tramways engineer and manager points out that the receipts from these cars are about three times the amount obtained from the remainder.

London County Council.—An important development of the London County Council tramway system has recently been entered upon by the construction of a line from New Cross to Lewisham. Such rapid progress is being made that the line is likely to be finished very shortly. It is probable that an extension will be made from Lewisham to Catford, and ultimately to Bromley and Bickley.

Ramsgate.—The secretary of the Isle of Thanet Electric Tramways and Lighting Co. has issued a notice to the shareholders stating that, in view of the recent accident at Ramsgate, the directors have decided to defer making any payment on account of the second half-year's preference dividend, usually paid on Sept. 1, until after the accounts for the company's financial year, which ends on Sept. 30, are made up.

Batley.—The contractors (Messrs. Dick, Kerr, and Co.) have pushed on so rapidly with the work of reconstruction between Batley and Dewsbury that the steam trams on the Bradford-road are to cease running in order that the reconstruction may be proceeded with. The paving has been carried on with such dispatch by the Batley Corporation workmen that they will be able to follow Messrs. Dick, Kerr, and Co. to the Batley and Birstall portion almost immediately.

Halifax.—The Board of Trade report on the Corporation tramway extension to West Vale states that there is one very steep gradient

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down Salterhebble-hill of 1 in 9·6 for a length of one furlong, and great care must be exercised in working cars down it. The report says the cars must be fitted with track brakes in addition to the ordinary brakes, and also with a special device for preventing cars from running backwards. The rails are to be kept well sanded in damp weather.

Sale.—At the meeting of the Sale Council it was decided to inform the Stretford Council, regarding the improvement of Crossford Bridge, that Sale's offer of £250 was conditional upon the preparation of a scheme for the widening of the bridge and its approaches on both the Lancashire and Cheshire sides of the river. The Sale Council, it was pointed out, was not blocking the tramway scheme in any way. The Stretford Council had written that the Manchester Corporation were desirous of pushing the scheme forward before the winter months.

Worcester.—The tramway company offer to extend the tramway along the Malvern road as far as the Brunswick Arms, on condition that the Council agree to the rails being laid on concrete and a single line of setts placed lengthwise along each side of the rails, the remainder of the paving to be of macadam; the Council undertaking to maintain the track, leaving the company responsible for the rails, etc., and offering to maintain the paving of the track for £20 per annum. The Streets Committee recommend that these terms be agreed to.

Hastings.—At the meeting of the Town Council, Councillor Harden asked the chairman of the Roads and Buildings Committee whether he was aware that the roadway on some parts of the tramway route, particularly in Silverhill and Hollington, was in a very unsatisfactory condition, and whether the committee would urge the company to expedite the reinstatement and repair where necessary. In reply, the Chairman stated that he had been over the roads on that and the previous day, and with two small exceptions, which were being attended to, the roads in that district were the best in the borough.

Preston.—For the year ending March 31 last the Corporation cars showed a net profit of £1,575. The receipts were £22,922 and the working expenses £12,030, while interest and sinking-fund charges absorbed £5,130 and £4,206 respectively. The balance of £1,575 has been carried to reserve. The earnings work out at an average of 10·64d. per car mile. The actual working expenses, exclusive of interest and sinking-fund charges, work out at 5·59d. per car mile. The earnings of all the routes appear to be satisfactory with the exception of Ribbleton-lane, the earnings of which were only 5·79d. per car mile.

Hanley.—At the meeting of the Town Council the following minute of the Tramways Committee was passed: "That the plan showing proposed double line of tramway joining up the Broad-street, Victoria-square, Shelton Church, and Howard-place loops or passing places be approved, and that the suggestion of the borough surveyor with regard to that part of the line between the Broad-street and Victoria-square loops, as laid before this committee on July 26, 1904, and confirmed by the Council on Aug. 30, 1904, be carried out." The Board of Trade have signified their approval, and the company have entered into a contract for the work.

Rhondda.—Some time ago the Board of Trade Commissioner conducted an inquiry in reference to the Council's tramway scheme. The Council have spent about £6,000 in the endeavour to get a provisional order, and at a public meeting of ratepayers a resolution was almost unanimously passed backing up the Council in its endeavour to provide the Rhonddas with a complete system of tramways. To this enterprising proposal there has been persistent opposition, and the report of the Commissioner has been awaited with considerable concern. This report has just come to hand, but for the moment its contents have not been disclosed. A meeting of the Council is to be held to-day, when the report will be made public.

Colchester.—The accounts for the 12 months ending July 27 show that there had been expended on traffic expenses £3,414. 16s., for general expenses £1,134. 10s. 2d., for general repairs and maintenance £964. 9s. 2d., for power expenses (cost being put at 1½d. per Board of Trade unit) £2,664. 5s. 10d.—total operating expenses, £8,178. 1s. 2d. The income included £11,270. 5s. 9d. from ordinary passengers, £33. 8s. from special cars, £424. 4s. by advertisements, £42. 12s. 6d. carriage of luggage, £101. 3s. 2d. interest on surplus revenue, and £26. 0s. 6d. rent. A gross profit of £3,719. 12s. 9d. has been carried to the revenue account, but allowance has been made for seven months' capital charges only.

Belfast.—At last week's meeting of the Corporation the city accountant submitted a statement showing that the total capital expenditure on the tramway undertaking was £521,116. 6s. It was decided to agree to an extension of the contract with Mr. J. W. Courtenay for the advertising on the cars for an annual payment of £3,000. The whole of the system is expected to be opened to the public by the middle of November. The Tramways Committee are to be approached by the Guardians, who have received an intimation from the National Telephone Co. that they cannot continue the telephone service to the workhouse because of the refusal of the Tramways Committee to allow the necessary cable to be carried across the street.

Derby.—The Walbrook-road extension of the Corporation electric tramway system was opened on Tuesday afternoon. Prior to the route being opened to the public it was officially inspected by the Board of Trade inspector, Major Pringle, who found everything in satisfactory order. Major Pringle travelled over the route on a special car, accompanied by Alderman R. W. Sprigg (chairman of the Tramways Committee), Councillors J. W. Gandy, J.P., C. Boam, and A. Simpson, the borough surveyor (Mr. John Ward), the electrical engineer (Mr. T. P. Wilmshurst), the manager of the tramways (Mr. F. Harding), and the assistant borough surveyor (Mr. C. A. Clews). The extension is about half a mile in length, and runs from the bottom of Dairy House-road to the Cavendish Hotel, thus linking the Pear Tree and Upper Dale routes.

Dover.—A trial trip was run over the new River tramline last week. There was no trouble in either the ascent or descent of the inclines on the route. The trial was for the testing of the equipment, and the athletic ground was as far as the car could travel, the ballasting and pitchering, as well as the electric equipment, being as yet incomplete beyond that point. There is a double line of rails laid all the way, but only one line was cleared for that run, there being as yet a little more work to be done on the surface of the track, both on Crabble-hill and down the approach to the Lower-road. The overhead wires are all up, but the bonding of the rails is still in progress. Most of the ballasting and pitchering between the rails has yet to be done on that section, and a few lengths of rails at the terminus as yet want the concrete base. The work on this section is now being pushed on with a view to an early opening for traffic. The Corporation have purchased four additional cars for the extension.

Motorcar Commission.—A Royal Commission on motorcars has been appointed, consisting of Viscount Selby (chairman), the Marquess of Winchester, Sir David Harrel, Sir W. B. Forwood (chairman of the Lancashire Quarter Sessions), Mr. Edward Richard Henry (Commissioner of Metropolitan Police), Mr. Wm. John Mure, and Mr. Horace Cecil Monro (one of the assistant secretaries of the Local Government Board). The Commissioners are instructed to inquire and report as to (1) the working of the Motorcar Acts, 1896 and 1903, and of the regulations under them; (2) the law and practice in relation to motorcars in the principal foreign countries; (3) what amendments, if any, should be made in the Motorcar Acts and the regulations under them; (4) the injury to the roads alleged to be caused by motorcars; and (5) whether any, and, if so, what, additional charges should be imposed in respect of motorcars, and how any money thus raised should be applied. Full power is granted to the Commissioners to call evidence from any quarter whence it is obtainable, to examine books and documents, and to personally inspect whatever places they may deem advisable. They are instructed to report "with as little delay as possible." Captain Charles Clive Bigham is appointed secretary to the Commission.

Penmaenmawr.—At a meeting of the Urban District Council a proposition was moved that a public meeting be called to consider whether an electric railway should be made to the top of the Green Gorge, 1,200ft. above the sea. The mountain lands to which such a line would give access were, said the councillor who moved the resolution, the one asset of Penmaenmawr, and they had never been properly exploited. Although the Council had almost reached the limit of their borrowing powers, in five years loans would be paid off which were now a considerable burden, and they might, perhaps, get from the local landowners and others loans without interest with which to make the line, such loans to be repaid at the end of five years, when the Council would be in a position to borrow the money. A 50-h.p. engine would generate current sufficient to work the line during the day and light the fine new promenade at night, and they had a convenient site for the power-house adjoining the railway station. The chairman expressed the opinion that the line suggested was the one thing needed in Penmaenmawr. The resolution was carried on the understanding that the committee would draw up a rough idea of the cost, route, etc., for presentation to the public meeting, incurring, however, only a small expense in connection with these preliminaries.

Heywood.—As the result of a lengthy conference between representatives of the Heywood and Rochdale Tramways Committees, last week terms were agreed upon for working the lines in Heywood, the arrangement being subject to the confirmation of the respective authorities. Heywood will pay to Rochdale 4½d. per car mile run as working expenses. Receipts earned in Heywood borough will be handed over to Heywood, and those earned in Rochdale will be kept by the Rochdale authority. The chief point of contention has been in regard to the division of the 3d. through fare. It was originally proposed that 2d. of this should come to Rochdale and the remaining 1d. be paid to Heywood. To this the Heywood representatives offered strong opposition on the ground that the distance between the Rochdale boundary and the Heywood Market-place is three furlongs over a mile, which is usually regarded as a 1d. stage. After a very lengthy discussion the Rochdale representatives conceded the point and agreed that the division of the through fare should be on the basis of car mileage run in each district. Bury had agreed to a joint sub-committee to decide upon the details of the service to be run, but Rochdale desired, for the first six months after opening, an absolutely free hand in working the section, and to this Heywood consented. The delegates propose that the agreement shall be for two years. The reconstruction of the track in Heywood is proceeding as rapidly as possible, and it is hoped to have the whole of it, from Heap Bridge to the Rochdale boundary, completed in November. No cars will run before then, as the Heywood electricity station will not be ready to supply current until after the whole of the track is finished.

Llandudno.—The extension of the powers of the Llandudno and Colwyn Bay Electric Railway Co. terminated on Aug. 31, and the company are negotiating for a further six months. The Urban District Council instructed a committee to consider the company's application for consent, and at the meeting of the Council last week the committee recommended the Council to support the application by the company, on condition that the company deposited £1,000 with the Council's bankers on or before Sept. 14, such sum to be refunded to the company within six months on the production to the Council of two certificates, one from the Board of Trade to the effect that the whole of the work necessary to complete the undertaking between the promenade at Rhos-on-Sea and the corner of Mostyn-street and Gloddaeth-street, Llandudno, had been carried out to the satisfaction of the Board; and the second, that of the surveyor to the Council, to the effect that the terms of the existing agreement, so far as they related to the construction of the light railway between the points stated, had been duly observed. Should these certificates not be forthcoming within the six months, then the £1,000 would be

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forfeited to the Council. In the event of these terms not being complied with on or before the 14th inst., the committee recommended that an objection to any extension be lodged with the Board of Trade. It was ultimately decided that the deposit of £1,000 should be returned to the company on satisfactory proof that £9,000 had been expended between Rhos-promenade and Gloddaeth-street. If the two certificates referred to are not forthcoming at the end of the six months, all rails, plant, etc., in the streets of the town are to be the absolute property of the Council. The surveyor reported that the rails and sleepers had been laid over 2½ miles.

Inquest.—At the London Hospital Mr. Baxter held an inquiry concerning the death of John Thomas Evans, aged 37 years, a bricklayer, who died from shock and severe burns received at the electrical sub-station, Whitechapel, in connection with the Underground Railway. It appears that on the day in question the men entered the high-tension chamber for the purpose of removing some iron floor plates, having previously taken some away two days before. They had lifted the plate from the ground when there was a loud report followed by a flash like lightning and the men were at once enveloped in flames. At the time it happened the electrician and the chief operator were talking together at the station door. In the course of their evidence they both said they did not see the men go into the tension chamber, neither had they any right to do so without permission. At the time of the occurrence half the chamber would be alive and the other half dead. The iron plate must have touched the feeder switch to make the electrical circuit. Henry Tuppin, the foreman, said he gave the orders for the men to fetch the plates. He was not aware that it was necessary to obtain permission to enter the room, neither was he aware of any special danger. He had never received any special instructions, and knew nothing about electricity. After further evidence the coroner, in summing up, remarked that it certainly was not right that men should be allowed to go into a place surrounded with all manner of dangers. The whole thing seemed carried on with great carelessness, and there were not sufficient precautions taken to prevent accidents. He thought the tension chamber ought to be kept locked, and notices posted at the entrance of the station warning people of the danger. It was a new system of working, and no doubt better precautions would be taken in the future. The jury expressed concurrence with the coroner's observations, and added that there had been negligence in the matter. In returning a verdict of accidental death, they added that sufficient care had not been taken to prevent the men entering the chamber, and they desired the coroner to draw the attention of the directors to the matter to prevent similar accidents.

LIGHTING AND GENERAL.

Newquay.—A light and power company has been registered and a site for the generating station acquired.

Hayward's Heath.—The local electric supply company has been asked by the Urban District Council to submit terms for electric lighting.

Liversedge.—The Urban District Council have decided to canvass the inhabitants with a view to ascertaining the probable number of lighting customers.

Chelsea Electric Supply Co.—The directors have declared an interim dividend on the ordinary shares for the half-year to June 30 of 2s. 3d. per share, or at the rate of 4½ per cent. per annum.

Newcastle.—The Tramway Committee having been allowed to amend their offer of £15 10s. to £11 per lamp for lighting certain streets, the gas company are to have a similar option.

Hammersmith.—The Borough Council has given notice that in future the price of electricity for lighting purposes to the residents of the borough will be reduced to a uniform rate of 3d. per unit.

Telegraphic Communication with Japan.—The Great Northern Telegraph Co. notifies that traffic with Japan is subject to delay, owing to interruption of the cables between Shanghai and Nagasaki.

London Gazette.—A receiving order has been made out on debtor's petition in the estate of William Jefferson, electrical engineer, carrying on business as Jefferson and Co. at 69, Skinnergate, Darlington.

Barnsley.—The Town Council have decided to make application to the Local Government Board for sanction to borrow the sum of £3,000 for the extension of mains and services and the purchase of meters.

South Metropolitan Electric Light and Power Co.—The warrants for the payment of the dividend on the 7 per cent. cumulative preference shares payable on the Aug. 31 have been posted.

Bridgend.—The District Council, on the recommendation of the Lighting Committee, have written to the South Wales Electrical Power Co. with regard to the fluctuations in the public lighting of the town.

Hove.—The suburb of Aldrington last week had an electrical supply inaugurated, the energy being supplied from the Brighton Corporation's new power-house, while the Hove Corporation undertakes the distribution.

Removal.—The Industrial Engineering Co., of Newton Ironworks, Hyde, manufacturers of electric dynamos, motors, gas-producer plants, and pneumatic tools, have removed their head offices to 12, Exchange-street, Manchester.

Ormskirk.—The Urban District Council propose to lease their prospective electricity undertaking, for which they have applied for sanction to a loan of £25,000, to the National Electric Construction Co., but the Board of Trade refuse their consent. The Board intimate that the Council should seek further parliamentary powers.

Turbines.—Following upon the electrification of various spinning and weaving mills in Lancashire, it is announced that turbines are to be tried in certain new factories in course of erection. The Kearsley Spinning Company have decided to place engines of the turbine type in the large mill they are building near Bolton, which is to accommodate close upon 100,000 spindles.

Horsham.—From the accounts of the Urban District Council's undertaking for the year ending March 31 we observe that the receipts amounted to £2,397 and the working expenses to £1,379, showing a balance of £1,018. Interest and sinking fund charges about £779 and £564 respectively, so that there is a slight deficiency. The figures for supply, however, evince a decided upward tendency.

Eastbourne.—The Corporation intend to have their pound of flesh—*i.e.*, the £10 they have agreed to contribute to the Olympia Electrical Exhibition is not to be treated as a donation, but is to be met by an equivalent in ticket. Apparently the Government have refused any payment for telephone wayleaves, and the Association of Municipal Corporations is to be communicated with in view of united action.

New Premises.—Messrs. W. F. Stanley and Co., 4 and 5, Great Turnstile, Holborn, notify that they have extended their business by taking additional premises at 286, High Holborn, abutting on their Great Turnstile works. They have transferred their showrooms and sale branch of surveying, drawing, mathematical, and optical instruments to the new address, where business will be conducted between 9 a.m. and 7 p.m. (Saturdays, 9 a.m. to 2.30 p.m.). Export and country orders should be sent to 4 and 5, Great Turnstile, as before.

Preston.—At the meeting of the Town Council the chairman of the Streets Committee moved the adoption of the committee's recommendation that gas be substituted for electricity in the public streets. He stated that, as against the £825 per annum for electricity, the cost for gas would be less than £400 a year. Councillor Andrew complained that no intimation of this proposal had been made to the sub committee of the Tramways Committee, who had sanctioned a scheme for the electric lighting of the power station and the destructor buildings, and eventually it was agreed to refer the matter to a joint meeting of the sub-committees of the Tramways and Streets Committees.

Bermondsey.—At Tuesday's meeting of the Borough Council the electric estimates for the year ending March 31 next were adopted. Generation charges are fixed at £6,112, or ·73d. per unit sold, as against £4,032 spent in the year ending March 31 last; distribution, rates and taxes, management, salaries, establishment charges, etc., £2,538 (3d. per unit sold), as against £1,182 in the last financial year; interest and instalment of loans £3,976, as against £3,164; and other charges a total of £13,906, as against £10,875. The receipts are estimated at £16,203, as against £12,015; the surplus at £2,302. As from Oct. 1 the charge for power purposes will be reduced to 1½d. per unit for the first four hours' average daily use of the maximum demand and ¾d. after; for lighting 6d. per unit the first hour and 2d. after, flat rate 4½d.; and the committee express the hope that they will be able to make a rebate of ½d. per unit on the street-lighting. The units generated in July, 1905, were 135,500, as against 55,054 in 1904. The London County Council have agreed to advance £6,796 for extensions in lieu of the £7,277 applied for.

Stock Exchange.—The committee has appointed the 13th inst. as a special settling day for Durham Collieries Electric Power Co.'s 85,102 6 per cent. cumulative preference and participating shares of £1 each, fully paid, Nos. 1 to 85,102; London United Tramways (1901) further issue of £300,000 4 per cent. first mortgage debenture stock. The committee has ordered the following securities to be quoted in the official list: London United Tramways (1901) further issue of £300,000 4 per cent. first mortgage debenture stock; River Plate Electricity Co.'s 119,691 ordinary shares of £1 each, fully paid, Nos. 1 to 119,657 and 120,521 to 120,507. 100,000 6 per cent. non-cumulative preference shares of £1 each, fully paid, Nos. 1 to 100,000, and £194,684 5 per cent. debenture stock; Anglo-Portuguese Telephone Co.'s £50,000 5 per cent. first mortgage debenture stock; Kalgoorlie Electric Power Co.'s £100,000 5 per cent. A debenture stock, and £100,000 6 per cent. B debenture stock; Rosario Electric Co.'s 12,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 12,000, and 8,000 6 per cent. cumulative preference shares of £5 each, £4 paid, Nos. 12,001 to 20,000.

St. Annes.—At the meeting of the Urban District Council the electrical engineer made the following report for July: Units sold during July, 55,855; units sold to July 31, 1905 175,243; equivalent to 8-c.p. lamps connected, 18,908; units sold per 8 c.p. lamps connected, 2·54; maximum load—lighting 200 kw., traction 330 kw.; total number of consumers, 361. Six applications have been received for the equivalent of 286 8-c.p. lamps. Arrangements have been made with the tramway company for use of feeder cable and installation of the balancer in the company's sub-station, and an annual rent of £50 has been agreed upon. It was reported that the tramways company were exceeding the agreed maximum demand of 400 amperes. The Council decided not to take any steps in this connection during the present busy season. It was decided to reply to complaints as to emission of smoke from the electricity works that all precautions for minimising the smoke had been taken. A letter was read from residents in Queen's-road asking for street lamps to be erected there. It was resolved that the matter be referred to the Electric Lighting Sub-Committee for their consideration. The question of charging a reduced price of 4d. per unit for public elementary schools was considered, when it was resolved that the price remain at 5½d. as heretofore. The electrical engineer was instructed to attend in Wolverhampton to witness the testing of the balancer at the Electric Construction Co.'s works. The district auditor having disallowed the expenses of the electrical engineer for attending the conference of the Incorporated Municipal Electrical Association, it was decided to make strong representations to the Local Government Board on the importance of local authorities sending delegates to such conferences.

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Llandrindod Electric Light Co. — Mr. Justice Lawrence has extended the time during which the registration of certain debentures may take place, the delay in registration having occurred through inadvertence.

"Ebonestos."—Messrs. B. Weaver and Co. advise us that on and after Sept. 1, 1905, this firm will trade as "the Ebonestos Manufacturing Co.," 22, Rosoman-street, London, E.C. The personnel of the firm will not in any way be altered.

New Offices.—Messrs. Balcke and Co., specialists in water cooling plant, of 27, Clement's-lane, London, have opened new offices at Newcastle and Glasgow, and have appointed Mr. J. E. Weyman their sole representative for the North of England and Scotland.

Swansea.—The contract for the work necessary to provide intercommunication between the municipal and National telephones at Swansea has to be completed in 11 weeks, and it is confidently expected that the long-desired intercommunication will be effected by that time.

Scunthorpe.—At the Urban District Council's meeting, plans and specifications for the electric light undertaking were approved. It was resolved to submit them to the Local Government Board for approval and apply for powers to borrow £4,500 for such purposes, the loan to be payable in 40 years.

South Shields.—The County of Durham Electrical Power Distribution Co. made an offer to the Corporation to supply current at ·45d. per unit, plus a fixed annual charge per kilowatt, and take over the Corporation's generating station and equipment at a substantial rental. The offer has been declined.

Hornsea (Yorks.).—At the meeting of the Urban District Council a letter was read from the Post Office in regard to telephone service, offering a £5 rate on 40 subscribers being obtained, and a £7. 10s. rate for a less number. The town has 3,000 inhabitants, and is in proximity to Hull. It was decided to accept the offer.

Cardiff.—Telephonic intercommunication between the two local telephone systems will be provided as soon as the necessary apparatus can be erected. As soon as intercommunication can be effected without causing delay in Cardiff district, subscribers to the Post Office and National Telephone services will receive notification.

Windsor.—At the last meeting of the Board of Guardians, the clerk reported that the plans with regard to the electric lighting scheme at Sunninghill had been received by him. A letter from a committee at Sunninghill asking for permission to erect the necessary standards for gas lamps was held over for the surveyor's report.

Eastern Telegraph Co.—The company notifies the opening of a telegraph station at Exchange-buildings, Quayside, Newcastle-on-Tyne, for the direct transmission of telegrams with all parts of Australia, New Zealand, China, Japan, Straits Settlements, Dutch Indies, Philippines, India, the Red Sea, Africa, the Mediterranean, Greece, Turkey, Spain, Portugal, and South America.

B.T.H. Lamps.—The British Thomson-Houston Co. will hereafter make no distinction in price as between their high-voltage and low-voltage incandescent lamps. Heretofore a distinction has been generally made against the high-voltage lamp in this respect, and this has not infrequently led to complaints from consumers when the supply has been changed over from low voltage to high voltage.

Bootle.—The following new scale, giving a reduction of charges has been adopted by the Corporation: For electric energy supplied for lighting, a flat rate of 3½d. for each unit used. Consumers at their own request will be charged on the demand indicator system as heretofore, at the rates of 6d. and 1½d. per unit. For power, heating, etc., 2d. for each unit to 500 units a quarter, and 1d. for each unit in excess of 500 units per quarter.

Torquay.—At the meeting of the Town Council on Tuesday, further consideration was given to the report of the Electricity Committee recommending that the generating station should be extended as advised by Mr. Waller, the consulting engineer, to provide additional energy for lighting, and also for the tramway system under construction by the Dolter Co., the total cost of the extensions being estimated at £9,500. After some discussion the report was adopted.

South African Work.—We gather from the *British South African Export Gazette* that an electric light installation for Vryheid is under consideration. The Natal Government propose to spend £36,000 on new electrical equipment (power, lighting, and cranes) for the Bluff. Owing to the wreck of the "Clan Munroe," fresh orders, it is stated, will have to be given out for the machinery for the power-house of the Johannesburg electric tramways. Electrical traction is to be installed at the Rietfontein "B" gold mine.

Chertsey.—The Rural District Council has received copies of resolutions from the Parish Councils of Windlesham and Chobham objecting to the application of Messrs. Foote and Milne for an electric lighting provisional order. The clerk also read a letter from the company, in the course of which it was stated that they had given up the idea of overhead wires running alongthe public roads, and that, if requisitioned, they would be bound to lay mains for a general supply anywhere within the area. This meets the chief objection of the two above Councils.

Mynyddislwyn.—At the monthly meeting of the Council a notice with regard to an application for statutory powers by a private company to supply electricity in the Rhymney Valley was discussed. Councillor D. Williams said that the Council had had expert opinion as to the advisability of the Council applying for a provisional order for themselves, and he thought, seeing that they had gone so far with the matter, they ought to go on with it and not allow themselves to be superseded by a company. Eventually the matter was deferred for further consideration.

Seaton.—At the last meeting of the Urban District Council, Mr. W. Purvis, engineer, of Exeter, appeared before the Council and said he intended to apply for a provisional order for the installation of electric light in Seaton. He asked the Council whether they would join in some draft agreement. The Chairman said they would take some time to consider the matter. He did not suppose they wished to say at once that they would have nothing to do with it, or that they would support the scheme. Mr. Purvis pointed out that any members of the Council who were gas shareholders could not speak or vote in the matter. It was stated that all the members of the Council were gas shareholders. This is hardly a case, however, in which silence gives consent.

Ellesmere Port.—At the monthly meeting of the Urban District Council the erection of telephone poles in the port was discussed. It was explained that the company would, as far as possible, fix no posts in the streets. In a few cases it was a necessity. In Station-road there was no difficulty. In Queen-street they must fix poles along the street, but these would be square and somewhat ornamental. Unless that privilege was granted it would be an impossibility to give the telephone service. The length of the poles would make it impossible to get them through some of the passages, and lifting them over the houses meant much expense, and sometimes damage. There were too many wires to fix them to the chimneys. It was agreed to help the company wherever possible, and permission was given to erect the poles along Queen-street.

Wembley.—At a recent special meeting of the Urban District Council it was resolved that a special committee be appointed to consider and report (1) as to the application of the North Metropolitan Electrical Power Distribution Co. and the Mutual Electricity Co. for provisional orders authorising them to supply electricity within the urban district of Wembley; (2) whether it is advisable to apply for a provisional order and work the undertaking themselves, or enter into any arrangement for the same to be taken over by a company; (3) if necessary, to inquire into and report upon the terms which either company or other companies are prepared to take over the order from the Wembley Urban District Council and provide and distribute electricity; and (4) generally, as to the proposal to provide the district with electric lighting.

French Cable Stations in Venezuela Closed.—It is reported from Caracas that, in consequence of the judgment of the Federal Court delivered on Aug. 4 confirming the dissolution of the contract with the French Cable Co., the Government ordered the company to close all its stations on the coast from the 5th inst. The cable can now be worked only between La Guayra and New York. Communication with the interior will be maintained by the National Telegraph at the rate of one bolivar a word. The decision is provisional pending the arrival of M. Bosquet, the cable administrator, who is expected on the 27th inst. M. Brun, the company's representative, has asked without avail for the postponement of the closing of the stations until M. Bosquet's arrival. He has accordingly communicated with the French Government and with the Legation here.

Shrewsbury.—At the meeting of the Town Council the Lighting Committee reported that the number of units of electric current sold in the March quarter was 118,801, an increase of 590 on the corresponding quarter of last year; and in the June quarter the sale was 61,732 units, an increase of 6,671, equal to 12·1 per cent. The alterations and extensions sanctioned by the Council, for which tenders had been accepted, were well in hand. The new boiler and the works in connection with the fixing of the covered tanks were completed, and the other work was being pushed on with all speed. The committee had for some time had under consideration the desirability of securing a larger day load, and with this object in view had considerably reduced the charge for electricity for motive power, and in this way they hoped to have a considerable increase in the number of power consumers. The report was adopted.

Hanley.—The Electric Lighting Committee learn that the Fenton Urban District Council have come to the conclusion that it would not be a profitable undertaking on their part to go to the expense of laying down mains and cables for the purpose of electricity in bulk being supplied for distribution in their district. It was decided that Mr. C. H. Yeaman be authorised to lay mains to enable electrical energy to be supplied to Cauldon-road and Wellington schools. The terms for supplying the new post office with electricity have been referred to a sub committee. At the same meeting the electrical engineer reported that he had found, upon examining some of the old solid mains, that the wood troughing had perished, and that as such material could not be expected to have a long life where laid in made-up ground, he recommended that in future mains be laid solid in earthenware troughing, and that for spare ways insulating pipes be laid when the ground is open to meet future needs.

Burslem.—The Town Council have recently completed the erection of electricity and refuse destructor works, at a cost of between £30,000 and £40,000. From these works the Corporation, under an arrangement with the Tunstall Urban District Council, propose to supply electric current for lighting power in the Tunstall district as well as in their own borough. On Tuesday afternoon the dual works were formally opened by Mr. Robert Heath, high sheriff of the county. The members of the Town Council, Tunstall District Council, Wolstanton District Council (a portion of whose area is also to be lighted from the electricity works), and a number of invited guests assembled at the town hall and proceeded to the works, which were formally declared open. Mr. Ashton Bremner, the borough electrical engineer, having given a short description of the works, the party returned to the town hall, where luncheon was served, and a number of congratulatory and complimentary speeches were made.

Wrexham.—At the last meeting of the Electricity Supply Committee the borough electrical engineer reported as follows: Total consumption in units for July, 1905, 32,556; July, 1904, 29,143. Total

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number of consumers July, 1905, 186; July, 1904, 138. The following statement of cost of extension scheme was laid before the committee: Amount included in loan of £5,600 for extension of cables, being the estimated cost of the original scheme, £5,514. Cost of extension work to date: on works included in revised scheme, and on works in addition to above (Norman-road, Lord-street, etc.), £3,583. Amount raised in excess of sum expended, £1,931. Expenditure to date below revised estimate, £1,111. A sum of £814 will be available for connection of future consumers on the route of extensions. The borough electrical engineer is to ascertain the number of gas lamps between points where incandescent lamps have been placed, and report as to the cost of providing means of street lamp lighting with electricity throughout.

PROVISIONAL PATENTS, 1905

AUG. 28.

17377. Improvements in stopping tramway motor and like road vehicles. William Henry Steep and Charles Robert Everson, 4, South-street, Finsbury, London.

17380. Improvements in automatic telephone exchanges. Charles Mark Jacobs and Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17402. Improvements in and relating to electric cells or galvanic elements and to switching devices for controlling the connections of the same. Heinrich Stern and Gustav Engisch, Thanet House, Temple Bar, London. (Complete specification.)

AUG. 29.

17433. Improvements in fittings and accessories pertaining to electrical incandescence lamps and the like. Walter Reginald Lambert, Birkbeck Bank-building, High Holborn, London. (Complete specification.)

17447. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17468. Improvements in alternating-current electromotors. Albert Henry Midgley and Benjamin Reed, Norfolk House, Norfolk-street, Strand, London.

17473. Improvements relating to electric lamp holders. James Paterson, 18, Southampton-buildings, Chancery-lane, London.

17495. An improved alternating-current commutator machine. Emil Korrodi, 6, Lord-street, Liverpool.

AUG. 30.

17521. Improvements in electrically-driven grinding attachment for metal-turning lathes. Henry Humphreys, William Humphreys, and Albert Humphreys, Horsedge Electric Works, Oldham, Lancashire.

17531. Improvements in polarised electromagnets. William Drury, Prince's road, Teddington, Middlesex.

17537. Improvements in telephone spring jacks. William Aitken, care of British Insulated and Helsby Cables, Limited, Edge-lane, Liverpool.

AUG. 31.

17572. Improvements in and relating to car brakes. William Sears Washburn, Old South-building, Boston, Massachusetts, United States. (Complete specification.)

17624. Improvements in automatic signalling and train-controlling systems. Henry MacDavenport, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 8, 1904, being date of application in United States). (Complete specification.)

17643. Improvements in electrical tractors. Léon Gerard, 4, South-street, Finsbury, London.

17653. Improvements in dielectric separators. Alfred Julius Boult, 111, Hatton-garden, London. (Henry Moore Sutton, Walter Livingston Steele, and Edwin Goodwin Steele, United States.) (Complete specification.)

SEPT. 1.

17674. Accumulator. Henry Warren and Gustave Busschots, 131, St. Domingo-road, Liverpool.

17679. Improvements in connecting wires to binding posts in electric batteries. William Mills, 77, Colemore-row, Birmingham. (Complete specification.)

17699. Improvements in or relating to electromagnetic switches or other electromagnetic mechanism. Michael Bird Field and Ferranti Limited, 111, Hatton-garden, London.

17717. Improvements in refining or purifying indiarubber, guttapercha, balata, and the like. Hubert Price, 4, South street, Finsbury, London.

17720. Improvements in the electrolytic production of copper wire strip or the like. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

17722. Improvements in sound transmitters. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (Submarine Signal Company, United States.) (Complete specification.)

17731. Improvements in or relating to the means for automatically operating the points or junctions and switches of tramways for the cars or vehicles travelling thereon. Frederick William Constantine, 8, Quality-court, Chancery-lane, London.

17737. Improvements in and relating to the deposition of metals. Ivon Esser Lewis and James Albert Corey, 27, Chancery-lane, London. (Complete specification.)

17740. Apparatus for exploding mines by means of electrical waves. Ferdinand Schneider, 60, Queen Victoria-street, London. (Date applied for under Patents Act, 1901, Oct. 25, 1904, being date of application in Germany.) (Complete specification.)

17742. Improvements in artificially-cooled electrical machines. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (The Maschinenfabrik Oerlikon, Switzerland.)

SEPT. 2.

17763. Improvements in and connected with signalling arrangements for electric tramway systems, railways, and the like. Nehemiah Norris, 5, John Dalton-street, Manchester.

17764. Improvements in fittings or appliances for use in connection with cable-suspended electric lamps. Frederick Ernest Spittle, 24, Temple row, Birmingham.

17772. An electric signal indicator for railway engines. Arthur John Hayter, 39 Heathfield South, Twickenham.

17800. Improvements in safety fuse apparatus for electrical installations. Josef Hartig, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17803. Electric reproducing apparatus for use with phonographs, gramophones, and the like. Philip Davenport, 322, High Holborn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 21.

1904.

11920. Manufacture of electrodes for electric accumulators. Bruno.

16760. Means for maintaining in juxta-position like poles of relatively movable magnets or magnet systems. Gercke. (Rights under Patents, etc., Act., 1901, not granted.)

18434. Apparatus for transmitting and receiving messages and the like. Donlevy.

18926. Terminal connections for electrical wires. McDermott.

19423. Internal insulation of tubes and fittings for electric conduits. Taylor.

19748. Apparatus for supplying alternating electric current. Berry.

19822. Starting resistances for electric commutator motors. Latour. (Date applied for under International Convention, Sept. 16, 1903.)

20553. Vapour electric apparatus for rectifying and other purposes. Carolan. (General Electric Company.)

20826. Seats for use in exposed situations such as the roofs of tramcars and elsewhere. Wetherell and Smith.

21144. Electric lighting of trains. Leitner and Lucas.

22511. Blowing magnet arrangement for arc light lamps. Beck.

22659. Manufacture of composition or compound for brushes of dynamo-electric machines, for bearings, and for other articles. Morgan Crucible Company, Limited, and Spiers.

22695. Mariner's compass. Thomson, Baron Kelvin, Kean, and Kelvin and James White, Limited.

22817. Electric power transmitting mechanism applicable to motor vehicles and other similar purposes. British Thomson-Houston Company, Limited, and Hoppe.

23015. Devices for automatically operating the points and switches of electric and other tramways and the like from the vehicles. Jones and Jones.

23093. Contact breakers for overhead systems of electric traction. Mitchell.

23438. Magneto electric apparatus for ignition purposes in connection with internal-combustion engines. Holden.

23835. Magnetic brakes for railway and other vehicles. Braun.

24166. Electric accumulators. Monterde.

24828. Apparatus for raising and lowering electric arc lamps. Mason.

25826. Space telegraphy. Stone. (Date applied for under International Convention, Feb. 13, 1904.)

1905.

370. Vapour electric apparatus. Krub. (Date applied for under International Convention, Jan. 9, 1904.)

1243. Clip or apparatus for the screwing up or the removal of the nut or ring used for securing the shade or reflector to electric lamp-holders. Parry.

1560. Dynamo electric machines. Serveau. (Date applied for under International Convention, Jan. 26, 1904.)

2882. Construction of double-decked tramcar and other similar vehicles. De Macedo.

3135. Carbon brush-holders for dynamo-electric machines and apparatus. Zingelmann.

5371. Methods of and apparatus for insulating electrical conductors. British Thomson-Houston Company, Limited. (General Electric Company.)

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5680. Drums or reels for electric cables. St. Helens Cable Company, Limited, and Kenyon.

6469. Electromagnetic speed gear applicable mainly to automobile vehicles and boats. Soc. en Participation des Automobiles "La Magnetique." (Date applied for under International Convention, Oct. 24, 1904.)

7016. Methods of receiving and indicating electrical impulses Troy. (Date applied for under International Convention, April 8, 1904.)

7029. Electrodes for electrolysers used in the manufacture of bleaching liquors. Kother.

8931. Points or switches for electric tramways working upon the slot conduit system. Connett.

10697. Receivers for electric waves. Schäfer. (Date applied for under International Convention, May 18, 1904.)

10599. Electromagnetic ignition device for explosion engines. Roos.

10629. System or apparatus for automatically releasing electric telegraphs. Ducretet.

10828. Overhead travelling hoist or "jenny" for electric or other power, and runway for same. Peake and Crosthwaite.

11290. Telephone exchange system. Dunbar.

11673. Portable electrical measuring instrument. Bourgeois.

12284. Electric tremblers. Minoggia and Mere. (Date applied for under International Convention, June 13, 1904.)

14333. Electric furnaces. Girod.

15590. Points or switches for electric tramways working upon the slot conduit system. Connett.

15752. Self-releasing brake handles for electric tramcars and other vehicles. Belmondo.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾ 6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	99-101 xd
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¼-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1¾
—— 4½ per cent. 1st Debenture Stock	100	..	90-93 xd
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	108½-110½
—— Ordinary	5	..	10-11
—— 5 per cent. Pref.	5	..	5-5⅜
Crompton and Co.	3	..	1¼-1⅜
—— 5 per cent. Debentures	100	..	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1¼-1⅜
—— "A" Shares, 01-017,139	5	..	2-2¼
—— 5 per cent. Debentures	100	..	89-94
—— 4 per cent. Deb. Stock, Red.	100	..	85 88
Electric Construction, Nos. 1 to 112,100	2	..	11/16-15/16
—— 7 per cent. Cumulative Pref.	2	..	1⅜-2¼
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-101
W. T. Henley's Telegraph Works, Ordinary	5	..	12 13 xd
—— 4½ per cent. Preference	5	..	4¼-5¼ xd
—— 4½ per cent. Debentures	100	..	109-111 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	£4¼-36½
—— 5 per cent. Bonds	100	..	102-104

Electric Lighting and Supply.—

Bournemouth and Poole, Ordinary	10	..	11¾-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9¾-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red	100	..	106-108
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	9¾-10¼
—— 7 per cent. Preference	5	..	9⅜-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9¼-9⅜
—— Nos. 60,001-80,000	5	..	9-9⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13⅛
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	6¾-7¼
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5⅛-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— ditto (1903) 40,001-80,000	5	..	4¾-5⅛
Chelsea Electricity Supply	5	..	6 6⅛
—— 4½ per cent. Debentures	100	..	108-110
City of London, Ordinary	10	..	10⅝-11⅛
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	103-105
County of London Electric Supply, Ordinary	10	..	8¼-9
—— 6 per cent. Cum. Pref.	10	..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5	..	6 1/16-6 5/16
—— 4½ per cent. First Mort. Deb.	100	..	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5	..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	99-102
Havana Electricity, 1-15,000	10	..	9¼-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	7⅜-8¼
Isle of Wight Elec. Lt. and Pwr., 4½ p c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅜-½
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	12-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10½
London Electric, Ordinary	3	..	2-2½
—— 6 per cent. Pref.	5	..	4¼-5⅜ xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	10¼-10⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	..	99-101
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	100-102 p.c
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0.9	5	..	7⅜ 8¼
—— do., 57,0.0-75,000	5	..	7⅜-8¼
—— 5 per cent. Pref., 1-57,000	5	..	6 6¼
—— do., 57,0 0-75,0.0	5	..	6-6¼
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6¼-7
—— 4 per cent. Debenture Stock	100	..	98 100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-104
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2¼ 2¾
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1	..	15/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1¼-1⅜ xd
—— 4½ per cent. 1st Mort. Deb.	100	..	106-109
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13¼-14¼
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97 99
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅝-4¾
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5¼-5⅜
Westminster, Ordinary	5	..	12¼ 13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6¼-6⅜

Electric Tramways.—

Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5¼ 6¼
—— Ord.	5	..	8¼-9¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100	..	101-106
Barcelona Tramways, Ord., 1-20,000	10	..	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9,-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	¼-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	96-98
British Columbia Electric Railway Co., Ord. Def.	100	..	111-114
—— Ord. Pref.	100	..	101-104
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	102-105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c
—— 4½ per cent. Vancouver Power Deb.	100	..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	..	8-8¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10½-11
—— 5 per cent. Perpetual Debenture Stock	100	..	125-125
—— 4½ per cent. 2nd Deb. Stock	100	..	98-100
Buenos Ayres and Belgrano Trams	5	..	3 3,
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4¼-4⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	..	105-107
—— Prov. Cert., all paid	100	..	102 105
Buenos Ayres Electric Trams., 5 p c. Deb. Stk., Red.	100	..	97-99
Calcutta Tramways, 1-102,268	5	..	9¾ 10¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1¼-1½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅜-4⅝
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13¼-14½
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9¾ 10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	99-102
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	¼ 5/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	106-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	105-107
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	101-104 xd
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9¾-9¾
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	103-106
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9-9¼
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.

Electric Railways.—

Central London, Ordinary	100	..	90-92
—— 4 per cent. Pref.	100	..	101-103
—— " " deferred	100	..	77-80
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	111-113

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Name.	Amount paid. £	Last price. £
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— " " " '95	100	117-120
—— " " " '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10 10½
—— Ordinary, 1-50,000	10	3¾-4½
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	98¼-99½
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid. £	Last price. £
Telephones.—		
National Telephone, Preferred	100	110½-111½
—— Deferred Stock	100	107½-109½
—— 6 per cent. Cum. First Pref	10	13¾-14¼
—— 6 per cent Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb Stock, Red.	100	99½-101½
—— 4 per cent. Deb. Stock Red.	100	104-106
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week. Ending	1905. £	1904. £	Increase or decrease Week. £	Current year. £	Miles of single track open. 1905.	1904.	Accounts for past year. Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger d.	Car mile. d.	£	Cost per car mile. d.
Aberdeen Corporation	Sep. 2	1,519	1,693	- 174	— h	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Aug. 26	424	403	+ 21	—	8	8	" 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1 33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sep. 5	1,212	1,039	+ 113	- 391	23 53	23½	March 31	55,025	11,145,551	1,309,903	1·18	10 08	2,338 b	6·03
Birmingham Corporation	" 2	350	276	- 2	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	Aug. 30	1,038	1,026	- 18	+ 709	24	24	" 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	" 31	2,148	2,231	- 83	+ 997	17½	17,	" 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Sep. 2	1,417	1,464	- 17	- 6 0	16½	16½	Dec 31	31 846	2,325 677	579,264	3 28	13·19	—	7·27
Bolton Corporation	" 3	1,858	1 812	+ 16	+ 1,731	40	38	March 31	95 765	20,216.196	2 161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	Aug. 30	1,932	1,4 5	+ 467	—	16 82	16 82	" 31	55,276	10,058,288	1 121,623	1 32	11 83	3,226	7·19
Bradford Corporation	Sep. 2	4,558	5,117	- 558	- 4,534	77	77	" 31	—	—	—	—	—	—	—
Brighton Corporation	" 3	1,275	1,280	- 5	+ 8 5	9	9	" 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	" 1	5,015	5,494	- 459	—	51½	51½	Dec. 31	259,739	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	" 2	1,167	1,117	+ 50	—	10 60	10·60	March 3	—	—	—	—	—		
Burton Corporation	" 3	323	332	- 59	- 863	8¼	8¼	" 31	17,950	3,818 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	Aug. 12	2,707	2,172	+ 534	+ 605	26†	—	" 31	112,209	24,131,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	Sep. 4	213	228	- 15	- 400	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	" 2	5,520	5,601	- 81	- 1,238	6	6	" 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway	" 3	2,238	2,439	- 201	- 332	6½	6½	" 31	—	—	—	—	—	—	—
Colchester Corporation	Aug. 10	241	258	- 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	" 31	526	567	- 41	+ 14	15½	15½	" 31	24,895	5,814,376	882,256	1·01	6 64	—	4·69
Darwen Corporation	Sep. 1	250	251	- 1	+ 212	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Aug. 12	344	317	+ 27	—	4½	4½	" 3	11,250	2,853,700	281,743	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Sep. 1	159	158	+ 1	+ 12	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	" 1	4,374	4,498	- 124	} —	47	46	" 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	" 1	1,146	1,293	- 147											
Dundee City Tramways	Aug. 20	819	866	- 17	—	22	22	May 15	—	—	—	—	—	—	—
East Ham Corporation	Sep. 2	810	746	+ 64	—	23	23	March 31	36,652	13,589 658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	" 2	15,227	15,126	+ 201	+ 10,187h	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	Aug 30	1,681	1,746	- 65	+ 1 8 0	35½	33	March 31	74,019	17,849.642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	Sep. 2	1,438	1,469	- 3	+ 640	35	35	" 3'	69,938	12,838,150	1,666 262	1 24	9·71	1,923	—
Hull Corporation	" 2	2,209	2,300	- 91	+ 570	27	26	" 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	" 31	—	—	—	—	—	—	—
Ilkeston Corporation	Aug 20	122	170	- 48	- 581	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	" 30	225	2 6	- 31	—	7,	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Sep 2	6,007	6,270	- 263	—	89	89	March 25	298,233	64.223,646	7,121.038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec 31	26,011	12,039,252	1,223,507	1	9·79	—	4·82
Liverpool Corporation	Aug 26	11,074	11,411	+ 663	+ 8,833	103	103	" 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	Sep. 3	1,513	1,594	- 81	- 490h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	Aug. 19	15,745	13,429	+2,316	+52,783	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128.867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	" 31	127	169	- 42	-	2½	2	—	4,740	850 121	112.227	1·33	10·13	2,370	—
Manchester Corporation	Sep. 2	12,772	12,987	- 215	+ 11,834	43	131½	March 31	631,956	126,900,875	14,123,124	1 19	10 73	4,299	6·99
Nelson Corporation	" 2	151	145	+ 6	+ 293	—	2¾	" 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	" 2	3,651	3,737	- 86	—	50	45	" 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	" 3	1 563	1 501	+ 259	+10 396	—	34	" 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	" 2	2,268	2,406	- 138	+ 1,764	—	29	" 31	95,702	19,625.329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	" 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	" 31	14,881	2 837,110	336,547	1·24	9·24	1,102	7·92
Rotherham Corporation	Aug. 3	440	645	- 205	—	9½	7½	" 31	23,563	5 251,472	593,054	1 07	9 53	2,612	7·49
Salford Corporation	Sep 4	4,141	4 197	- 16	+ 6 331	70½	—	" 31	214,111	39,213,560	4,884,580	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	" 3	4,735	4,809	- 74	+ 5 0·4	—	52½	" 31	—	—	—	—	—	—	—
Southampton Corporation	Aug. 30	1,070	1,148	- 78	- 283	—	18	" 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	—	—	—	—	—	—	9	" 31	—	—	—	—	—	—	—
Stockport Corporation	Sep. 1	800	610	+ 200	—	—	10½	" 31	—	—	—	—	—	—	—
Sunderland Corporation	" 3	1,409	1,388	+ 21	+ 801	—	20	" 31	—	—	—	—	—	—	—
Swindon Corporation	Aug. 30	215	—	—	—	—	4½	" 31	4,937	1,315,757	102,751	0·87	11·53	1,371	•
Wallasey U.D.C.	Sep. 2	836	859	- 23	+ 601	11·85	10 5	" 31	38,768	7,412 881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	" 31	17,157	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	Aug. 31	2,092	1 212	+ 880	+15,119	46	8 62	" 31	—	15,773.742	1,237,165	—	—	—	—
Wolverhampton Corporation	" 20	801	799	+ 2	—	—	7½	" 31	—	—	—	—			

† And 88 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Electricity and Sanitation.—In a report to the Poplar Borough Council, Dr. F. W. Alexander, the medical officer of health, suggests the manufacture of a disinfecting fluid by electrolysing sea-water or artificial salt water. The action of the electric current changes the chlorides into hypochlorites, powerful deodorants and disinfectants. Further details of the proposed equipments are given elsewhere in this issue.

New Publications.—Messrs. Harper Bros. are about to publish an addition to their list of electrical hand-books a volume entitled "Practical Electric Wiring for Lighting Installations," by C. C. Metcalfe, of the Manchester School of Technology. The book, which is fully illustrated, is written for foremen, wiremen, and students, and for those who wish to acquire a practical knowledge of wiring, jointing, and fitting for the installation of electric light. The price is 5s. net. The *Journal* of the Western Society of Engineers (Chicago) dated August contains papers on "By-Products of Coke Ovens," by W. H. Blauvelt; "Experimental Determination of Air-Gap Reluctance," by Chas. H. Smoot; "The Division Engineer in Railway Work," by W. Beahan; and "Steam-Turbines," by Prof. Storm Bull.

Underground Telegraphs.—At the meeting of the Middlesbrough Chamber of Commerce a letter was read from Lord Stanley stating that, though it was true that his predecessors and himself had contemplated an underground line from Leeds to Newcastle as a future development of the underground scheme, there was no intention at present to proceed with such an extension, as there were no funds available for the purpose. His lordship added that, so far as he was aware, telegraphic communication from Newcastle had not been entirely stopped by storm, and there had not, as alleged, been occasion to send telegrams from Newcastle to London by way of Copenhagen, except in a few instances. The secretary averred that Lord Stanley was incorrect on this latter point, so that either there must be a difference of opinion as to what constitutes a "few" instances, or one side or the other must be misinformed. If the error rests with St. Martins-le-Grand, it is to be hoped that the Chamber will continue their agitation for an improved service.

Dissociation of Ternary Electrolytes.—In the *Zeitschrift Elektrochemie* Mr. G. Kümmell contributes a reply to the criticisms of Drucker, and an abstract of his reply appears in the *Journal* of the Chemical Society. The author shows that the depression of freezing point produced by a mixture of magnesium and potassium chlorides is almost equal to the sum of the depressions of the separate salts. Hence it is probable that complex ions are not formed from these salts. The E.M.F.'s of cells consisting of two calomel electrodes, one with potassium or sodium chloride, the other with magnesium chloride solution, are shown to be 0·004 and 0·002 volt respectively when the solutions are isohydric. This confirms the view that the concentrations of the chlorine ions in these isohydric solutions are the same, the small E.M.F.'s observed being due to the different mobilities of the $Na^{\cdot}$ or $K^{\cdot}$ ions and the $MgCl^{\cdot}$ ions. Drucker's method, based on the depression of freezing point, is only exact when applied to very dilute solutions. It has also the disadvantage of giving the ionic concentrations only at the freezing point, and is, therefore, unsuitable for electrolytes the dissociation of which is much affected by temperature.

Icemaking by Electricity.—The Cataract Ice Company have installed at Niagara Falls an electrically-operated icemaking plant, a description of which appears in the *Scientific American*. The machinery installed comprises a 100-h.p. 2,200-volt Westinghouse induction motor to operate an ammonia compressor, and smaller motors for the air compressor, brine pump, and crane. The tank is divided into eight compartments, each containing four plates. One of these eight compartments is emptied daily, eight cakes of ice being taken out, each of which latter weighs about four tons, or showing a daily capacity of 32 tons. The water, which is supplied from the city mains, is filtered before passing to the freezing compartments of the tank. In the operation of the plant, the anhydrous ammonia is compressed, and thereby heated and converted to a gas. It then passes to a condenser, where it is brought into contact with cold water, thus reducing it in temperature to the temperature of the water, and conveying it back to a liquid. It is then expanded into the freezing coils, which are encased in the freezing plates. These plates being submerged in the water the ice forms on the outside, and after a period of eight days this cake of ice is complete.

Magnetic Observations.—The British Association appointed Sir W. H. Preece (chairman), Dr. R. T. Glazebrook (secretary), Prof. W. G. Adams, Captain Creak, Mr. W. L. Fox, Principal Sir Arthur Rücker, and Prof. A. Schuster to co-operate with the committee of the Falmouth Observatory in their magnetic observations. A review of the investigations was presented to Section A at the South African meeting of the association. The results of the observations during 1904 have been published in the annual report of the National Physical Laboratory, and are very satisfactory. The vertical force curves have been measured for the first time, and the results for 1903 and 1904 are given in the report. Dr. Chree has published "An Analysis of the Results of the Falmouth Magnetographs on Quiet Days during the 12 years 1891 to 1902," in the *Transactions* of the Royal Society for 1904; this contains a number of interesting results, which confirm in a remarkable manner the consequences deduced from his earlier paper dealing with the Kew curves. The committee regret to learn that the difficulty of the situation has caused great delay in the building of the new observatory at Eskdale Muir, which, they are informed, cannot be ready until the end of 1906. In view of the importance of maintaining continuity of the magnetic records, they ask for reappointment, with a grant of £50.

Telegraphic Facilities. — The Corporation of Coventry are uniting with other municipalities asking for continuous day and night telegraphic facilities, and also that a Sunday service shall be available both for the receipt and delivery of telegrams. At present telegrams can in the ordinary course only be dispatched and received in Coventry during the ordinary hours of post office business, and the only way of dispatching a telegram when the post office is closed is by calling up the postmaster or telegraphist and paying a late fee, which is not returned if the telegram cannot be dispatched in consequence of the office to which it is addressed being closed. Representations were made to the Postmaster-General, who replied that it is not usual to provide for continuous attendance at places of the size of Coventry. The Corporation are, therefore, approaching various municipalities throughout the country with a view to united action being taken to secure a continuous service in towns having, like Coventry, a population of over 50,000. It is proposed to forward a resolution to the Postmaster-General and to the local members of Parliament, and also to bring the subject before the autumn meeting of the Association of Municipal Corporations. The important part which telegraphy plays in modern life well

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justifies the action of the Coventry Corporation, especially as towns like Falmouth, Queenstown, and Inverness, with populations under 50,000, are provided with such a service.

Water Electrolyzers.—Attempts to obtain hydrogen and oxygen by the electrolytic decomposition of water have usually been attended with economic and other objections. The Oerlikon Company, of Zurich, have recently devised a new apparatus for this purpose, which is stated to obviate many of the disadvantages of other forms. Cast-iron electrodes are used, and between them are located resistant diaphragms, which act as insulators. The cells are connected in series, and a 10 per cent. solution of potassium carbonate is used as the electrolyte. The gases pass through openings in the plates into two separate pipes, and, together with part of the solution, are carried into the separators, where the gas is freed from the water, which flows back into the apparatus through a common pipe. It is stated that the gas can be evolved under a pressure of 2·5m. of water, the oxygen being 97 per cent. pure and the hydrogen 99 per cent. The pressure used is about 2·7 volts per chamber, although, after the apparatus has been in use for some time, the temperature rises to its maximum, about 60deg. C., when 2·3 volts are sufficient. During operation no attention is necessary, apart from the renewal of the water. To produce three cubic metres of gas 12 kilowatt-hours are required, the exact price of the gases depending, of course, on the cost of the current used. Taking this at ½d. per kilowatt-hour, one cubic metre of the gases—*i.e.*, one-third cubic metre of oxygen and two-thirds of a cubic metre of hydrogen—will cost 2d. Economically, this appears to be little better than the results obtained from the Schuckert method, but it is claimed for the Oerlikon apparatus that it is of simple construction and needs little attention.

Scientific Education in South Africa.—In his address to the Education Section of the British Association, Prof. P. D. Hahn reviewed the early instructional efforts in Cape Colony, when the land was first occupied by the Dutch in 1652, at which time the educational system was of a very elementary character. The beginning of the second period was marked by the foundation of the South African College in 1829, supplying the demand for higher education. A number of colleges were subsequently established in various parts of the colony—at Graaff-Reinet, Somerset East, Rondebosch, Stellenbosch, Grahamstown. The third period was inaugurated by the establishment, in 1873, of the University of the Cape of Good Hope; the teaching of science as an essential part of higher education dates from then. The endowment of the Jamison Chair of Chemistry at the South African College, and the building of the chemical laboratory in connection with that institution, were soon followed by the establishment of chairs of botany, physics, geology, zoology, and engineering in this and other colleges of the colony. In 1895 the South African School of Mines, with courses in Cape Town and Kimberley, was opened, and in 1902 the Technical Institute of Johannesburg was called into existence. At present the facilities for studying science at the colleges are well advanced in South Africa; but the teaching of descriptive natural science in the elementary and high schools of the colony is far from satisfactory, notwithstanding the strenuous efforts made in this direction by the Department of Public Education. With regard to the present position of the teaching of science, it appears that the schools of the colony are now going through the same experience as the high schools in the more advanced Continental countries during the last century. In conclusion, the author gave his views as to the organisation of the teaching of the descriptive natural sciences, and of the elements of the experimental sciences in the schools and high schools of the colony.

Atmospheric Electricity in South Africa.—A paper on this subject was presented to Section A of the British Association by Prof. J. C. Beattie, Mr. J. Lyle, and Mr. W. H. Logeman. The observations carried out up to now consist of a series made at Bloemfontein in 1902-1903 by Mr. Lyle, of the Grey College, Bloemfontein, and a less complete series made during the same period at Cape Town by Mr. W. H. Logeman. Observations have also been carried out in Cape Town by Mr. Fincham during the present year. The instruments used were an Elster and Geitel dissipation apparatus, and—less regularly—a Kelvin portable electrometer. The paper contains the records of daily readings of temperature, humidity, pressure, and both positive and negative leaks for morning and afternoon hours. These results are used to determine the annual variation; a harmonic analysis of the results being obtained in the usual way. Cape Town is on the coast practically at sea-level. Bloemfontein is inland, and about 4,500ft. above sea-level. The magnitude of the leak is greater at Bloemfontein than at Cape Town. The positive leak, both at Cape Town and at Bloemfontein, is less than the negative in the morning; the positive leak in the afternoon in Bloemfontein is greater than the negative in the summer months, less in the winter months. In Cape Town, so far as the observations go, it seems probable that the opposite is true, that is, from June to October the positive leak is greater than the negative, and in November and December less. Mr. Lyle and Mr. Fincham had in addition observed on several days throughout the whole day. The chief results are similar to those obtained in Europe. Formation of fog leads to a diminution in leak. The rate of leak changes with the relative humidity and with the pressure.

Institute of Mining Engineers.—The sixteenth annual general meeting of the Institute of Mining Engineers in Manchester was opened on Wednesday last, and the programme extends until to-morrow. The meetings are being held in the Lord Mayor's parlour at the town hall, where some interesting papers are being read and discussed. Amongst the five new papers presented to the meeting the first four are more or less interesting to our readers, and their titles and authors are as follows: "Leading Features of the Lancashire Coalfield Extended," by Mr. Joseph Dickinson, F.G.S; "Up-to-date Electrical Power Distribution," by Mr. Robert Loraine Gamlen; "Can Explosions in Coal Mines, with their Associated Toxic Fatalities, be Prevented," by Mr. B. H. Thwaite; "Earth in Collieries, with Special Reference to the recently issued Departmental Rules," by Mr. S. F. Walker. The second and fourth of these are referred to elsewhere in our columns. Papers which have been reproduced already in the *Transactions* of the institution are also open to discussion, and amongst these we notice the following: "The Firing of Babcock and other Boilers by Waste Heat from Coke Ovens," by Mr. T. Y. Greener; "The Electrical Driving of Winding Gears: Supplementary Note," by Mr. F. Hird; and "The Conveyor System for Filling at the Coal Face, as practised in Great Britain and America," by Messrs. W. C. Blackett and R. G. Ware. Amongst the excursions arranged for the members is one to the Lancashire Electrical Power Company's works, another to the British Westinghouse Company's works at Trafford Park, where the cable works of Messrs. W. T. Glover and Co. and the Trafford electric light and power station will also be viewed. The Manchester Corporation station at Stuart-street is to be inspected, and the

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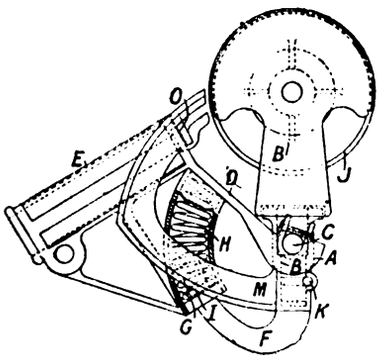
municipal school of technology will doubtless attract a large number of visitors. The meeting is, we understand, being well attended.

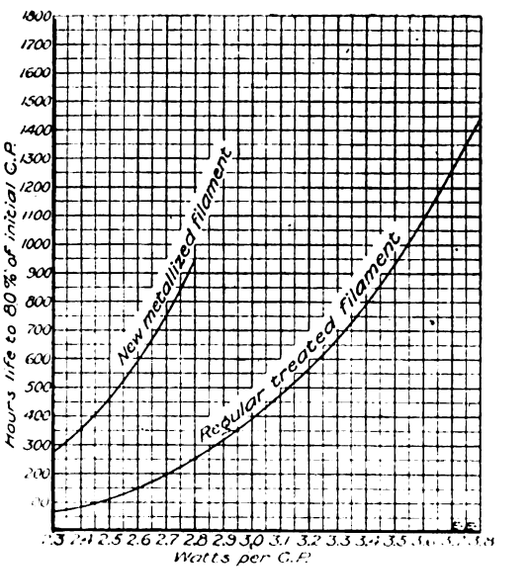
Improved Trolley Head.—We illustrate herewith a new type of trolley head for electric tramways, which was patented last year by Mr. T. Blaney, of Liverpool. Its object is to reduce the shock when the trolley wheel is passing over the suspending ears or other solid parts of the overhead system. The trolley head in question



has the socket which carries the trolley fork, B^1, pivoted at C, in a forked extension, D, of the pole socket, E, to absorb shocks due to unevenness of the wire and to reduce sparking. Two extensions of the pivoted socket are shown, one being the curved arm, F, terminating in a shoulder, I, which is in contact with a spring or an air cushion in a chamber, H, fixed to the arm D, and the other the curved arm, M, which terminates close to the periphery of the trolley wheel, J, and also carries two stops, O, normally pressed against the pole socket by the spring, H. When the wheel, J, meets a joint or any other uneven place in the wire, the wheel moves rearwardly on the axis, C, and compresses the spring, while the arm M moves with the socket and prevents the wire or any obstruction from getting between the wheel, J, and pole socket, E. The spindle, B, is grooved, and engages a pin placed in the hole, K, thus permitting the trolley wheel, fork, and spindle to revolve, but preventing them from leaving the socket A.

New South Wales.—From the report of the Commissioners for the year ended June 30 we observe that the N.S.W. Government railways and tramways both show an increase of revenue. In the case of the trams, however, there is a slight decrease in the profit, owing to an increase in the working expenses, which have advanced in rather greater ratio than the receipts. We observe that the cable system has now been entirely superseded, though a considerable mileage of steam trams still exists, and in one or two instances the horse tram is still to be found. In Sydney, which represents more than 73 out of a total of 125¾ route miles in the Colony, all the trams are electrically operated. The percentage of working expenses to revenue for Sydney, though somewhat high (83 per cent.), compares favourably with the results obtained from the other forms of traction. The precise figures for the tramways in the whole Colony were as follows for 1905 and 1904 respectively: earnings, £813,569 and £802,985; expenditure, £685,682 and £673,625—balance, £127,887 and £129,360. The electric plant at the Ultimo power-house, including an additional turbo-generator set, installed in January last, has worked satisfactorily. The total output for the year was 33,555,887 kilowatt-hours, of which the alternating-current supply was 19,110,640 kilowatt-hours, and the direct-current 14,445,247 kilowatt-hours. Of the total output, 335,080 kilowatt-hours were used for other than traction purposes. The Waverley and North Sydney sub-stations have each been equipped with an additional transforming and converting unit, while the first unit has been established at Botany sub-station, but has not yet been put into service owing to the non-completion of the high-tension feeders. A new battery-house has been erected at Five Dock, and put into service in connection with the conversion of the Abbotsford steam line to electric. The total cost of constructing the track for the 125¾ miles was £2,016.520, giving an average cost per mile of £16,036. This, however, is calculated upon route, not single-track, miles. The average total cost of the system per route mile, including all charges, works out at £28,931.

Improved Carbon Filament.—At the annual convention of the Ohio Electric Light Association Mr. F. W. Willcox contributed a paper entitled "High Efficiency High Candle-Power Incandescent Lighting Units," of which an abstract appears in the *Electrical Review* of New York. The author described an improved carbon filament for incandescent lamps, which has been developed by the General Electric Company in their laboratory at Harrison, N.J. To evolve the new filament the same process is employed as for the present type, with the addition of heating in an electric furnace at a temperature of over 3,000deg. C., this "firing," as it is termed, being employed both before and after the filament arrives at the condition in which it has hitherto been regarded as complete. It also undergoes other treatment, of which our contemporary does not give particulars. The product is an extremely pure form of carbon, having considerably less specific resistance and greater density than the present filament. The additional processes change the temperature coefficient from negative to positive. Unlike the present filament, the new type starts brilliantly and declines to normal brightness. The practical effect of these new processes is to make the filament more refractory, rendering it capable of operating at a higher efficiency. As compared with the present highest standard efficiency of incandescent lamps, an actual gain of 20 per cent. is claimed for the new type, so that it will be seen that the improved efficiency marks a very appreciable



advance. The curves in the accompanying diagram illustrate the useful life performance at various efficiencies for the new and previous filaments.

Petrol-Electric Automobiles.—One class of electrically-driven vehicle which is being experimented upon largely includes electricity only as a speed and torque varying gear between a constant-running prime mover and the axles of the car. Quite a number of the petrol-driven carriages now being experimented with for branch lines on main railways have such electrical transmission between

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the engines and the driving wheels. The British Thomson-Houston Company patented recently one such arrangement for driving with an interesting controlling gear, of which the following is a brief description. In it two dynamo machines are provided, one of which always acts as a generator and the other as a motor. They are so connected electrically that both the speed and the torque can be varied. Fig. 1 shows a typical arrangement, and Fig. 2 a diagram of the connections. The armatures of the generator, G, and motor, M, are mounted on a shaft, *c*, connected to a load, C. The field magnets of the generator are driven by the gas-engine, A, and the field magnets of

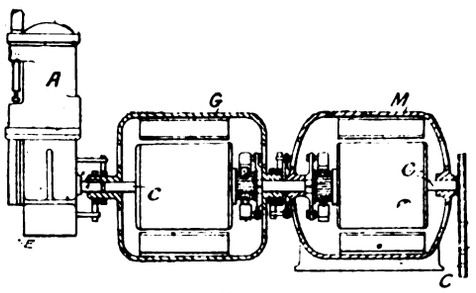


FIG. 1.

the motor, M, are fixed. The two machines are preferably electrically connected in series, and the field-magnet excitations are controlled by a controller, D, S being a reversing switch. In the position 1 one-third only of the generator field is excited, and the machines are started. In the position 3 the two machines are in series, and this position gives the slowest speed and greatest torque. In the positions 4 and 5 parts of the motor field are cut out, and the motor speeds up. In the position 6 the motor is cut out and the generator closed on itself, forming a clutch, the engine and load rotating at the same speed. In the position 7 the motor is again connected up with part of its field reversed, and the speed is thus increased beyond that of the engine. The positions 1^1, 2^1, and 3^1 are braking positions, the generator being disconnected and the motor circuit closed through the resistances, R, which in the

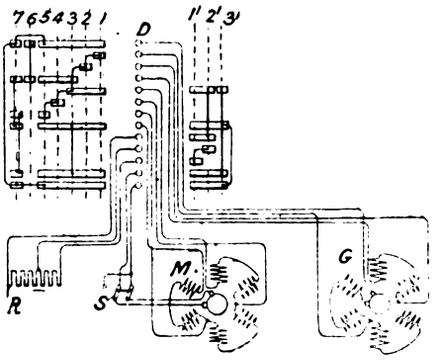
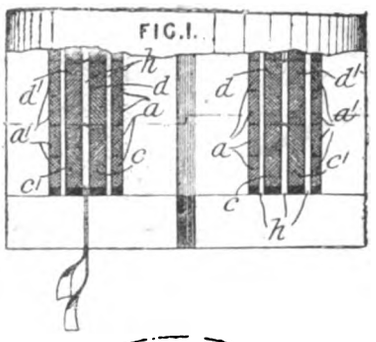
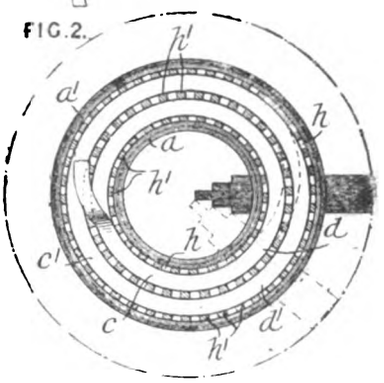


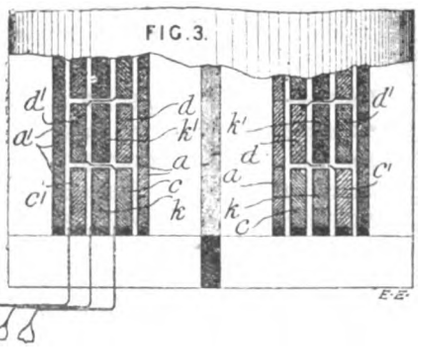
FIG. 2.

position 3^1 are cut out to give the maximum braking power. When the reversing switch, S, is thrown, the backward speeds depend upon the difference between the torques of the two machines.

High-Tension Transformer Windings.—With the increase in size of transformer units the construction of transformers has to be varied considerably from that found satisfactory in smaller sizes, in order to provide ventilating surface to carry away the heat corresponding to the energy lost in the coils and core, and also to give efficient insulation. The various devices invented by Mr. A. F. Berry to this end have been described to a certain extent in our columns. The following, however, is a description of one of his latest patented ideas for the construction and arrangement of the high-tension windings of large transformers. In the accompanying illustrations the high-tension windings, *c*, c^1, *d*, d^1, etc. (Figs. 1 and 2), consisting of insulated metal tape, preferably copper, wound flatways so that the flat surfaces of the convolutions are at right angles to the axis of the coil, and arranged in sets of concentric coils, *c*, c^1, *d*, d^1, etc, are placed between the inner and outer coils, *a*, a^1, of the low-tension winding. The inner and outer coils, *c*, c^1, of one set are connected respectively to the outer and inner coils, d^1, *d*, of the next set, and so on, the two circuits being connected in parallel or in series. In the modification shown in Fig. 3, in which there are three coils in each set, the inner and outer coils are connected as above, while the intermediate coils, *k*, k^1, etc., are connected together in series. Longitudinal ventilating passages, *h*, are left between the coils in each set, the passages being







maintained by numerous insulating strips, h^1, placed between adjacent coils. Ventilating passages may also be provided between the primary and secondary windings and between adjacent sets of coils, as shown in Fig. 3.

Incorporated Municipal Electrical Association. We have received from the secretary of this association the *Proceedings* of the Edinburgh meeting, which took place in June and July last. All the papers then read are reproduced, together with a full report of the discussions on the same. These papers will be found in our columns for the early part of July. The volume also contains the tenth annual report of the council, which shows satisfactory progress both as regards membership and the active interest which is taken in everything likely to further electrical supply. Amongst the matters contained in the report is some information repecting the testing and certification of carbon filaments in incandescent lamps. The council of the association felt that the average value of the lamps in

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use was considerably lower than it ought to be, with the result that consumers are called upon to pay heavier amounts, and an unfair and unnecessary advantage is given to the competition of gas and other systems of illumination. The council therefore formed, in April last, a sub-committee, consisting of the president and Messrs. Fedden, Pearce, Snell, Taite, and Wilkinson, to investigate and report, with a view to securing uniformity of practice amongst lamp manufacturers, a more accurate and reliable grading of lamps, and the discontinuance of the use on municipal supply systems of lamps which are offered at low prices, but which do not give the amount of light marked thereon, and are wasteful of energy. The sub-committee presented its report at the May council meeting in the form of a standard specification, with recommendations for the testing and certification of lamps by electricity supply authorities. The report is divided into the following sections: (1) general instructions; (2) wattage tests; (3) tests for candle-power; (4) standard candle; (5) standard of wattage; (6) standard pressure; (7) marking of lamps; (8) method of obtaining standard candle-power; and (9) limit figures allowable. Contemporary with the presentation of the above report the council received a communication from the secretary of the Engineering Standards Committee, stating that its Sub-committee on Physical Standards was about to consider the standardisation of electric lamps, and requesting that two members of the Municipal Electrical Association council be appointed as members of the Physical Standards Sub-committee. Having in view the advantages of co-operation and the probable ultimate uniformity in the findings of both authorities, the council decided to postpone the publication of its report, and has appointed Messrs. Taite and Wilkinson as representatives of the Municipal Electrical Association on the Physical Standards Sub-committee. The council hopes to issue the standard specification at an early date, and believes that uniformity in manufacture and improvements in lamp efficiencies may be looked for as a result, and this without interfering with private trading interests in the many towns and districts concerned. The balance-sheet of the association is most satisfactory, and shows a considerable surplus on the year's working. Amongst the vexed questions which were brought up for discussion at the annual meeting was the tenure of office for members of the council. A resolution was moved that a chairman of committee when once elected should serve for three years instead of one. After considerable discussion, the whole question of the representation and election of members of the council, and also the question of the commencement of the association's year, was referred for a report to be brought up before the next convention meeting. At the end of the volume a complete list is given of all the papers which have been laid before the association since its commencement. The *Proceedings* containing these can be obtained from the secretary, Staple-inn-buildings, Holborn, at the published price of 3s. 6d. per volume.

North-East Coast Institute.—In the note in our last week's issue under this heading we reversed the rival figures of cost per kilowatt installed for private power plants. Mr. W. C. Mountain, in pointing this out to us, kindly gives us some further information as follows, which was also sent in a letter to the institute. The letter reads: "With reference to the remarks made by Mr. Snell in the discussion in which he criticises the figures which I communicated to the meeting, I shall feel that my personal reputation is at stake, and I cannot under these circumstances allow his remarks to go unanswered. The main point upon which Mr. Snell and I disagree is the cost per unit for the necessary plant in a generating station, including the buildings and foundations. In installations for factories and collieries where the purchasers are prepared to put down really reliable slow-speed horizontal engines with crankshaft generators, I don't think it is necessary to instal duplicate generators, but if duplicate machinery is required, then, assuming that 600 kw. was to be installed, I would suggest putting in three units, each 250 kw., two of which would carry the maximum load in case any accident occurred, and this would probably increase my estimate of £9,000 by, say, an additional £3,000, making a total of £12,000 for, say, 600 effective kilowatts, or at the rate of £20 per kilowatt installed, this figure being rather less than half the amount stated by Mr. Snell—viz., £45. Considering further the installation of three 250-kw. sets, I don't think Mr. Snell acts quite fairly in his remarks, because if these are read carefully it will be noted that I give the figure of £12 per unit installed, or £18 assuming that one of the units is a stand-by; this, again, is only about one-third of the cost given by Mr. Snell—viz., £45. Mr. Snell then starts to challenge my figures, and writes as if I had no knowledge of the business I am engaged upon. I can only say: (1) The figures given for the two sets of engines and dynamos of 300 kw. of the slow-speed type are actual figures extracted from a contract which my firm have in hand at the present time. The same remarks can apply to the estimate for the three high-speed sets each of 250 kw., so that there is no question of doubt whatever as to the correctness of these figures. (2) Mr. Snell then takes the estimate in pieces, and makes the statement that you cannot get three high-pressure Lancashire boilers for £1,500. As a matter of fact, in an estimate I have before me at the present time a firm quotes me £440 each, or for the three £1,320. (3) Mr. Snell then questions the item of £800 as the cost of the buildings. It may interest Mr. Snell to know that in an installation which my firm recently carried out, instead of the chimney costing £800 for three 30ft. by 8ft. 6in. Lancashire boilers, the chimney, which was 101ft. 9in. high, including all foundations and a first-class job throughout, cost £268. 6s. 8d. The three boilers with their seatings, including the boiler-house, complete covering of the three boilers, etc., cost £348. 17s. 9d. The power-house, large enough for three sets of high-speed engines, would only require to be about 50ft. long by 25ft. wide by, say, 15ft. high, cost just over £500, so that if you add these three items together you will see that the estimate that I gave of £1,000 was as nearly as possible correct, and this is for a substantially-built power station and everything of the best. I further trust that Mr. Snell will kindly withdraw what he calls my ill-considered estimates, as I am sure that no practical engineer who knows the value of machinery will for a single moment accept Mr. Snell's figures of £44 per kilowatt as a reasonable price for a power installation, either in a factory or at a colliery." We agree with Mr. Mountain that power stations have an immense future before them when they can supply current within the cost at which it can be produced in private installations. It is only right, however, that owners of works should know what is the cost of private installations, both to lay down and to work, so that they can consider the relative advantages of having a public supply or generating their own power. It is interesting in this connection to remember that Messrs. E. Scott and Mountain drive the major portion of their new new works in Gateshead by means of electrical energy obtained from the local power company. The rest of their works are driven from engines and dynamos in their own power station, so that they have at their disposal every facility for making such a comparison,

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THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.

BY ALFRED STILL, M.I.E.E., A.M.I.C.E.

The question of transmission of power to a distance is becoming daily of greater importance, and the following has been written with the object of presenting in as clear and simple a manner as possible the various points to be borne in mind when considering a scheme of power transmission to a distance by means of alternating currents. The choice of system to suit any given conditions hardly forms part of our subject, except incidentally. Every case must be most carefully considered on its own merits, and without a fair working knowledge of alternating currents and of the losses which occur in their transmission it is not possible to arrive at any definite conclusions. It may be found, if the distance is not very great, that continuous currents can be used with advantage; but if the distance is considerable, involving (for the sake of economy in transmission) very high pressures, alternating currents will be found more suitable.

We shall consider in succession single-phase, two-phase, and three-phase transmission; but it may be stated that at the present time, the latter system is the most generally adopted. It would be premature to discuss at this early stage the merits and demerits of the various systems, but after each system has been independently considered, we shall be in a better position to make useful comparisons between them.

Losses in Transmission.—With high voltages, such as are necessary for the economical transmission of electric power to a distance, we have to consider, not only the losses due to the heating of the conductors by the current, but also the power lost in the dielectric forming the insulation of the cables, or, in the more usual case of overhead lines, the discharge at the surface of the conductors, and the waste of power in the air. This loss of power, which is due to discharges from the surface of the conductors, is not—in the present state of our knowledge—easy to predetermine; but it will be greater with high pressures and conductors of small diameter; it will also depend largely upon the wave form of the alternating E.M.F., and to a certain extent upon the distance between the conductors, and the frequency. It is true that exceptionally high pressures have to be applied before a visible discharge to the air takes place from the surface of the conductor—probably between 100,000 and 200,000 volts for a wire ·5in. diameter—but it does not follow that there is not an appreciable leakage taking place at very much lower pressures, especially in the case of small wires. In addition to these two causes of power dissipation, we must not overlook the leakage over insulators on a long high-tension aerial line; but the amount of current which leaks to earth, or between conductors, in this manner, is very small on a carefully-designed and well-constructed line, and it is generally permissible to neglect it. The allowable loss of power in a transmission line is a matter of the greatest importance, and it will be again referred to after we have considered the various systems and arrangements of conductors; but for the present a certain percentage loss in transmission will be assumed, apart from economical considerations.

Choice of Voltage.—Generally speaking, the higher the pressure the more economical will be the transmission, because, for a given total power, the current, and, therefore, the weight of the conductors, is reduced. But there are, obviously, many considerations which stand in the way of very high pressures being used in all cases; and each particular scheme must be examined from every possible point of view before definitely deciding upon the voltage to be adopted. In the first place, a small current at a very high pressure costs more to produce than a larger current at a proportionately lower pressure, either because the generators themselves will be more costly, or because step-up transformers will have to be used. If, however, the line losses would be very considerable with the larger currents, then it might be more economical to lay out capital in step-up transformers, extra insulation of conductors, and step-down transformers at the receiving end, and so save copper in the lines. In other words, the most suitable voltage will depend very largely upon the *distance* to which the power has to be transmitted. Indeed, Mr. C. F. Scott has suggested as a rough-and-ready rule that the pressure in thousands of volts should be taken as equal to about one-third of the total distance in miles. Thus, a pressure of 10,000 volts would be suitable for a 30-mile transmission.

It is doubtful whether this rule would be applicable to the case of very long transmissions, because the difficulties of dealing with very high pressures would be enormous. As an example: for a line 300 miles long—which is by no means an unlikely distance to be practically dealt with—the pressure, according to Mr. Scott's rule, would be 100,000 volts. This is not an impossible pressure, although 80,000 volts have not been exceeded up to the present. At the same time, it is exceedingly unlikely that, for distances over 300 miles, pressures above 100,000 volts would be found possible, even if—which is equally unlikely—they could be shown to be economical. It must not be overlooked that, although by raising the pressure we reduce the losses *in* the wires, there is an economical limit beyond which the losses *between* the wires—*i.e.*, through the air and over insulators—become of the greatest importance. It has, indeed, been found that above 50,000 volts these losses between conductors increase at a more rapid rate, and it would almost appear as if the limit of economical power transmission, at the present time, is something between 400 and 500 miles at a pressure not exceeding 60,000 to 70,000 volts.

With regard to underground cables, these are quite out of the question in connection with long-distance transmission. Their cost would be prohibitive, and, apart from this, they are unsuitable for very high pressures. It is true that so long ago as 1891 there was a short length of Siemens cable at the Frankfort Exhibition conveying current at a pressure of 20,000 volts, and there are now many lengths of cable in daily use at this pressure, and even at 25,000 volts; but it is unlikely that insulated cables will be used in the near future for pressures above 30,000 volts, not only because of their excessive cost, but also on account of the very considerable capacity effects and large dielectric losses. There will, however, always be a use for insulated cables at comparatively high pressures, in connection with transmission schemes, because of the objections to carrying the overhead conductors, at extra high pressures, through towns or populous districts.

Transmission by Single-Phase Alternating Currents.

Let us assume, in the first place, that not only the load at the distant end, but also the transmission line, are without self-induction or capacity.

If E = volts between conductors at generating end;
C = the current in amperes;
R = resistance of "load" at distant end;
r = resistance of each of the two conductors;

then the total power transmitted will be

$$W = E \times C,$$
$$= C^2 \times (R + 2r),$$

and the pressure lost in transmission will be $2r \times C$.

These relations are simple, and such as would be obtained if continuous current was being transmitted instead of alternating; but if the conductors are of comparatively large diameter there will be an inductive effect which, by causing an unequal distribution of current in the conductors, leads to the *apparent resistance*, and the loss of power, being greater with a rapidly alternating current than with one that is steady and unidirectional.

Conductor Impedance.—Imagine a straight length of cable of fairly large cross section, through which a steady continuous current is flowing. The lines of magnetic induction due to this current will not all pass through the non-conducting medium surrounding the conductor, but a certain number of them—due to the current in the central portions of the cable—will pass through the substance of the conductor itself. In other words, the magnetic flux surrounding one of the central strands of the cable will be greater than that which surrounds a strand of equal length situated near the surface. It follows that, if the circuit be now broken, the current will die away more quickly near

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the surface of the conductor than at the centre; and, for the same reason, on again closing the circuit the current will spread from the surface inwards.

If, now, we imagine the conductor to be used for conveying an alternating current, it is evident that, with a sufficiently high frequency (or even with a low frequency if the conductor be of large cross-section) the current will not have time to penetrate to the interior, but will reside chiefly near the surface of the cable. This crowding of the current towards the outside portions of the conductor has the effect of apparently increasing its resistance; and it follows that, if C is the total current in the cable, and r its ohmic resistance, the power lost in watts would no longer be $C^2 r$, as would be the case if the current were a steady one, but $C^2 r'$, where r', which stands for the apparent resistance of the conductor, is greater than r, its true resistance. This effect has been very carefully investigated by Lord Kelvin and others, and it is from the data obtained from their calculations that the curve in Fig. 1 has been drawn.

It is found that, for any given apparent increase in resistance of a circular conductor due to the unequal distribution of the current, the square of the diameter must vary inversely as the frequency, and for this reason the product *area of conductor* × *frequency* has been taken for the ordinates of the curve in Fig. 1, while the ratio, k, measured

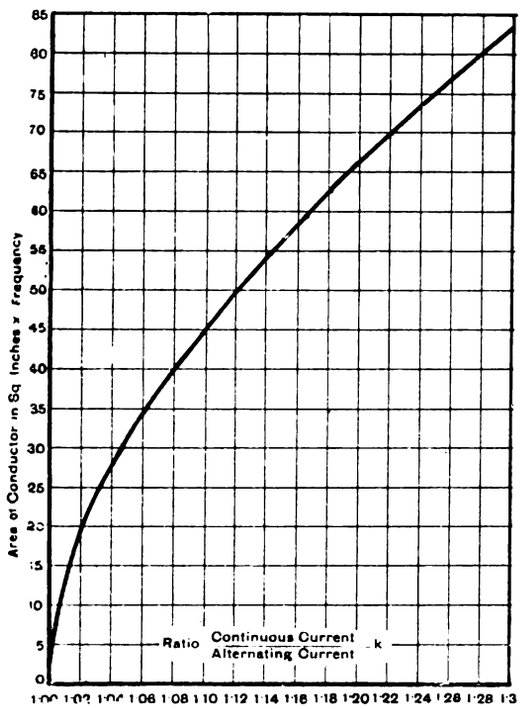

FIG. 1.

horizontally, is the number by which the true ohmic resistance has to be multiplied in order to give us the apparent resistance. As an example, consider a copper conductor ¾in. in diameter, and assume a frequency of 50. The product sectional area × frequency works out at 22·1, corresponding to a multiplier $k = 1{\cdot}025$. If, therefore, the ohmic resistance of the transmission line is r ohms per conductor, the power lost in overcoming the resistance will not be $C^2 \times 2r$, but $C^2 \times 2r'$, where $r' = r \times 1{\cdot}025$. In this example the increased loss of power with alternating current is very small, and had we taken the frequency at 30 instead of 50, which would not be exceptionally low for a power transmission scheme, the multiplier k would have been almost negligible; but with higher frequencies and large conductors the correction should always be made. The values of k obtained from the curve (Fig. 1) are correct only if the conductor is of *copper*. To obtain k for any other "non-magnetic" cylindrical conductor, the product of the sectional area and frequency must be multiplied by the ratio

$$\frac{\text{conductivity of metal of conductor}}{\text{conductivity of copper}}$$

before obtaining the corresponding value of k from the curve. If the conductor is of iron (or other "magnetic" material), the value of k may be much greater than the value read off the diagram.

It is a not uncommon belief that when aluminium conductors are used in place of copper there will be a greater increase of resistance to alternating currents than when the conductors are of copper, because of the greater diameter of wire required to give the same ohmic resistance; but the above multiplying ratio makes it clear that the percentage increase of losses with alternating currents of the same frequency will be independent of the material of the conductor (iron excepted), because the greater sectional area necessary to give the same ohmic resistance of the lines when a wire of lower conductivity is used, is evidently exactly balanced by the higher specific resistance of the metal.

Effect of Inductive Load on Line Losses.—Let us still assume the line to be without self-induction or capacity, and see what is the effect on the line losses if the "load" at the distant end has a power factor less than unity, such as would be the case if the current is supplied to induction motors. Assuming a lag of 37deg., which corresponds to a power factor (*cos* 37deg.) of about ·8, the total current to deliver the same power at the same pressure will be 1·25 times greater than if the power factor were unity, and since, for the same loss of power in the line, the resistance multiplied by the square of the current must remain constant, it follows that the cross-section of the conductors must vary inversely as the *square* of the power factor, the proper correction being made for increased *conductor*

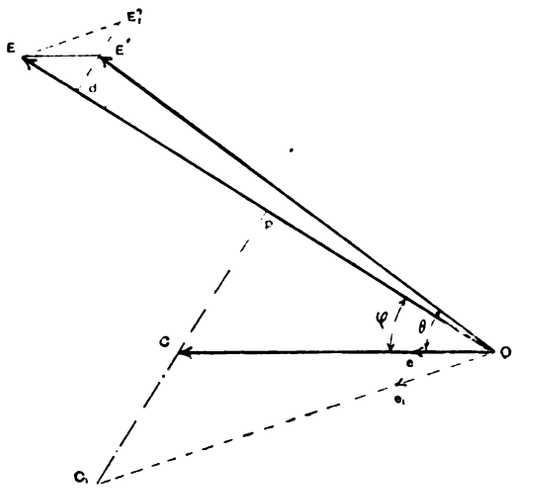

FIG. 2.

impedance if of sufficient importance. In the case under consideration the cross-section would have to be increased in the ratio of 1 to ·64, which corresponds to an increase in weight of copper of over 50 per cent. It does not follow that it would be economical to increase the section to so great an extent, but the importance of a high power factor must not be overlooked.

In the vector diagram (Fig. 2) O E′ is the voltage at receiving end, and O C the current, lagging behind E′ by an angle θ; O e is the loss of pressure in the line (equal to $2r \times C$, or to $2r' \times C$ if the correction for conductor impedance is made), and O E—obtained by compounding E′ and e—is the initial pressure at generating end. A study of this diagram leads to the conclusions (1) that the power factor at the generating end is greater than at the receiving end, and (2) that, *for a definite percentage $C^2 r$ loss in the line*, the actual difference between the pressures at the two ends of the line (represented by the distance E d) will become *less* as the load becomes more inductive—*i.e.*, as θ is increased. If, on the other hand, we let the losses in the line take care of themselves—that is to say, if we consider a line of *definite resistance receiving a definite total amount of real power at the generating end*, and examine the effect of variable power factors, we shall find (3) that for comparatively small percentage losses in the line the actual difference, E d, between the pressures at generating and receiving ends is practically constant, and independent of the power factor. The dotted lines in Fig. 2 will make this clear. Assuming the initial pressure, O E, to remain

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constant, the point C of the current vector O C must lie on the perpendicular p C to the line O E whatever may be the power factor (since the *power*, $E\,C\cos\phi$, is constant): this means that the point, E′, of the vector representing the *receiving end* pressure must lie on the perpendicular d E′ to the line O E, the triangles O C p and E E′ d being similar. Moreover, since the length of the perpendicular d E′ or d E′$_1$ is small in comparison with the length O d, it differs very little from the arc of a circle described through d from the centre, O, and, therefore, the difference between O E and O E′ is practically constant under the conditions stated above.

Effect of Taking into Account the Self-Induction of the Lines. Since there must be a certain distance separating the two wires forming the go and return of the alternating-current transmission line, there must of necessity be an E M.F. of self-induction produced by the alternating magnetic flux in the space between the wires, which will be directly proportional to the amount of current in the line.

In Fig. 3, O E′ is the pressure at receiving end, and O C the current, lagging behind by an angle θ, exactly as in Fig. 2; but now, instead of merely considering the effect of the ohmic drop, O e, we must also take into account the back E M.F. due to the self-induction of the transmission lines. This E M.F. will lag behind the current by a quarter of a period, and the vector O L has been drawn 90deg. *in advance* of the current to represent the component of the total pressure at generating end necessary to balance the E.M.F. of self-induction. The

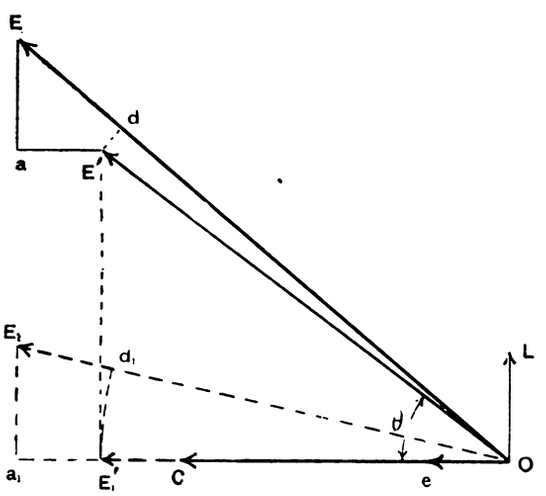

FIG. 3.

total requisite initial pressure is evidently O E, obtained by compounding the forces O E′, O e, and O L. The dotted lines show the effect of resistance drop combined with inductive drop for the same current in the line, and the same total amount of power transmitted, when the power factor at receiving end is unity—*i.e.*, when $\theta = 0$ * A study of this diagram (Fig. 3) leads to the following conclusions: (1) the additional loss of pressure due to the self-induction of the lines is of considerably greater importance on an inductive than on a non-inductive load; (2) for a given current and $C^2 r$ loss in the line, the difference in the power factors at the two ends is greatest when the load is non-inductive; (3) on a partly inductive load there is a certain value of the self-induction which, at a given frequency, will make the power factors at the two ends of the line equal—*i.e.*, it will bring O E, in Fig. 3, to coincide with O E′. If the self-induction is *greater* than this particular value, the power factor at generating end will be *less* than at receiving end, and *vice versâ*.

Predetermination of Inductive Drop.—In the diagram (Fig. 3) we have assumed the inductive pressure drop—represented by the vector O L—to be known. In order to calculate it, we must know the coefficient of self-induction of the circuit formed by the go and return wires. This will depend, not only upon the distance separating the wires, but also upon their diameters. The greater the distance between wires, and the smaller their diameter, the larger will be the amount of magnetic flux produced by the passage of unit current.

The curve drawn in Fig. 4 is plotted from figures published by Messrs. Houston and Kennelly in an article which appeared in the *Electrical World* a few years ago. It gives the coefficient of self-induction per mile of *single conductor* ·4in. diameter in millihenrys.* If the diameter of the wire is not ·4in., the coefficient of self-induction must be read off the curve, not to correspond with the actual distance, a, between the wires, but for an imaginary distance, a', such that

$$a' = a \times \frac{\cdot 4}{d},$$

where d = the actual diameter of the wire in inches.

The well-known formula for the E M F. of self-induction, *on the assumption of the wave forms being sine curves*, is

$$e = 2\,\pi\,n\,\mathrm{L\,C},$$

where n = the periodicity;
L = the coefficient of self-induction in henrys;
C = the current in amperes.

And we are now in a position to calculate the value of the vector O L in Fig. 3.

Example — Consider an overhead transmission line delivering a total power of 1,000 kw. a distance of 50 miles with a pressure of 20,000 volts at a periodicity of 25 The current (if we suppose the power factor to be unity) will be 50 amperes, and we shall assume the conductors to be

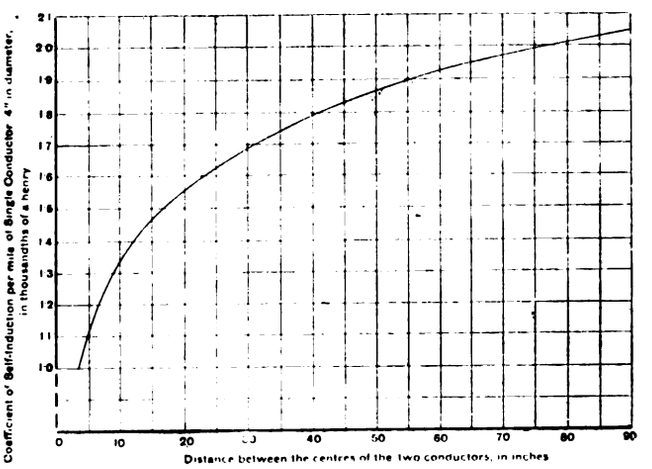

FIG. 4.

·36in. in diameter, separated by a distance of 3ft. In the first place, the correction to be made for the diameter of wire, before referring to the curve (Fig. 4), gives us

$$a' = 36 \times \frac{\cdot 4}{\cdot 36} = 40\text{in.},$$

and, taking this figure as the distance between wires, instead of the actual distance of 36in., we find the coefficient of self-induction per mile of single conductor to be 1·79 millihenrys, which makes the probable value of L for the line

$$\mathrm{L} = \frac{1{\cdot}79 \times 50 \times 2}{1{,}000} = \cdot 179 \text{ henrys},$$

and, on the assumption of the current wave being a sine curve, the expression $e = 2\,\pi\,n\,\mathrm{L\,C}$ becomes

$$e = 2 \times 3{\cdot}1416 \times 25 \times \cdot 179 \times 50 = 1{,}410 \text{ volts},$$

* This method of drawing the diagrams, which assumes the current constant and the pressure variable, to comply with the condition of constant *power* at different power factors is sometimes convenient, but the construction can readily be modified to suit the condition of a definite initial pressure.

* The calculations are based on the assumption of an even distribution of current throughout the section of the wire, such as would occur if continuous currents were transmitted, but when the applied E M.F. is a rapidly alternating one, the current does not utilise the central portions of the conductor to the same extent, and although the flux of induction *outside* the bounding surface of the conductor will be the same as before, the lines which pass through the space occupied by the material of the conductor are now fewer than in the first instance. The result is that, in the case of comparatively high frequencies, the figures obtained from the curve will lead to a calculated inductive drop somewhat *higher* than would actually be obtained. It is, however, usually unnecessary to apply any correction on this account, seeing that the wave form of the alternating current cannot be exactly predetermined, and the results of calculation are, at the best, but a more or less close approximation to the results obtained in actual working.

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which gives us the length of the vector O L in Fig. 3 for the particular case considered and under the condition of full load. This is not a large percentage of the total pressure, and, moreover, the effect of this inductive drop on the pressure regulation is considerably less than if it were in phase with the supply pressure; but with large currents, high frequencies, and low power factors, the loss of volts due to the self-induction of the lines may become a very serious matter.

(To be continued.)

ALTERNATE-CURRENT ELECTROLYSIS.*

BY PROF. ERNEST WILSON, M I E E

It is well known that if an alternate current be passed between metal electrodes in an electrolyte, electrolysis may take place. For instance, it has been shown that in the case of lead plates in dilute H_2SO_4, the SO_4 combines with the lead to form $PbSO_4$, and the plates are eaten away.

The plates in a given cell were of like metal, and were separated $\frac{1}{8}$in. (·317cm.), with their opposing faces parallel. They were held in position by wooden blocks and ebonite distance pieces, bolts, and nuts. The wooden pieces covered the back of each plate, with the view of confining the current to the opposing faces. The area of each of the surfaces exposed in the electrolyte was about 150 square centimetres, but not all of each plate was submerged. For the purpose of obtaining the potential difference between the electrolyte and one of the plates, an exploring electrode, cut from the plate itself, was placed in the electrolyte midway between the plates, and by aid of a revolving contact-maker on the alternator shaft and a quadrant electrometer the curve was obtained. The distance between the exploring electrode and the plate was about 1mm. Similarly the curve of current was obtained by observing the instantaneous value of the potential difference across a non-inductive resistance placed in the circuit. The curve of current was controlled by inserting a considerable non-inductive resistance in the circuit. The E.M.F. of electrolysis is, therefore, a dependant variable as regards

Experiment.	Metal.	Solution.	Duration of Test in Hours.	Frequency.	Density of Solution		Temperature of Electrolyte C		R.M.S. Amperes per sq. cm.	Max. Coulombs per half period.	Weight of Plates in grammes.		Difference in weight of two plates after rinsing in water and drying.	Difference in weight after rubbing with wash-leather.	Average grammes per hour per sq. c.m. after rinsing in water & drying.	Remarks.
					Before.	After	Before	After.			Before.	After.				
1	Lead	H_2SO_4 dil.	15	21·5	1,050	1,049	17·0	—	0·0236	0·0394	401·019 397·065	385·050 382·834	− 30·2	—	0·00629	
2	,,	,,	15	92·5	1,050	1,049	17·5	—	0·0236	0·0094	398·077 402·190	390·651 394·016	− 16·5	—	0·00344	
3	,,	,,	8	92	1,050	1,036	21	32	0·0847	0·0335	389·900 393·105	346·155 348·925	− 87·9	—	0·03230	Fig. 1.
4	Zinc Amalgamated	,,	14⅜	25·5	1,038	1,068	17·6	19·1	0·0240	0·0345	110·58 116·67	97·98 103·08	− 26·19	—	0·00530	Fig. 2.
5	,,	,,	18	92	1,038	1,054	21·3	22	0·0253	0·00956	101·724 104·718	96·647 99·073	− 10·72	—	0·00189	Fig. 2.
6	,,	,,	7	92	1,054	1,066	19·5	27·5	0·0923	0·0346	96·047 99·073	88·939 91·029	− 15·15	—	0·00695	Same solution as in experiment 5.
7	,,	,,	8	92	1,048	1,055	21	25	0·0889	0·0335	115·155 109·865	112·952 107·776	− 4·29	—	0·00166	Fig. 3.
8	,,	,,	8	32	1,050	1,058	28·5	23	0·0307	0·0334	110·120 97·935	104·760 94·500	− 8·795	—	0·00337	
9	,,	,,	8	92	1,050	1,054	28·5	25·5	0·0889	0·0335	105·147 104·457	103·810 103·133	− 2·661	—	0·00103	
10	Zinc	Zinc chloride	12½	25·5	1,255	1,260	15	20·5	0·0247	0·0345	113·135 114·505	113·300 114·790	+ 0·450	—	+0·000116	Fig. 4.
11	,,	Zinc sulphate (saturated)	14⅜	25·5	—	—	—	—	0·0240	0·0345	109·860 115·237	Not taken	—	—	—	
12	,,	Sodium sulphate	18	92	1,100	1,104	20	22·5	0·0241	0·00956	106·703 111·747	106·795 111·841	+ 0·186	— 0·033 +0·033	+0·000031	Fig. 5.
13	Iron	Ferrous sulphate	18	92	1,114	1,122	21·5	21	0·0273	0·00956	64·188 61·199	63·174 59·786	− 2·427	—	0·000462	Fig. 5.
14	,,	,,	7	92	1,122	1,125	19·5	29	0·0979	0·0346	63·098 59·786	62·537 59·407	− 0·940	− 1·101	0·000457	Same solution as in experiment 13.
15	,,	,,	8	92	1,174	1,186	20·6	25	0·0929	0·0335	60·085 61·330	55·490 56·280	− 9·645	—	0·00389	Tap water used.
16	,,	,,	8	92	1,174	1,186	20·6	25·5	0·0929	0·0335	62·464 59·319	57·211 53·526	− 11·046	—	0·00445	Tap water used.
17	,,	,,	8	32	1,066	1,102	18·5	21·4	0·0340	0·0334	55·450 56·242	54·460 55·381	− 1·851	− 2·012	0·000787	Distilled water used.
18	,,	Sodium chloride	18	92	1,138	1,134	22	21	0·0262	0·00956	67·168 66·242	67·190 66·312	+ 0·092	−0·027 —	+0·000017	Fig. 5.
19	,,	,,	7	92	1,134	1,128	19·5	23·5	0·0929	0·0345	67·141 66·312	67·225 66·490	+ 0·262	+ 0·173	+0·000121	Same solution as in experiment 18.
20	,,	,,	8	32	1,086	1,090	19·5	21	0·0312	0·0334	56·977 53·295	57·139 53·397	+ 0·255	—	+0·000100	
21	Copper	Copper sulphate	12½	25·5	—	1,105	16·25	17·3	0·0265	0·0345	138·145 140·215	138·013 140·162	− 0·185	—	0·000051	Fig. 4.
22	,,	,,	8	92	1,060	1,092	19	30·5	0·1000	0·0335	134·550 136·875	134·527 136·717	− 0·181	—	0·000079	
23	,,	Sodium chloride	18	92	1,138	1,132	21·5	21	0·0241	0·00956	134·235 133·500	134·157 133·413	− 0·165	− 0·276	0·000028	Fig. 5.
24	,,	,,	8	32	1,066	1,098	18·4	20·3	0·0340	0·0334	134·085 133·365	133·762 133·035	− 0·653	—	0·000278	
25	,,	Sodium phosphate	18	92	1,042	1,050	21·2	21·5	0·0241	0·00956	134·674 136·891	134·682 136·892	+ 0·009	— −0·014	+0·0000015	Fig. 5.
26	Tin	Proto chloride of Tin	12½	25·5	1,110	1,120	16	16·8	0·0244	0·0345	123·571 119·491	123·500 119·305	− 0·26	—	0·000066	
27	Aluminium	Potash alum solution (sat.)	2	92	—	—	20·6	98	0·1030	0·0335	—	Not taken	—	—	—	

The present paper gives an account of some experiments made to determine what may be the effect upon certain metals of passing alternating currents between them and certain electrolytes under given conditions. Suppose that an alternating current be passed between electrodes in an electrolyte, and that the curves of potential difference between the electrolyte and one electrode and the curve of current be observed. Let the curve of potential difference be corrected for the fall of potential due to the conductivity of the electrolyte, thereby giving the E.M.F. of electrolysis measurable in volts. Let the current curve be integrated, giving the quantity of electricity measurable in coulombs. We should expect that as the maximum coulombs per half period increased the E.M.F. of electrolysis would also increase until it had the value given by continuous current, and that with further increase of the maximum coulombs per half period, the E M F. of electrolysis would have a constant amplitude. If the process were truly reversible, we should expect to find that the E M F. of electrolysis and current would have an effective phase displacement of one quarter period in time.

wave-form. Further research should deal with variation of wave-form. Small test pieces were placed in the solution to see if any action took place without the passage of the electric current. It should be noted that during the experiment the solution in a given cell changes, and, therefore, an average result has been obtained. No special care was taken to keep the temperature of a given cell constant, and the volume of fluid in each cell was about two litres.

LEAD.

H_2SO_4 dil.—**The electrolysis produced by an alternating current when passed between lead electrodes in dilute H_2SO_4 (100 parts H_2O + 5 parts H_2SO_4 by volume) has already been studied.* It was shown that for a given R.M.S. current density over the plate, less lead per square centimetre per hour was dissolved at frequency 92·5 than at frequency 21·5. A R.M.S. density of 0·0236 ampere per square centimetre would eat away the lead in one year to a depth of 2·6cm. and 4·8cm. respectively at the above frequencies. The same current density with direct current would eat away 70cm. in a year. Since**

* Paper read before the Faraday Society, July 3, 1905.

* See the *Electrician*, April 18, 1902.

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the R.M.S. current density is the same and the wave-form is the same in the two experiments, the maximum coulombs per half period will vary in the inverse ratio of the frequencies, but we do not find that the dissolved lead varies as the maximum coulombs. Referring to the table, experiments 1 and 2 show that at frequency 21·5 0·00629 grm. per hour per square centimetre were dissolved. This, multiplied by the ratio of the frequencies, would give 0·00146 grm. per hour per square centimetre, as against 0·00344 actually measured. Experiment 3 was undertaken to discover if at 92 frequency and approximately the same maximum coulombs per half period the weight of dissolved lead would be the same as in experiment 1. We find that five times as much lead is dissolved at the higher R.M.S. current density. The effect may depend upon the current density, since the maximum

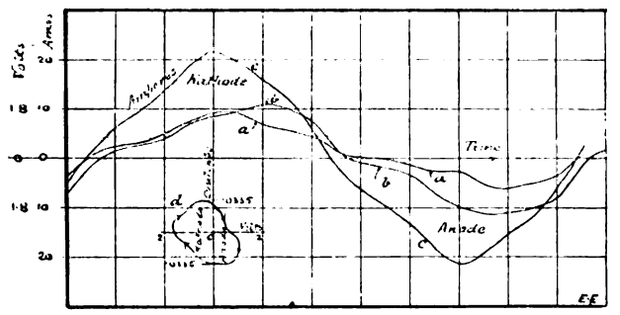

FIG. 1.

coulombs per half period are slightly less in experiment 3 than in experiment 1, whereas the current density is nearly fourfold. Also in experiment 3 the density of the electrolyte fell to 1,036 in eight hours, as against 1,049 in 15 hours in experiment 1. In experiment 3, curve *a*, Fig. 1, is the potential difference between the lead exploring electrode and one plate. This can also be taken to give the E.M.F. of electrolysis, since the conductivity drop is sufficiently small. The curve *b* is the potential difference between the plates, and *c* is the curve of current. It will be observed that the E.M.F. of electrolysis, *a*, does not change sign at the moment the plate begins to be an anode; the difference in phase represents the time taken to reverse the E.M.F. existing since the coulombs were last a maximum. The work done during this time is returned to the system. This is not the case when the plate begins to be a cathode, as the reversal of E.M.F.

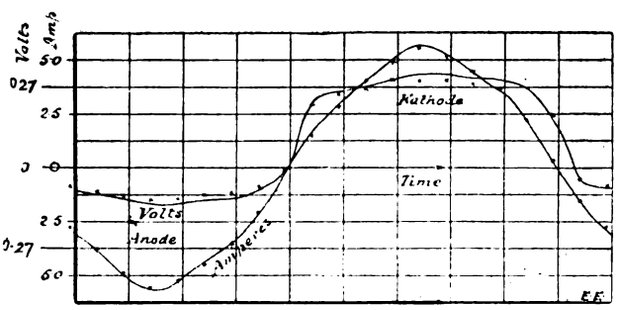

FIG. 2.

occurs simultaneously with the current. The coulombs have been plotted co-ordinately with the E.M.F. of electrolysis, giving the cyclical curve, *d*. As was previously pointed out, more work is done on the system during the time that the plate is a cathode than when it is an anode. The evolved hydrogen combines with the oxygen of the PbO_2, leading to the formation of $PbSO_4$, the maximum coulombs being sufficiently great to produce the peroxide. The plates are not, however, fully polarised in this experiment, much less so in experiment 2, and it may be that the low result in experiment 2 is attributable to the small value of the maximum coulombs. The electrolysis with lead electrodes at low current density is a subject worthy of further research. It is conceivable that electrolysis by alternating currents may be influenced by diffusion and certain local conditions. When observing the E.M.F. of electrolysis it was noticed that the electrometer deflection became unsteady at certain times of a period, indicating how easily it may be affected. In these experiments the plates were purposely placed near together, and did not give such facilities for diffusion as might otherwise have been obtained.

ZINC.

H_2SO_4 dil.—The most marked effects with zinc have been obtained when it has been amalgamated and placed in dilute H_2SO_4 (100 parts H_2O + 5 parts H_2SO_4 by volume). In experiments 4 and 5 the current densities are nearly the same, but the frequencies are different. The dissolved zinc at the higher frequency is greater than we should expect if we simply took the ratio of the maximum coulombs per half period into account. The figures are 0·00147, as against 0·00189 observed, and agree more closely than was the case in experiments 1 and 2. Again, comparing the results of experiments 4 and 6, in which the maximum

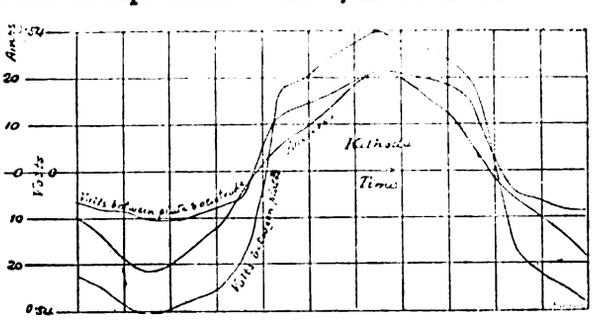

FIG. 3.

coulombs are the same, we find 0·0053 grm. per square centimetre per hour dissolved, as against 0·00695 at the higher frequency. It should here be noted that in experiment 6 the plates were not freshly amalgamated, nor was the solution freshly put up. After weighing at the close of experiment 5, the plates were again placed in the same solution and experiment 6 made. In experiment 7 freshly amalgamated plates and fresh solution were used, and the result is quite different from that obtained in experiment 6. To test the importance of the degree of amalgamation and the period of rest between amalgamation and starting the experiment, four new zinc plates were amalgamated to the same degree as nearly as possible and left nearly three days before being used. Experiments 8 and 9 were then made. Comparing experiment 9 with 7, in which the duration of test, frequency, and current density were the same, the agreement is better, since the

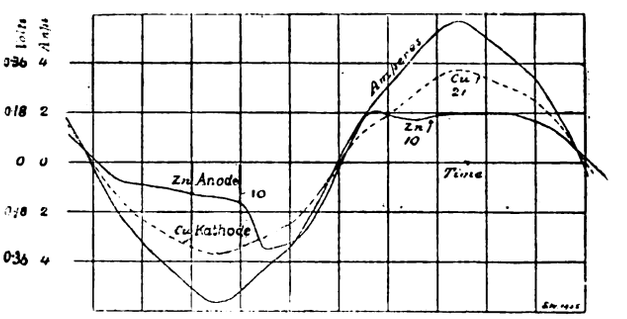

FIG. 4.

average grammes per square centimetre per hour are respectively 0·00103 and 0·00166 The results no doubt depend upon the preparation of the plates before the experiment. The full line curves in Fig. 2 were obtained during experiment 4, and the crosses show the corresponding points obtained during experiment 5. The agreement as to wave-form, phase, and amplitude of the E.M.F. of electrolysis at the two frequencies demonstrates that in the case of amalgamated zinc in dilute H_2SO_4 a change from 25 to 92 periods per second does not affect the possibility of the E.M.F. of electrolysis taking the same wave-form, amplitude, and phase relation. Experiments made with sufficiently increased frequency might throw some light upon the time taken to accomplish dissociation. Fig. 3 shows the curves obtained during experiment 7. The phase relations are practically the same, but the effect of conductivity upon the E.M.F. observed between the exploring zinc electrode and one plate when the current is near a maximum, is

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slightly observable. Test pieces of amalgamated zinc were in the solutions during the experiments, and were practically unchanged in weight.

Zinc Chloride (strong).—The zinc plates in experiment 10 had, when immersed in the solution, a smooth, clean surface, and when taken out after the test they were highly oxidised. In Fig. 4, curve 10 was obtained between the zinc exploring electrode and one plate. The potential difference rises to a maximum of 0·32 volt when the plate is an anode, of which 0·01 volt may be due to conductivity. Curve 10 may be taken to be the E.M.F. of electrolysis, and it is nearly in phase with the current. Although the plates have increased in weight during the experiment, it is due to oxidation which leads to their disintegration.

Zinc Sulphate (saturated).—Experiment 11 has had little or no effect upon the zinc plates immersed in saturated zinc sulphate solution. The potential difference between the zinc exploring electrode and one plate has the same wave-form as, and is in phase with, the current. There is no visible oxidation, and the process is probably almost reversible.

Sodium Sulphate (strong).—Under the conditions of experiment 12 the zinc plates immersed in this solution have gained in weight, and are still (than before experiment) after being rubbed with wash-leather to remove the surface oxide. The potential difference between the exploring electrode and one plate is shown in Fig. 5, curve 12.

Iron.

Ferrous Sulphate (strong).—The iron plates were cut from good transformer plate and cleaned with emery paper,

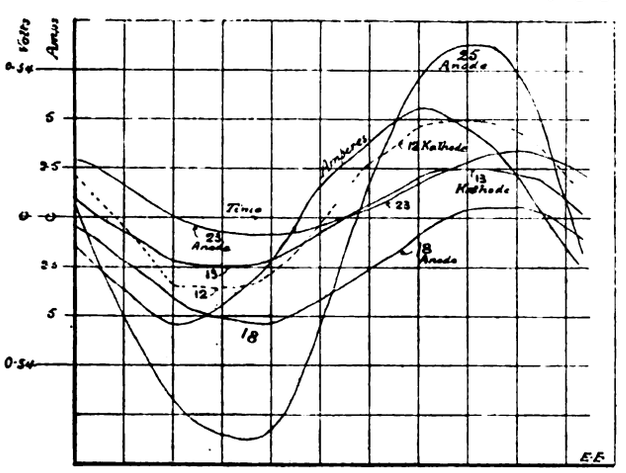

Fig. 5.

thereby presenting a bright but not perfectly smooth surface. Alternating currents have a marked effect upon iron in this solution. Experiment 13 was made first, and it was found that the plates lost 0·000462 grm. per square centimetre per hour. Without changing the solution, which during the experiment had taken up 2·4 grm. of iron, the plates, after being dried and rubbed with wash-leather to remove the surface oxide, were again inserted and experiment 14 made. The frequency was the same in each experiment, but the maximum coulombs were increased from 0·00956 to 0·0346. The result was to dissolve only 0·000457grm. per square centimetre per hour, as compared with 0·000462 in experiment 13, the solution again going up in density. Experiments 15 and 16 were then made with fresh solutions, but using tap water instead of distilled. A small quantity of H_2SO_4 was added to delay oxidation and to correct the calcium salts in the water. The result shows that 0·00389 grm. and 0·00445 grm. per square centimetre per hour were thrown down, and these are roughly eight-fold the weight thrown down in experiment 14, although the frequency and maximum coulombs are the same. The presence of some free acid in experiments 15 and 16 may be accountable for the high figues obtained. A test sample in the solution of experiment 13 lost 0·4 per cent. of its weight in 58 hours, as against 2·5 per cent. of the submerged portion in seven hours in the experiment. There is considerable electrolysis. Experiment 17 was then made. In it the solution was made with distilled water acidified to the extent of one cubic centimetre of H_2SO_4 in 2,000 cubic centimetres of water to delay oxidation, and nearly saturated with pure $FeSO_4$. Comparing experiments 13 and 17 for the relation between grammes dissolved and maximum coulombs per half period, we find that 0·000229 grm. per square centimetre per hour should be dissolved if the relation held, as against 0·000462 observed at the higher frequency. Similar results were obtained in the cases of lead and zinc in dilute H_2SO_4. Lead and iron give, roughly, the same ratio between the observed and calculated weights. It should be remembered that in these experiments not the whole of the plate is submerged in the solution, and there may be some additional effect at the surface of the liquid where it joins the plate. The curve obtained in experiment 13 between the exploring iron electrode and one plate is numbered 13 in Fig. 5. Its flat top indicates that the plates are fully polarised. It is considerably out of phase with the current.

Sodium Chloride (strong).—After washing and drying, the iron plates in experiment 18 have increased in weight, but in the solution a totally submerged test sample through which no current was passed increased weight nearly to the same percentage, so that there is no conclusive evidence of serious electrolysis. Curve 18 (Fig. 5) was obtained between the iron exploring electrode and one plate. It is very much displaced with regard to the axis of time, possibly due to the fact that the plate is easily attacked when it is an anode, thereby requiring less work during that half period. When passing from the cathode to the anode states a full quarter period in time is required before the work done on the plate becomes positive. Experiments 19 and 20 show that an increase in the weight of the plates takes place, thereby leading to disintegration.

Copper.

Copper Sulphate (strong).—In experiment 21 the copper plates acquire a fairly easily removable copper deposit, and show slightly diminished weight. The potential difference between a copper electrode, in the solution between the plates, and one plate is given in Fig. 4, curve 21. The curve is nearly in phase with the current, and has the same wave-form. One would expect a little electrolytic action. Comparing experiments 21 and 22, we see that, although the maximum coulombs are the same, more copper is dissolved at the higher frequency—*i.e.*, at the higher current density. The deposited copper in experiment 22 was not so easily removable as in experiment 21.

Sodium Chloride (strong).—In experiment 23 the copper plates were highly discoloured and covered with an easily removed metallic powder. The plates show diminished weight. In Fig. 5 curve 23 shows the potential difference between a copper exploring electrode and one plate. Comparing experiments 23 and 24, we see that much more copper has been dissolved at the low frequency than the ratio of the maximum coulombs would lead us to expect. The effect is considerable in experiment 24, and as sodium chloride is largely met with in the earth, this experiment may have practical importance. The difference would have been a little more noticeable if the detachable deposit had been removed from the surface of the plate before estimating the loss of weight.

Sodium Phosphate Na_2HPO_4 (strong).—In experiment 25 the copper plates were discoloured, but not diminished in weight. In Fig. 5 curve 25 gives the potential difference between a copper exploring electrode and one plate. Comparatively this potential difference is large. If correction were made for conductivity, the phase displacements might be sufficient to show almost complete reversibility, and thus account for the small effect observed. If this were so, the effect would be similar to what has already been observed when an alternating current is passed between platinum plates immersed in dilute H_2SO_4. Dissipation of energy still occurs owing to the decomposition of the electrolyte at the plates. Any copper phosphate formed in experiment 25 during one half period would be reduced during the next half period.

Tin.

Protochloride (strong).—In experiment 26 we see that 0·26 grm. of tin have gone into solution, thereby indicating considerable electrolytic action. The curve of potential difference between the exploring tin electrode and

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one plate is not given in Fig. 4, as there was a possibility of the electrode touching one plate during the experiment. It indicated a very small amplitude as compared with the others.

ALUMINIUM.

Potash Alum (saturated).—A good deal of work has been done upon aluminium in connection with alternate currents. It is known that the film formed on the surface offers considerable resistance to the electric current. In experiment 27 two aluminium plates were immersed in a saturated potash alum solution, and owing to the formation of a surface layer the internal resistance gave rise to such dissipation of energy that the solution was boiling after the experiment had progressed three-quarters of an hour. The plates were very much eaten away in places, but quite bright where they had been protected by the surface layer.

In conclusion, I wish to express my thanks to Prof. E. F. Herroun for valuable suggestions. Mr. D. Sheppard worked with me all through, and prepared the experiments. Mr. T. Mitchell has also rendered assistance, and has worked out some of the results. To these gentlemen I tender my thanks.

INTER-RELATION OF BALLAST AND GLOWER IN THE NERNST LAMP.*

BY LEWIS A. TERVEN.

The problems presented by the glower and the ballast are very difficult taken singly, but when a problem of one

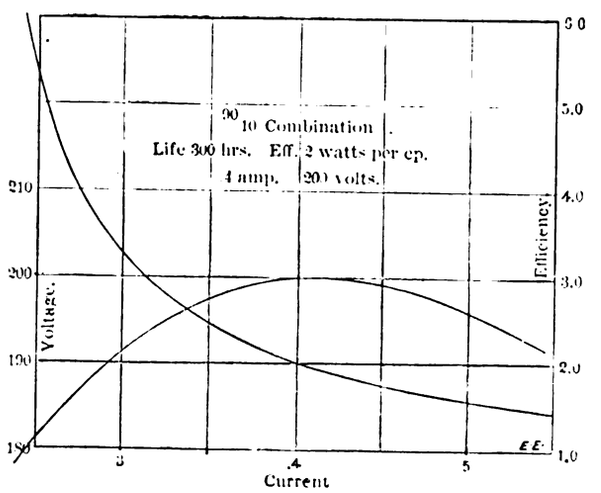

FIG. 1.—Curve on Average Glower.

is complicated by interconnection with a problem of the other the case becomes very complicated. It has been often said that the more complicated in theory an apparatus is, the simpler it operates in practice. While this is of itself untrue, at the same time the saying carries some truth. It is well known that the induction motor is an apparatus capable of a great deal more abuse than the direct-current motor, although direct-current apparatus is much simpler in design. Such is the case with the Nernst lamp. That it is a complicated lamp is freely granted, but that these complications interfere with the operation of the lamp is not admitted. The understanding of the physical occurrences of minor importance in the filament of the ordinary incandescent lamp offers just as many difficulties as do the parts of the Nernst lamp, but these small things have never been thoroughly investigated for the simple reason that there was no practical use in doing so.

Because the Nernst lamp glower is an unstable device it is necessary to use a steadying resistance in series with it, and this resistance has been called the ballast. As is commonly known, the ballast used consists of a fine iron wire, sealed into a bulb containing hydrogen. The hydrogen not only prevents the iron from oxidising, but, on the other hand, it materially affects the molecular arrangement of the iron resistance, so that the curve between current and volts is found to be much steeper in a hydrogen atmosphere than it is under other conditions.

* From the *Electrical World and Engineer* of New York.

Fig. 2 shows the normal ballast curve. It will be seen that the rise in resistance of the iron wire is quite rapid just above the point upon the curve where the lamp is normally operated. The ballast curve is usually plotted on the basis of percentage. This is the only fair way to show a ballast curve, but the current scale is extended in the curve shown, which makes the ballast curve appear flatter than it really is. The ballast is a very interesting piece of apparatus from quite a number of standpoints.

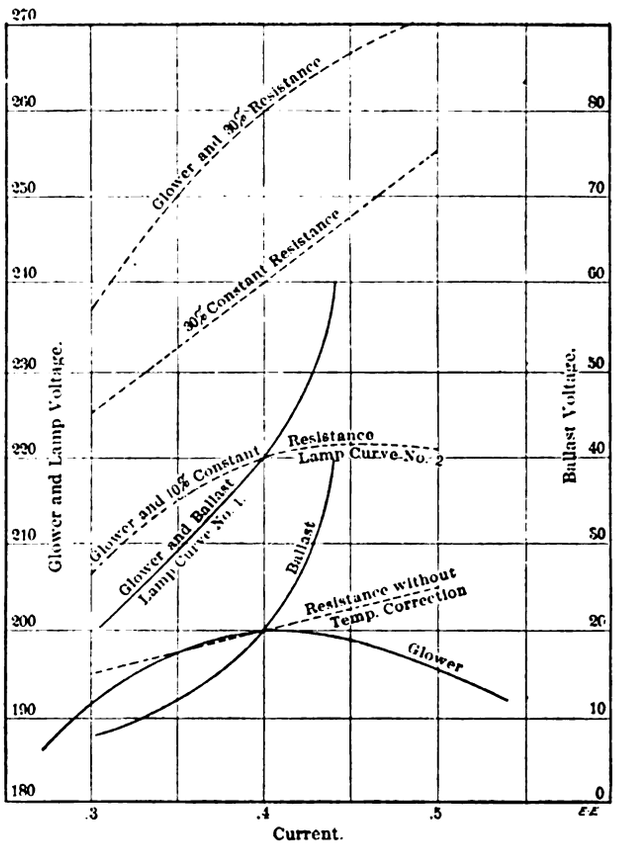

FIG. 2.—Normal Ballast Curve.

The shape of the curve may be changed and one may get a different characteristic from the lamp by working at different points upon the curve. The selection of the proper quality of the iron to be used for wire is of very great importance.

The beauty of the ballast is its sensitiveness. The reverse of sensitiveness is known as sluggishness; that is, failure of the ballast to immediately respond to changes in the line voltage. This is due to the specific heat of adjacent materials, as well as to interheating of parts and other things.

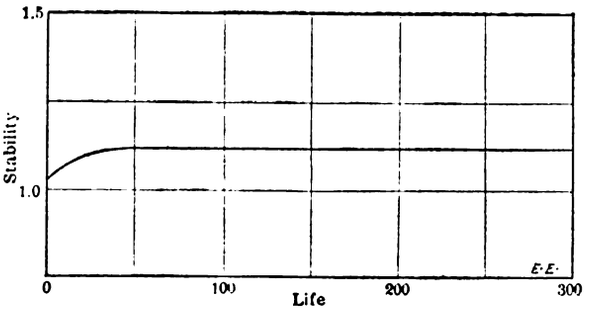

FIG. 3.—Curve showing Stability of Glowers.

The glower curve is shown in Fig. 1. This curve was taken at 300 hours, and is much steeper than the usual glower curve. In other figures, such as Fig. 4, glower curves are shown where the glower had been run only an hour. It can easily be seen by inspection that the glower changes its characteristics remarkably with age.

A very peculiar point is to be noted here. While the glower surface emission deteriorates about 13 per cent. during its life, the point upon the glower characteristic at which one operates at constant efficiency does not shift, or at least, if it does shift, moves over towards a more stable

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position. This can be seen by an inspection of Fig. 3. The curve shows a very rapid rise in stability during the first 100 hours, after which the curve is flat. By stability is meant the ratio of the abscissa of the peak of the curve to the abscissa corresponding to the point of two watts per candle-power on the glower curve between current and voltage. Of course, it must be borne in mind that the glower may be operated beyond the peak of the curve, in which case the stability must be reckoned as a negative quantity.

In a previous paragraph the need of a ballast has been referred to. The necessity can be easily seen by reference to any of the later curve sheets of the paper. In Fig. 2, which shows two lamp curves taken from an aged glower, one of the curves is taken in connection with a normal ballast, while the other one is taken in connection with a straight resistance, which consumes 20 volts at ·4 ampere. Lamp curve No. 1 shows how a rise in voltage is easily taken care of by the ballast, while curve No. 2 shows a very unstable lamp, and a rise of 5 per cent. in voltage would mean the destruction of the glower. If a simple resistance is to be used as a ballast, the percentage of ballast would have to be increased from 10 to 30, in order to take care of the variation in line voltage, and even this 30 per cent. resistance does not accomplish the same

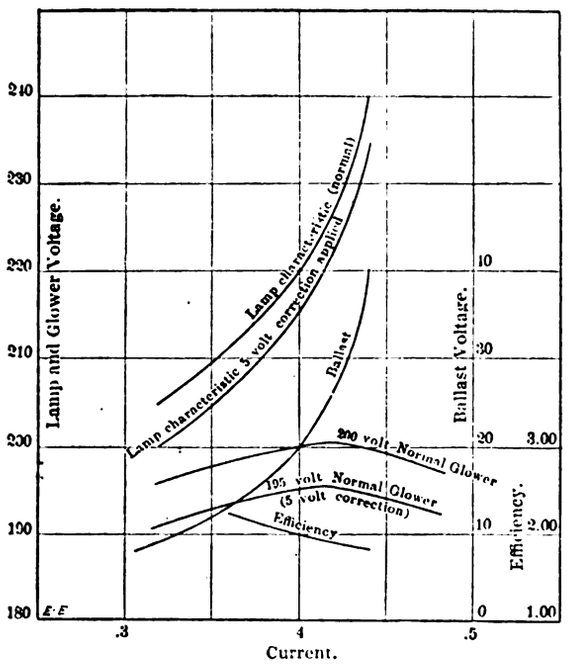

FIG. 4.—Effect of Glower Correction on Normal Glower.

result as the 10 per cent. iron ballast. One advantage of the ballast, which has no temperature coefficient, is due to the fact that the lamp is non-sluggish and the glower never gets an excess current, except that corresponding to an over-voltage circuit. The question of ballast sluggishness is a very broad one and is much too extended to be taken up in this paper.

The best way to learn how the ballast and the glower combine to make the lamp is to study curves illustrating different cases. Theoretically one has an innumerable variety of circumstances. For instance, the glower may be normal, or it may be squirted for too low or too high an efficiency. The ballast with which these three glowers are combined may be a normal, an under-voltage, or an over-voltage ballast. Taken in this way, nine curves would result, but all of these are not necessary. In Fig. 4 the normal ballast curve is combined with the normal glower curve to produce the normal lamp characteristic. The lamp curve so shown is very stable, and the lamp will withstand a 10 per cent. excess of voltage for continuous service.

The lamp will stand a temporary over-voltage of 20 per cent. without injury. On the same sheet (Fig. 4) a lamp curve is shown corresponding to a glower which is five volts lower sorted voltage than it should be. This corresponds to a method formerly used for so-called glower correction. During the early stages of the Nernst lamp development, and, in fact, up to 1903, glowers commonly had quite a rise in voltage during life. This amounts to from three to four volts per 100 hours on constant current. When such a glower is run in the lamp, during the first 100 hours it does increase in voltage by three volts, but afterward, because of running at a higher current, caused by a rise in glower voltage, the rate of rise in voltage of the glower is very small, because the rise in voltage of the glower is a direct factor of the specific consumption at which the glower is operated.

In order to partially overcome this feature, glowers after being sorted had a certain glower correction applied to them. This amounted usually to four or five volts, and was supposed to correspond to the rise in voltage of the glower during the first 300 hours—*i. e.*, a 195-volt glower would be rated as a 200—and at the end of 300 hours the voltage of the glower would really be 200 volts, which would put the lamp on its normal basis. It is seen by reference to the curve that this expedient threw the ballast into the position of an over-voltage, and the over-voltage which the lamp could stand was decreased thereby. At the same time, the glower ran at a larger current than normal, and necessarily gave more light than it was intended to give, and the efficiency was accordingly much higher than normal. Under such circumstances the decrease in candle-power of the lamp was very rapid. The custom of adding

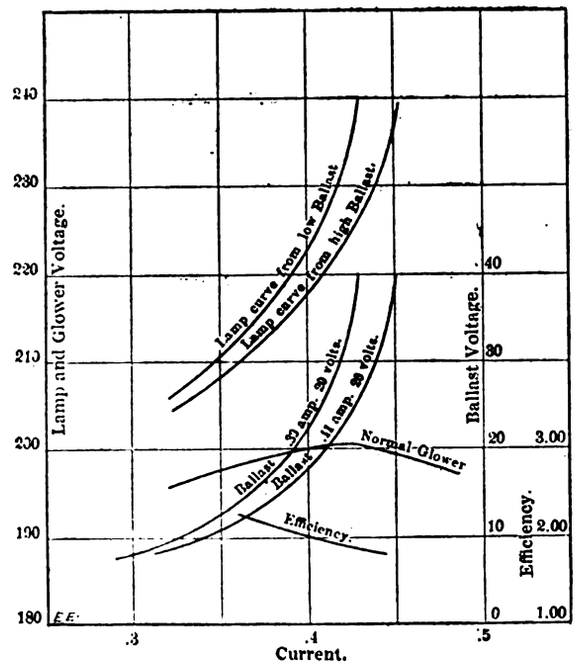

FIG. 5.—Effect of High and Low Correcting Ballast.

glower corrections was done away with in the early part of 1904, due to an arrangement being made to correct the glower mixture so as to get a material giving a very small rise in voltage with life.

Fig. 5 shows a normal glower when combined with a ballast running high in current. By referring to the efficiency curve it can be easily seen how the glower must do over duty when running with a ballast which takes an excess current, while the glower in the lamp with a small current ballast does not operate at a specific power consumption sufficiently low for a satisfactory efficiency.

A very peculiar thing may happen in case of a circuit with bad regulation, and a concrete example occurs to me which explains what I mean. Some single-glower lamps were installed upon a circuit which had a very bad regulation, rising from 104 to 117 volts, and staying at the latter figure throughout the latter part of the night. In the morning, when the light was really needed at its best, the voltage was down to about 108. Now, ordinarily, had we installed 112-volt glowers, 108 volts would have given a fairly good light, but it must be remembered that these glowers had been operated during the night on an over-voltage, and after quite a deal of service upon over-voltage necessarily rose to meet the maximum demand—that is, the glower tried to approximate the necessary voltage to take 0·4 ampere on 117 volts. Now, when burned on 108 volts one can readily see how small the current taken

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will be. Such a case is not against the glower, but really shows how it accommodates itself, just as the human eye adjusts itself for the maximum light within vision.

The effect of missing the die is shown in Fig. 6. One glower has a specific consumption of 2·15 at 0·4 ampere, while the other has a consumption of 1·85 at 0·4 ampere. When compounded with a normal ballast, the glower which resulted from the large die does not get its full amount of current necessary to bring it to two watts per candle-power, as can be seen from its efficiency curve, while the glower with the small die gets more current than it should and runs at an over-consumption and strains the ballast. In Fig. 7 the worst conditions possible have been shown. Here ballast curves have been plotted where the current is too high and too low. Glower curves have been plotted where the consumption of the glower is too high and too low. By combining the ballast which runs low with the glower which runs at an under-consumption, the worst conditions are obtained for light emission. This may be seen by reference to curve No. 1. Lamp curve No. 2, which is made from the ballast curve with high amperage and the glower curve with too high consumption, is seen to be more unstable. This is because the glower runs at such a consumption as to bring it over the bend of the curve. Such a lamp will give a great deal of light, but will strain the glower. In the previous example the glower will receive no injury, but the ballast will be strained.

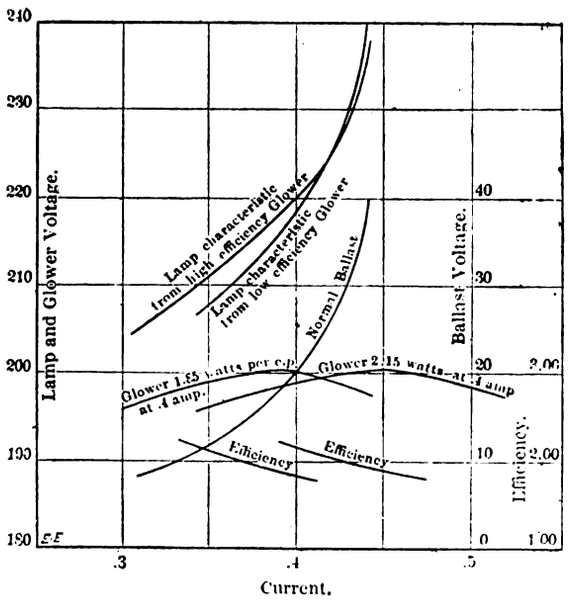

FIG. 6.—Effect of Combining with a Normal Ballast a Glower which has missed the Die.

For easy reference there is compiled a table of strains. A strain is always referred to the normal lamp, which consists of a normal glower in series with a normal ballast. When either the glower or the ballast in a lamp is abnormal, it is presumed that the parts suffer as the standard product would under conditions which produce a similar strain. For instance, if a ballast which runs 0·39 ampere at 20 volts is put into a lamp and the lamp current is found to be 0·395, the ballast is in a condition of strain, because its normal is 0·39 ampere instead of 0·4 ampere, as in the case of the regular product.

The check of any strain when referred to a similar strain upon the normal lamp is that the condition of the glower or ballast considered shall be physically the same; thus glowers are compared on the basis of equal efficiency (specific consumption) and ballasts on the basis of temperature of the iron resistance wire.

Numerical examples will illustrate the methods described. Take the case of the lower consumption glower and low ballast shown in Fig. 7. A lamp composed of these parts would take 0·397 ampere at 220 volts. The normal for the glower is 0·43 ampere—that is, at this amperage the glower runs at two watts per candle-power. Hence the glower is running at a current 0·033 ampere less than its normal. When compared to the normal lamp we find that a current of 0·368 of an ampere is required to produce similar conditions, so far as the glower is concerned, when

$$\frac{\cdot 397}{\cdot 43} = \frac{x}{\cdot 400}, \text{ or } x = \cdot 368 \text{ ampere.}$$

Referring this amperage (0·368) to the standard curve of Fig. 4, it is found that 212·8 volts is the lamp voltage which will produce 0·368 ampere in a normal 220-volt lamp.

For the ballast we have the current as above at 220 volts upon the abnormal lamp, equal to 0·397 ampere. Now, the ballast normal is 0·39 ampere, and equating as above

$$\frac{\cdot 397}{\cdot 39} = \frac{x}{\cdot 4}, \text{ or } x = \cdot 407 \text{ ampere.}$$

In other words, a current of 0·407 ampere flowing through a normal ballast produces a strain upon it which is equivalent to the strain produced upon a 0·39-ampere ballast when 0·397 ampere flows through it. Comparing this value with those found from the curves of Fig. 4, it is seen that 221·9 volts upon a normal lamp will produce 0·407 ampere.

The table of strains shows several things that could not be well obtained by a glance at the curves. Above all, it shows the great care that must be exercised in the manufacture of the glower and ballast that they will not vary in their relations to each other.

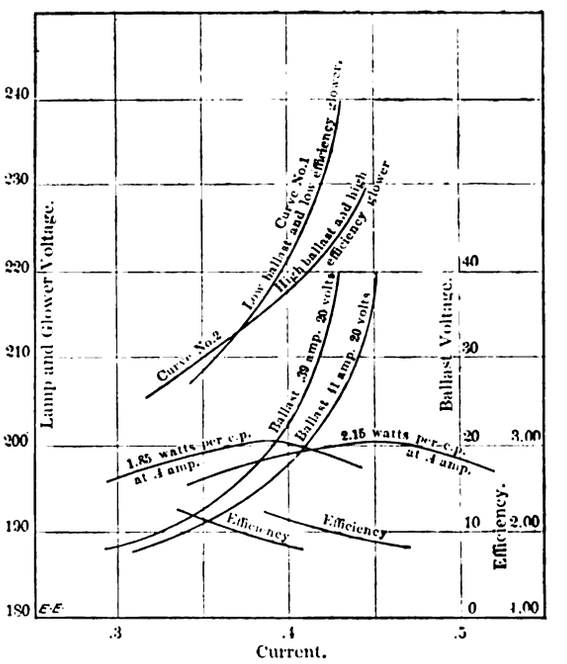

FIG. 7.—Effect of Combining a Glower which has missed the Die, with High and Low Correcting Ballasts.

TABLE OF STRAINS.

	Equivalent circuit voltage on glower.	Equivalent circuit voltage on ballast.
Five volts correction on normal glower	224·8	224·8
Low ballast with normal glower	217·5	220·4
High ballast with normal glower	222·5	219·6
Low-consumption glower and normal ballast	214·2	221·0
High-consumption glower and normal ballast	232·0	219·0
Low-consumption glower and low ballast	212·8	221·9
High-consumption glower and high ballast	240·0 plus probably 245.	220·0

The fact has been mentioned before that the glower characteristic can be materially changed by altering the proportions of chemicals used in manufacture. One certain mixture is adhered to because it is found that this mixture gives the best all-round working results, but the standard mixture is not quite so stable as a glower mixture differing only by a small percentage in its components. The curve may also be slightly changed by altering the physical characteristics of the chemicals used, without varying the proportions. It is an important matter to get as steep a characteristic as possible, and one which does not reach the knee of the curve between volts and current until a very good efficiency has been attained. However, it does not seem possible to do much better than is now being done.

When a glower is first run a great deal more light is emitted from its surface in proportion to the tem-

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perature at which it is operated than happens afterward in its life. This is explained by the fact that the glower surface initially has a selective radiation—that is, the radiation is concentrated in the visible spectrum. It is not certain that the glower has a selective radiation. The phenomenon is possibly caused by the fact that the glower has a certain porosity when new, but with age it attains a crystalline structure. The quality of the light does vary with the surface. When the glower is new the light is of a whiter hue. As the glower obeys the common law for black bodies heated to incandescence, although it is a white body, the hue of the light depends upon a function of the absolute temperature of the glower. The quality of the light may also be shifted toward the blue end of the spectrum by absorbing rays that fall within the red and orange part of the spectrum. The light falling upon a surface after being transmitted through a thin cobalt glass wall will appear very white, even though the glower may be operating at a specific power consumption as high as 2½ watts per candle-power.

Because daylight differs so much owing to different amounts of diffusion which it has undergone, it would be difficult to give a table showing how near the Nernst glower approaches daylight for different efficiencies. If a glower is exposed to the sun on a bright day, and it is attempted to make the light of the glower falling on a white screen equal in value to the light falling direct from the sun, it will be found that the glower must be operated at as low a consumption as 1·2 watts per candle-power. Under such circumstances a glower will not live very long. On the other hand, if one wishes to duplicate diffused daylight in a hall it can be easily done with glowers running at two watts per candle-power, but it must be remembered that if shades are put upon the glowers the tendency is to throw the spectrum down toward the red end. The diffused light in ordinary residences is duplicated almost exactly by the light received from Nernst lamps using opalescent balls absorbing about 16 per cent. of the light passing through them. Heavier balls usually give a yellowish effect to the light. Sand-ballasted and etched balls do not play so much havoc with the colour value of the light.

In what precedes is given a study of the ballast and the glower under circumstances where a sufficient time has elapsed after starting the lamp that the operation of the lamp will have attained its final value. Everything is much more complicated during the time the lamp is starting and up to 30 minutes after the switch is turned.

UP-TO-DATE ELECTRICAL POWER DISTRIBUTION.

BY ROBERT LORAINE GAMLEN.

A paper on the above subject was communicated on Wednesday last to the meeting of the Institution of Mining Engineers in Manchester. In the first part of this the author gives an interesting *résumé* of electrical progress during the past 28 years, confining his attention more particularly to the growth of the distribution of electrical energy. The transmission of current to London from the Deptford station at 10,000 volts in 1885 is referred to as the pioneer to long-distance power transmission. The introduction of the three-phase system for transmission and the three-wire system for distribution are also alluded to by the author. He also shows that electric lighting engineers have appreciated the value of a power load as a means of increasing the hours during which their plant can be usefully employed. In this respect, however, the large power companies have the advantage that their works are designed after experience gained from the smaller stations of electric supply undertakings. Thus he shows that in the records of electricity concerns a capital of £100 per kilowatt of plant is no uncommon figure, but a quarter of this figure should be obtained by a power company. The capital of an electric supply company is spent on lands, buildings, boilers, engines, dynamos, auxiliary machinery, switchboards, mains, sub-stations, and distributing apparatus. The factors controlling the choice are absolute immunity from breakdown, perfect regulation, small fuel consumption, ease of working, and consequently a low wages bill. The balancing of these factors so as to obtain the best economic results is the art of designing the power system.

Mr. Gamlen then describes what has been done by the Lancashire Power Company in their new station now completed. Before doing so, however, he refers to one point which has been discussed a good deal lately with reference to power generation, and it would be as well to dispose of it now. The question is that of generation of power by means of gas-engines, the only excuse for the gas-engine being diminished coal bills. The cost at which power can now be produced by large turbines is so low that the diminution which could be obtained by using gas is of less importance than it was some years ago. A really large saving can only be obtained by using ammonia recovery, and such processes are hardly desirable adjuncts to high-pressure power stations. The arguments against the utilisation of the gas-engine are chiefly constructional ones: the floor space required for a 2,000-h.p. two-cycle gas-engine, without any auxiliary apparatus, is about 2,800 square feet; a Curtis turbine of the same capacity need only have 120 square feet. But 2,000 h.p. for a power company is a smallish set, 8,000 h.p. being more near to the useful standard size. No gas-engine of such size has yet been constructed, and if it were it would be a horrible enormity. The time may come when the long-dreamed-of gas-turbine will become an accomplished fact. This will, of course, greatly change matters, and then steam may find a serious rival in the internal-combustion engine. Another objection to the gas-engine is that the angular velocity is not sufficiently constant, and upon perfectly even turning a great deal of the utility of the modern power company, especially in Lancashire, depends. The turbine has an absolutely constant angular velocity. A turbine drives a three-phase generator with even running, the speed of the three-phase motor bears an exactly constant ratio to that of the generator, and consequently the machine, driven by a motor in this way, will also have a perfectly constant speed. Further, experience has not yet demonstrated the reliability of gas-engines of above 500 h.p. or 600 h.p., and it is essential that a power company shall be reliable above all other things.

The power companies have in nearly all cases laid out their schemes on somewhat similar lines. Three-phase distribution has been adopted at a pressure generally of about 10,000 volts. The current has been generated at high pressure, generally by means of turbines running with high vacuum and high superheat. The water-tube boiler has been universally adopted and one or another form of mechanical stoker used.

In the case of Lancashire, the first station has been placed between the River Irwell and the railway, upon the far side of which is a coal mine, from which supplies can be obtained. The site is convenient, inasmuch as there is an ample water supply for condensing purposes; the railway being situated above the boiler-house, the coal is conveyed by gravity into the bunkers, and thence it is fed on to chain-grate stokers operated by electric motors. The first boiler-house is divided into two banks of three boilers. The two banks are each capable of evaporating 60,000lb. of water per hour. The boilers feed on to one common ring of pipes, and the turbines are fed from the same, so that two turbines are fed from one bank. One bank of boilers, then, with its chimney and two turbines, constitute one unit. It is proposed to make extensions in like manner, except that, instead of one bank of boilers feeding two turbines, each bank will feed one machine of larger capacity. The water-tube boiler is used on account of the very great steaming capacity for a given floor space, and for its great powers of responding to forcing. It is, of course, highly important when dealing with large-size generators to arrange that sufficient boiler capacity can be available without the steam having to travel through vast lengths of main. By placing the boilers at right angles to the turbines, very satisfactory arrangements can be arrived at.

The turbines revolving at 1,000 r.p.m. look, of course, exceedingly small for the amount of work they do; indeed, the amount of power that can be obtained on a certain floor space by their means seems nearly incredible to the engineer who has been accustomed to work with the older slow-speed engines. The turbine lends itself particularly

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well for condensing; in the case of the Curtis turbine there is no exhaust pipe, the condenser being coupled direct to the engine. This can be done in two ways, either by placing the condenser side by side with the turbine, or underneath, either arrangement being very compact and convenient. In Lancashire the air-pump is placed beyond the condenser, so that the three form really one plant. The result is that an engine-room only 96ft. long and 32ft. wide is needed to house four sets of 2,000 kw. each, or 8,000 kw. in all, whereas in nearly all previous cases as large a building has been necessary for an engine of 800 h.p. and less. When the extensions take place, this ratio of plant and buildings will diminish again, as the diameter of the 5,000-kw. set is comparatively little larger than the 2,000-kw. plant. In the case of the Curtis combination, the dynamo is placed on the same spindle as the driving buckets and vertically above them. Owing to the high speed of rotation the electrical generator is of very small proportions, the diameter being only some 7ft.; whereas an ordinary direct-coupled set, at about 150 r.p.m, would be somewhere about 25ft. to 30ft. high, and, of course, much more expensive.

Mr. Gamlen then deals with the switchboard construction, which is of the British Thomson-Houston Company's type, with remote control for all the main switches. He also shows the advantage of having high voltage for transmission, as this enables the supply to be given economically over large areas, thus securing a great variety of load on the station. It is likely, therefore, that the number of units produced by a power company when attaining to moderate size for each kilowatt demanded should reach 2½ times that of the ordinary town supply—that is, the load factor of an ordinary combined lighting and power supply will be high at 18 per cent, that of the power company should reach 45 per cent.—and this, as before explained, greatly reduces all the annual capital charges.

There is great prejudice in this country against the use of overhead mains, but this is gradually being overcome, and already great advances are being made. In the original scheme, the whole of the Lancashire mains were intended to run underground; already it has been arranged that some 10 miles of route shall be overhead. By this means expensive insulation is saved, and also the excavation and reinstatement of the roads, greatly reducing the cost of the transmission system. Further reduction is obtained also, as often the cross-country overhead route is much shorter than if the roads had to be followed. The main routes are laid in duplicate, and are planned to go through the most likely districts for supply.

Arrangements are made with the various local authorities for the supply in their areas. In some cases the current is sold to the authorities and they distribute to the small consumers at low pressure, and in other cases the company act more or less as agents for them, and look after the distribution. In all cases large power users are served direct from the high-tension mains. In most cases the current used is three-phase, as this is most suitable for almost all purposes; the reduction apparatus in this case has no moving parts and requires no attendance, so that even in this extra stage to that needed by the ordinary supply concern no extra expense is incurred.

The following points show out the general scheme of the lay-outs of the power company, and show where the difference occurs between it and the ordinary town supply: (1) the power company chooses its site near the fuel and by the water; (2) the power company spreads out over a large area and caters for a large long-hour load, consequently it can start on large lines with large units of plant, the capital cost of plant per horse-power diminishing as the size increases; (3) the load factor of the power company should reach 45 per cent.; and (4) all the working expenses of the power company per unit are extremely small on account of the size and convenience of the units. On the other hand: (1) the town supply is located by the area of supply, and it seldom can be placed near water, and hardly ever near a coal pit; (2) the town supply has a constricted area and can only work in small units, and small units are more costly per horse-power than large ones; (3) a good mixed town supply can hardly ever have a better load factor than 18 per cent.; and (4) the wages bill of a town supply is generally a large factor of the total costs.

The preceding recited points show that power companies hope to be able to supply electricity far more cheaply than town undertakings, and the future will show whether their ideas are based on fact or fiction.

ELECTROLYSED SALT WATER FOR DISINFECTING PURPOSES.

Mr. W. F. Alexander, the medical officer of health for the metropolitan borough of Poplar, has presented a report to his committee upon the manufacture of electrolysed salt water for disinfecting purposes. He shows in his report that this disinfectant can be economically obtained, and that it would be quite as effective as the disinfectants now issued by his department. The following extracts from his report will revive interest in a process which was introduced into this country some 10 or 12 years ago for the treatment of sewage by means of electrolysed salt water. This was the Hermite process, the use of which has not been extended beyond the few places where it was first tried. It is quite likely, however, that as a disinfectant for private use or for flushing drains that the electrolysed salt water may be more economical than the disinfectants now used. The production of the same would provide a steady and valuable load for the local electric supply station, as the process could be carried out in such a way as not to clash with the lighting peak. This would enable a very cheap supply of electricity to be given. We omit a considerable portion of Mr. Alexander's report which deals with the chemistry of the process, as this will be well known to the majority of our readers. To put it briefly, the electricity passing through the salt water converts the magnesium and sodium chlorides into hypochlorites. We are more concerned with the figures of cost, and on this point a good deal of recent information is given. Mr. Alexander in his report states: "I have been in communication with a firm of electrical and mechanical engineers, Messrs. Geipel and Lange, of Vulcan Works, 72A, St. Thomas-street, S.E, the successors to Messrs. Paterson and Cooper, the firm which installed the plant (Hermite system) at Ipswich, Lytham, and the Victoria Hospital, Netley. These engineers, at my request, have been in communication with friends in Paris, and finally write me as follows: 'This is as small an apparatus as we could make, and is capable of producing 250 litres of disinfectant solution per hour, having a strength of 1 grm. of chlorine per litre. Such a solution is strong enough for deodorising sewage and other like purposes, but we are of opinion that for ordinary cases of domestic sanitation a solution of half this strength would be sufficient, so that it would be possible by watering down to obtain from this apparatus 500 litres of solution having a strength of ½ grm. of chlorine per litre. We believe that with this apparatus and with solution of this strength you could have excellent results. This electrolyser would require 30 amperes continuous current at a pressure of 110 volts, but, if more suitable to you, 20 amperes would be sufficient for longer periods, or, if necessary, 40 amperes could be put into the apparatus. It would be necessary to have a rheostat in the circuit to regulate the current; the only other apparatus would be a tank or reservoir placed at a higher level to the electrolyser containing the solution to be electrolysed, which reservoir should be connected to the electrolyser by a rubber pipe. Our price for this electrolyser complete, but without the tank above referred to, would be £95, carriage from Paris extra. The solution to be employed with this apparatus should be composed of water, 1,000 litres; ordinary salt, 40 kilos; chloride of magnesium, 10 kilos.'"

As regards the cost of electricity, Mr. Bowden, borough electrical engineer, has written to Mr. Alexander that "the pressure on the ordinary low-tension mains is 230 or 460 volts. To give you a special service at an E.M.F. of 110 volts would necessitate the installation of a motor-generator, or a large resistance which would be very wasteful, unless the machinery which you propose to drive would be in duplicate, when you could run two in series,

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and thus overcome the loss in the conversion from 230 or 460 to 110 volts. With reference to the cost, the lowest price that I think we could at the minute quote you for this small amount would be a flat rate of 1½d. per unit, and taking your own figures—*viz*, 30 amperes at 230 volts—this would represent somewhere about five to six units per hour, equal to 9d. per hour."

The author has also been in communication with another firm for the supply of plant for making the electrolysed solution, and understands that both firms would be prepared to supply the necessary equipment on rental or royalty. He points out that it would be more economical to instal a motor-generator to reduce the voltage than to employ a rheostat, which would involve waste of practically half the energy used. As regards the cost of manufacturing, the report reads as follows: "Mr. Bowden quotes 9d. per hour for 30 amperes at 230 volts, and, therefore, for eight hours, an ordinary day's work, the cost for electricity would be 6s. This with a rheostat, but it would be cheaper with a motor-generator, as 110 volts for one apparatus is required, but without a rheostat or motor-generator two plants can be worked in series for this sum. With a pressure of 110 volts and 30 amperes continuous current, 250 litres can be made, or 440 pints or 55 gallons per hour, the cost of the electricity, even with the waste in the rheostat, should there be no motor-generator, being 9d. In a working day of eight hours, therefore, 2,000 litres can be made, or 3,520 pints or 440 gallons, at a cost of 6s. for electricity. Rock salt costs £2 per ton; chloride of magnesium £4. 10s. For every 55 gallons of fluid there would be required 22½lb. of salt and 5½lb. of chloride of magnesium, and at the price quoted above for 440 gallons of fluid the cost would be 3s. 3d. for salt and 1s. 10d. for chloride of magnesium, and with 6s. for electricity, the total cost of 440 gallons would be 11s. 1d., against £15 for a like amount of our present fluid."

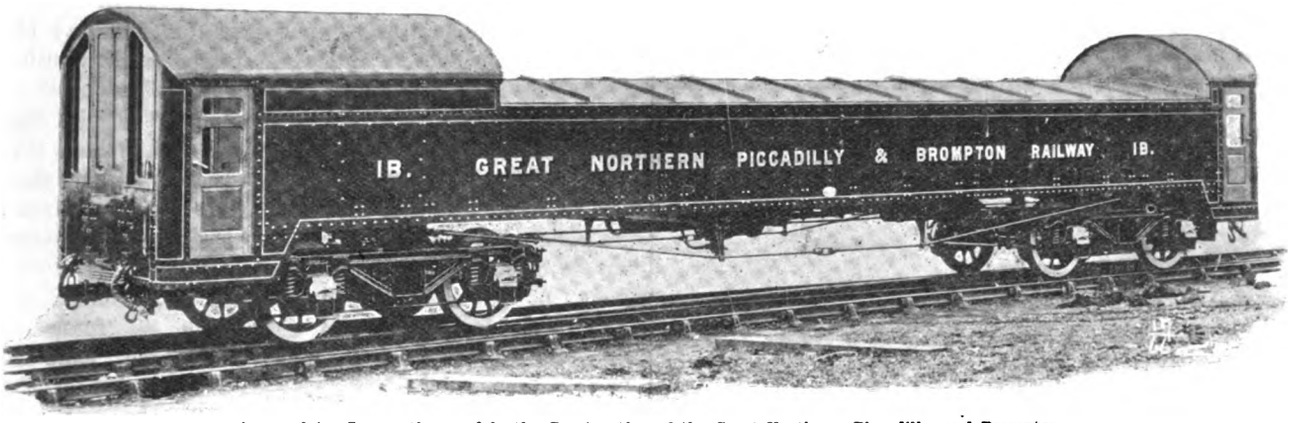
Our readers are hardly concerned with the details of the disinfectants actually issued last year by the Poplar health department, but the total cost of the same was practically £458, exclusive of labour, which cost £292 more. It will be seen, therefore, that on this expenditure there is room for considerable economies, and that it is worth while going to a reasonable capital expenditure.

In conclusion, the author states that in his opinion the health of the district must be materially enhanced by the use of electrolysed salt water as a disinfectant, and a great saving of money will be assured to the ratepayers.

We understand that if the proposal is adopted, the strength of the solution actually delivered to the public would be one containing 4 grm. of chlorine per litre. It is likely, also, that two electrolysers would be used in series, so as to avoid the first cost of the motor-generator or the energy which would be wasted in a rheostat. The first cost of the motor-generator in question would be £72, while the second electrolyser would only cost £95. It will be interesting to see the outcome of this report, and we trust that the proposed system will be given a good trial in Poplar. Success there should lead to its adoption elsewhere in the country.

ACCUMULATOR LOCOMOTIVES.

For the purpose of removing excavated material and taking in the iron tunnel segments, sleepers, rails, and other material required in the construction of the Great Northern, Piccadilly, and Brompton "Tube" Railway, there have recently been constructed by Messrs. Hurst, Nelson, and Co., Limited, of Motherwell, N.B., two electric locomotives to be worked by storage batteries, and also eight bogie wagons for use in conjunction with the electric locomotives. The locomotive bodies are 50ft. 6in. in length over buffers, and are constructed of steel, with a flooring of jarrah wood. The floor frames are of 9in. by 3½in. by ½in. channel steel, the side sills being of 8in. by 4in. by ½in. steel girders, intermediate sills of 7⅞in. by 3in. by ⅜in. channel steel, the whole trussed by two side truss rods placed under each side sill, and H steel girder needle beams carried across at each truss post. The side frames are of steel plate ¼in. thick riveted to the side sills at the bottom and to a steel angle and flat at the top, and, where the storage battery is located, are lined with jarrah wood. A view of one of the locomotives is given herewith. The batteries, which have been supplied by the Chloride Electrical Storage Company, consist of 80 Chloride cells, each containing 21 plates, and weighing in all about 36 tons. The normal discharge current is 179 amperes, whilst the maximum emergency load is 800 amperes. The batteries will be capable of storing sufficient energy to operate for a whole working day without recharging.



Accumulator Locomotive used in the Construction of the Great Northern, Piccadilly, and Brompton Tube Railway.

At each end of the locomotive there is a driver's cab fitted with a British Thomson-Houston master controller, whilst one cab (10ft. 10in. in length) is extended so as to accommodate the controlling apparatus, the air-compressor, and the air-receiver. The cabs are constructed entirely of steel, and are so arranged that they join the portion carrying the battery, the latter being on the jarrah wood floor in two divisions, separated by a lattice girder frame passing longitudinally down the car from cab to cab, and its top supporting a series of sloping doors which cover and protect the secondary batteries. The width of the locomotive is 8ft., whilst the height from rail level to top of cabs is 9ft. 6in, the distance from rail level to top of battery tank being 6ft. 8in.

The locomotives weigh 65 tons each, and their free running speed on the level, when hauling a load of about 60 tons, is from 7 to 10 miles per hour. They are each fitted with the automatic centre coupler buffers, and also with the Westinghouse air-brake.

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Winders for direct-current and alternating-current work. Apply to Bruce Peebles and Co., East Pilton, Edinburgh. See advertisement.

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RAILWAY AND TRAMWAY COMPETITION.

The chairmen of our large railway companies have of late years given many detailed statements as to the effect of tramways on the traffic returns of their systems. These statements are reflected in the report of the Board of Trade for 1904 as to the working of the whole of the railways within the United Kingdom. A few extracts from this report are given in this issue. The figures as to the total number of passengers carried for a series of years show that in the days of horse tramways the railways held the supremacy. In 1899 and 1900 there was little to choose between the total number using railways and tramways, but since then electric traction has put the tramways far ahead. In 1904 some seven hundred millions, or 65 per cent., more passengers used the tramways than the railways. The figures for the rate of increase on each system are even more striking, and indicate that the railway passenger traffic has nearly, if not quite, reached a maximum. With tramways, on the other hand, the yearly rate of increase is itself increasing. So far as mere numbers are concerned the result is bad for the railway companies, and it is obvious that the competition is by no means a fair one. They provide a service over lines laid on private rights-of-way secured at great cost, whereas the tramways use public streets without any further charge than is involved in the maintenance of a certain portion of the street surface. It is also the network of lines possible in public streets which gives the tramway the great advantage over its rival as a passenger distributing agent. This is shown by a comparison of the fares obtained from each passenger on the two systems. The third-class railway fares average 6·5d. per journey, which shows that the travellers on railways go for a considerable distance. The tramway fares, on the other hand, average between one penny and three halfpence, so that the rival systems may be compared to the feeders and distributors respectively of an electric power station. Considered on these lines, it would seem as though the future of our railways will be confined more and more to long-distance travel, and that the distribution of the population through industrial areas will be taken up entirely by tramways. With electrified railways vast improvements could be made on these lines in the intercommunication between adjacent towns, and between towns and definite tramway centres in the country. Another feature in the report which electrical engineers will do well to study is the respective gross income of the railways from passenger and goods traffic. These figures for 1904 show that some forty-eight million pounds were received from passengers, as against fifty-five million pounds from goods traffic. The earning power of trains used for the two services is also given as 48·09d. per train mile from passengers and 85·42d. per train mile from goods. Thus as a nation we spend about 15 per cent. more per annum for the transport of our raw materials, manufactured goods, and food than we do in travelling for business or pleasure. A large portion of this goods traffic must always be conducted on the railways, but here, too, there is a great opening for a cheaper distributing agent. Several of our larger tramway undertakings have instituted goods services, but the work done is infinitely small compared with what is possible in this direction. Electric traction will quicken the goods service and render it economical to increase the frequency of dispatch, which will attract business which the present railway facilities cannot meet. This is especially the case in industrial districts, where a goods service on electrified light railways or tramways will render the factories in outlying districts most valuable aid. The improvement

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in the load factor on the lines from the diversity of load so obtained will render remunerative many lines which cannot be financially successful if run for passengers only. The above report indicates clearly the influence of electricity on the transport facilities of the country, and that by improved methods a greater traffic is dealt with than was possible some years ago. Co-operation between the present rivals, rather than competition, is to be desired for the public good.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COST OF POWER PLANT.

SIR,—I note in a report which you give of the discussion of Mr. Snell's paper that you have reversed the figures of the cost of the installation of generating plant in private power stations. Mr. Snell stated that a private installation could not be erected under a cost of £45 per kilowatt, and as I considered that his estimate was altogether too high, I gave him certain figures, which are actual costs of installations which my firm have in hand at the present time, and these are as per copy attached, marked No. 1 Mr. Snell objected to my figures both as regards cost of plant and the cost of production, and unfortunately I was not present at the discussion, but I sent a communication to the North-East Coast Institution, of which the attached, marked No. 2, is a copy.

In conclusion, I can only state that the figures which I give are not imaginary figures, but are costs well on the high side of actual work in hand. There is no doubt that power stations have an immense future before them when they can supply current at prices within measurable distance of what it can be produced in private stations, but it is only right that consumers should know what the cost of a private installation should be if they had to consider the merits of either producing themselves or purchasing from the supply company.—Yours, etc., W. C. MOUNTAIN.

[This matter is referred to again in our front notes.—ED., *E. E.*]

HOTEL WIRING.

SIR,—I have just read your article on hotel wiring on p. 229 of your issue of the 18th ult., and trust a little criticism and additional information will not be out of place. I quite agree that on the Continent the various convenient adaptations at the disposal of wiring contractors are better appreciated and oftener brought before the notice of hotel proprietors than they are at home, although such have a fair adoption here also.

Fig. 1 of your article is an old friend to wiring contractors at home, and large hotels here were so fitted as far back as 1891. Anything a visitor finds a convenience at an hotel would be a large factor in inducing him to come again and also recommend the hotel to his friends, as novel applications remain in mind and are the means of providing good advertisements for the proprietor. Your remarks *re* the ugly appearance of treble flexible on porcelain insulators would have little interest here, as such wiring is not very general, although no doubt in the near future it will be made good use of. Fig. 2, I fear, is of little use, and would be unpopular on account of the necessity of both switches having to be placed in their "off" positions before the lamp can be extinguished. Fig. 3 is an old friend up to a certain point—viz, a two-way and "off" position switch controlling either of two lights. The same objection as in Fig 2 also exists here—viz., that switch S must be in its "on" position before lamp L_2 can be lighted by the two-way and "off" position switch, U. Fig. 4 is the most convenient and economical adaptation, the two-way switch, U_2, being usually placed near the door, the lamp, L_2, controlled by it being placed over the dressing table; the three-way switch is placed near the bedside, and controls both, only one, however, being in use at a time. It will be obvious that this arrangement is a most economical one for hotel proprietors to adopt, as it prevents considerable waste of current by users.

This method of circuit wiring is at present being installed in the King's Sanatorium now building at Midhurst, Sussex. My diagram (*a*) herewith will show the connections a little clearer, two-way and three-way switches as used being of tumbler type.

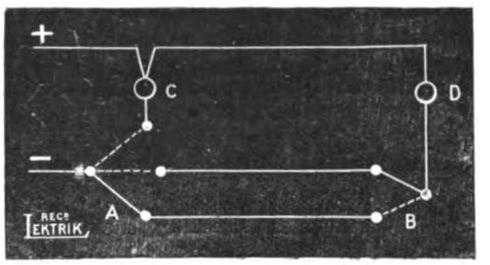

Diagram (*a*).

Fig. 5 is simply a three-way switch with "off" positions, controlling separate circuits.

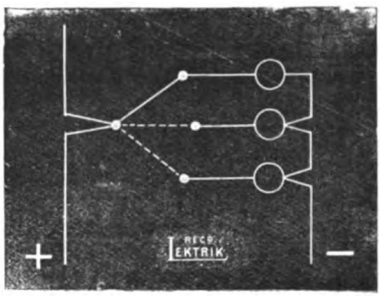

Diagram (*b*).

My diagram (*b*) will show a three-way tumbler switch controlling three separate lamps, a single-way switch being, of course, necessary to break the "common" wire. My diagram (*c*) shows the circuit connections employed for lighting or extinguishing *either* of two lights from two positions. Three three-way tumbler switches are used, two of them being coupled together, as is commonly done for double-pole switches.

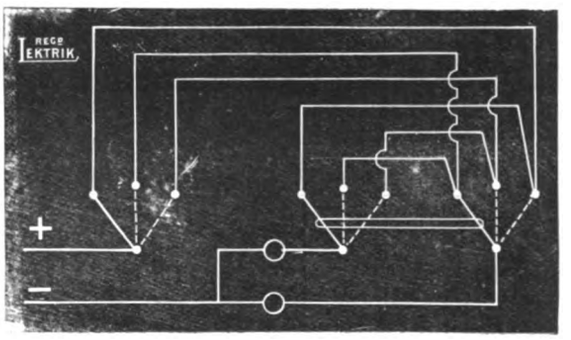

Diagram (*c*).

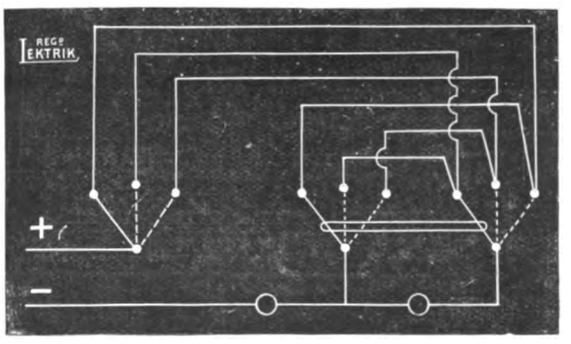

Diagram (*d*).

Diagram (*d*) shows a similar arrangement, giving (1) one lamp full, (2) two lamps series (dim light), (3) "off"

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position, all from either position. Diagram (*e*) shows a similar adaptation using a double-filament lamp, the circuit

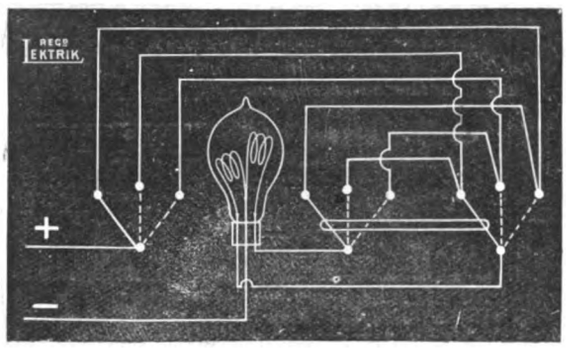

Diagram (*e*).

allowing *either* filament being lighted or both extinguished as desired, the small filament being conveniently used as a

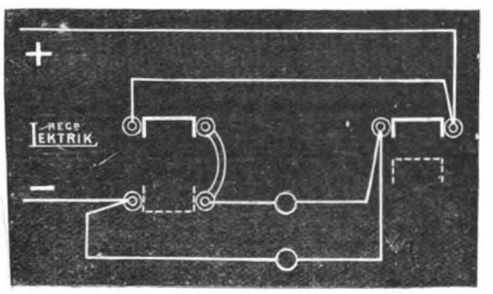

Diagram (*f*).

night-light. Diagram (*f*) shows how a single-way and a two-way switch may be connected to give the following results: (1) one lamp only, (2) two lamps parallel, (3) two lamps series, (4) "off" position. Diagram (*g*) shows how

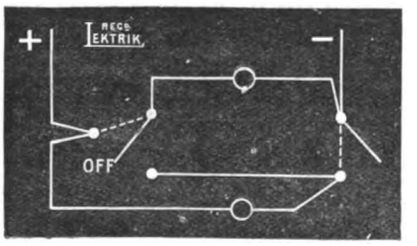

Diagram (*g*).

a single-way switch and a two-way switch with "off" position may be connected to give the following results: (1) one lamp, (2) another lamp, (3) both lamps in parallel, (4) both lamps in series, (5) "off" position. In the last two applications, if metal covers be used, it is advisable to have them lined with insulating material for the two-way and two-way and "off" switches used.

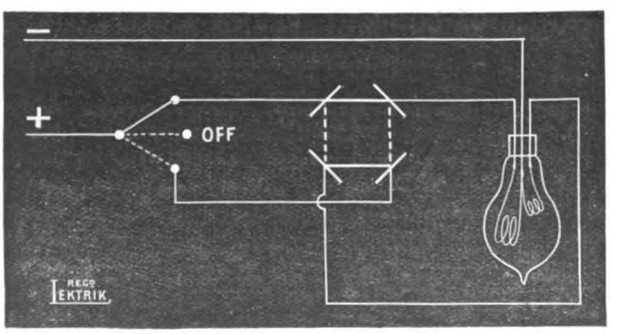

Diagram (*h*).

Diagram (*h*) shows another useful system for hotel bedroom wiring. A two-filament lamp is used (usually 16 c.p. and 1 c.p.). A "duplex" two-way and "off" tumbler switch is fixed near the door, and a "pivot intermediate" tumbler switch near the bedside. The latter switch allows either full light or a dim light for night-light use. The "duplex" switch at the door provides (1) full light, (2) dim light, (3) "off" position for use during daytime or if the room is required left in darkness. Trusting the foregoing will prove of interest to your readers—Yours, etc.,

GUS. C. LUNDBERG.

STATIC ELECTRICITY IN PAPER.

SIR,—I feel very grateful to "M. M." for his suggestions regarding above, but one device he refers to—that is, a series of metallic brushes and connected to earth—has been in operation here for some years, but without effect. He also suggests to reduce the friction on the paper, but the machine travels at a high speed—350ft. per minute—consequently the paper is very quickly dried. Might not a great deal of the electricity be generated by evaporation? I think neutralising it would be the only way out of the difficulty. How would it do to insulate the last roll on the machine, which is a copper one, from the frame, and make it part of an alternating-current lamp circuit? Would that neutralise it? If you can find space in your valuable paper, I shall be glad to hear more on the subject.—Yours, etc., JAMES WOOD.

6, Bank-street, Woodside, Aberdeen.

[N B—The last suggestion of our correspondent would not be serviceable, due to the insulating property of paper. Any useful means of removing the static charge caused by friction must operate on the surface of the paper on its way to the final roll. Perhaps Mr. Wood does not realise that the effect complained of is largely caused by the machines on which the paper is used.—ED., *E. E.*]

UNITS UNACCOUNTED FOR.

SIR,—I beg to call your attention to an inaccuracy which occurs in the Tonbridge electricity accounts in your issue for Sept. 8. You will observe that the total quantity o power generated is 156,582 units, and the total quantity accounted for is exactly the same. This is a state of affairs which is too happy to exist. The amount of power generally given under the "Not accounted for" heading includes all losses in transmission, leakages, etc. Probably the total quantity generated is given wrongly.—Yours, etc, E. P. H.

[We had seen the inaccuracy noticed by our correspondent in the accounts for the Tonbridge electricity supply undertaking. On looking through the same again, we find that the loss in mains (5,800 units) is included under the "Quantity used on works." This is a wide reading of the accepted term which, we think, is not justified. Also it is evident that leakage and discrepancies in meter readings must also come into this item, which should appear under "Quantity not accounted for."—ED. *E. E.*]

RAILWAY RETURNS.

The annual returns of the capital, traffic receipts, and working expenditure of the railway companies in the United Kingdom for 1904 have just been issued, together with a report on the same addressed to the Secretary of the Board of Trade. This report is a complete statement correcting the figures issued early in May last. As foreshadowed in the report for 1903, additional returns have been obtained from railway companies whose lines are worked wholly or in part by electricity, but the form in which these returns were collected being a tentative one, it is not proposed to publish the information thus acquired. It is hoped, however, that valuable returns relating to railways worked, or partially worked, by electric traction will be available for publication in the reports relating to future years. In this report there appear figures for those railways which are worked throughout by electricity, but the statistics refer to traffic only. The democratic tendency of the age is shown by a further falling off in first and second class passengers, which is more than counter-

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balanced, as far as numbers, in the increase in the third-class. The average receipts per passenger are for first-class 23·6d., for second-class 11d, and for third-class 6·5d. These figures for the whole of the United Kingdom clearly show that the bulk of the railway passenger service is for short-distance travellers. The increase in the number of third-class passengers was rather greater in 1904 than in 1903, but it was still small as compared with the annual increases shown by the returns for years previous to 1902. That this falling off in the rate of increase is due, in a great measure, to the increasing competition of tramways, may be deduced from the following comparative statement:

Year.	Third class railway passengers (years ended Dec. 31).	Increase. Number.	Increase. %	Tramway passengers (years ended June 30).	Increase. Number.	Increase. %
1896	888,604 000	—	—	759 466,000	—	—
1897	935 160,000	46,556 000	5·2	788 570 000	29 104,000	3·8
1898	963 674 000	28 514,000	3 0	858 486 000	69,916,000	8 9
1899	1,003,996,000	40 322,000	4·2	924,820 000	66,334,000	7·7
1900	1,038,873,000	34,877,000	3·6	1,065 374,000	140,554,000	15 2
1901	1,068,919,000	30,046,000	2·9	1,198,227,000	132 853,000	12·5
1902	1 080 625,000	11,706,000	1·1	1,394 453,000	196,226,000	16·4
1903	1,086,205,000	5,580 000	0 5	1,681,949,000†	287,496,000	20·6
1904	1,092,649,000	6,344,000	0·6	1,799,343,000‡	—	—

It will be seen that the number of tramway passengers carried in 1900 was greater than the number of third-class railway passengers carried in that year, and that the increases in subsequent years have been proportionately much greater in the case of the tramway passengers than in the case of the railway passengers. The date to which the returns relating to tramways and light railways (street and road) were made up has recently been altered, as stated in the footnote appended, and consequently the increase in the number of passengers during the year ending June 30, 1904, cannot be ascertained. It must be borne in mind that the increase in tramway passengers in the year ending June 30, 1903, is somewhat abnormal, owing to the inclusion for the first time in the returns for that year of particulars relating to public road lines authorised under the Light Railways Act, 1896.

The following statement shows the average receipts per train mile, distinguishing goods and passenger trains, during each of the last six years:

Year.	Receipts per train mile. From passenger traffic. d.	From goods traffic. d.	From passenger and goods traffic. d.
1899	48·36	70·29	58 06
1900	49·08	71·06	59·01
1901	49·61	73·25	59·92
1902	49·50	77 03	61·27
1903	49·21	82·55	62 79
1904	48·09	85 42	62·74

The ratio of working expenses to gross receipts for the year stood at 62 per cent. as last year. The actual average expenditure per train mile for the two years was as shown in the table below:

Expenditure on account of—	Cost per train-mile. 1904. d.	1903. d.	Increase (+) or Decrease (−) in 1904. d.
Maintenance of way	6·40	6·41	(−) 0·01
Locomotive power	11·18	11·28	(−) 0·10
Rolling stock	3·41	3·41	—
Traffic expenses	12·37	12·40	(−) 0·03
General charges	1·59	1·58	(+) 0·01
Rates and taxes	2·86	2·73	(+) 0·13
Government duty*	0·22	0·23	(−) 0 01
Compensation to employés	0·10	0 09	(+) 0·01
Personal injuries to passengers	0·08	0·10	(−) 0·02
Damage to goods	0·24	0·27	(−) 0·03
Legal and parliamentary expenses	0·18	0·20	(−) 0·02
Miscellaneous	1·20	1·13	(+) 0·07
Total (exclusive of expenditure on steamboats, docks, harbours, and canals)	39·83	39·81	(+) 0·02

* For Great Britain only. The railway passenger duty is not charged in Ireland.

† Particulars relating to public road lines authorised under the Light Railways Act, 1896, included for the first time.

‡ These figures represent the number of passengers carried by street and road tramway and light railway companies during the year ending Dec. 31, 1903, and by street and road tramways and light railways owned by local authorities during the year ending March 31, 1904. The period to which the figures relate consequently overlaps to a considerable extent the one to which the 1903 figures relate.

The passenger receipts per mile of line averaged £4,586 for the year. This figure is not directly comparable with that we give in our electric tramway returns each week of receipts per mile of single track. About one half of the total mileage of railways, or 12,590 miles out of 22,654 miles, have two or more tracks. Still, if this is allowed for, it will be seen that the traffic returns per mile of tramway track is not very different in the average to that from railways. The rest of the above report will repay careful study by those interested in the electrification of railways.

THE EDDY-CURRENT BRAKE FOR TESTING MOTORS.*

BY D. K. MORRIS, PH D., AND G. A. LISTER, ASSOCIATE MEMBERS.

Introduction: Methods of Motor Testing in Use.

The testing of a motor for efficiency and suitable rating requires that the motor shall be subjected for short or long periods to a measured load of any desired amount. Steady maintenance and accurate measurement of the load are necessary, while the means of applying it should in no way affect the conditions under which the motor works. It is interesting to review the methods of motor testing which have been proposed, and generally to consider the possible methods of absorbing and measuring the energy of a motor.

Table I.—Methods of Motor Testing.

Nature of energy-absorbing apparatus.	(1) Energy utilised.	(2) Energy dissipated (absorption brakes).
Mechanical.	Lifting weights — *e.g.*, in determining combined efficiency of cranes or hauling gear.	(*a*) Block (Prony, etc.). (*b*) Rope. (*c*) Band (Soames, etc.).
Fluid.	Pumping — *e.g.*, in determining combined efficiency of motor pumps.	(*a*) Water (Froude). (*b*) Air friction.
Electric.	(*a*) Load taken up in separate generator of known efficiency. (*b*) "Hopkinson" methods as below.	(*a*) Eddy currents only. (1) Fixed field. (2) Revolving field. (*b*) Eddy currents and hysteresis. (1) Fixed field. (2) Revolving field.
	Losses supplied.	
	Mechanically. | Electrically.	
	By belt. By direct-coupled motor. | Parallel system. Series system.	

Table II.—Electric Testing Brakes.

—	Eddy currents only.	Eddy currents and hysteresis.
Fixed field	(*a*) Air-cooled (Pasqualini, 1892; Grau, 1900; Siemens and Halske) (*b*) Water-cooled	(*a*) Air-cooled (Rieter, 1897) (*b*) Water-cooled
Revolving field	(*a*) Air-cooled (*b*) Water-cooled	(*a*) Air-cooled (Rieter) (*b*) Water-cooled (Korting)

They group themselves naturally as in Table I., according to the nature of the device employed, whether mechanical, hydraulic, or electrical, and to the method of absorbing the energy, whether the latter is or may be utilised, or whether it is immediately dissipated. In Prof. Threlfall's calorimetric method the motor output is not measured directly, but is derived from the input by subtracting the measured losses. Transmission dynamometer methods are properly

* Paper read before the Birmingham Local Section of the Institution of Electrical Engineers.

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applicable only to the testing of generators, while the "slowing-down" method of Dr. Sumpner, not being one in which the motor is continually loaded, is not classed in the table.

The electrical methods in which the energy is immediately dissipated may be classified as shown in Table II. In all the above eddy-current brakes the revolving portion only is carried by the motor spindle, the fixed portion being supported on either circular or knife-edge bearings.

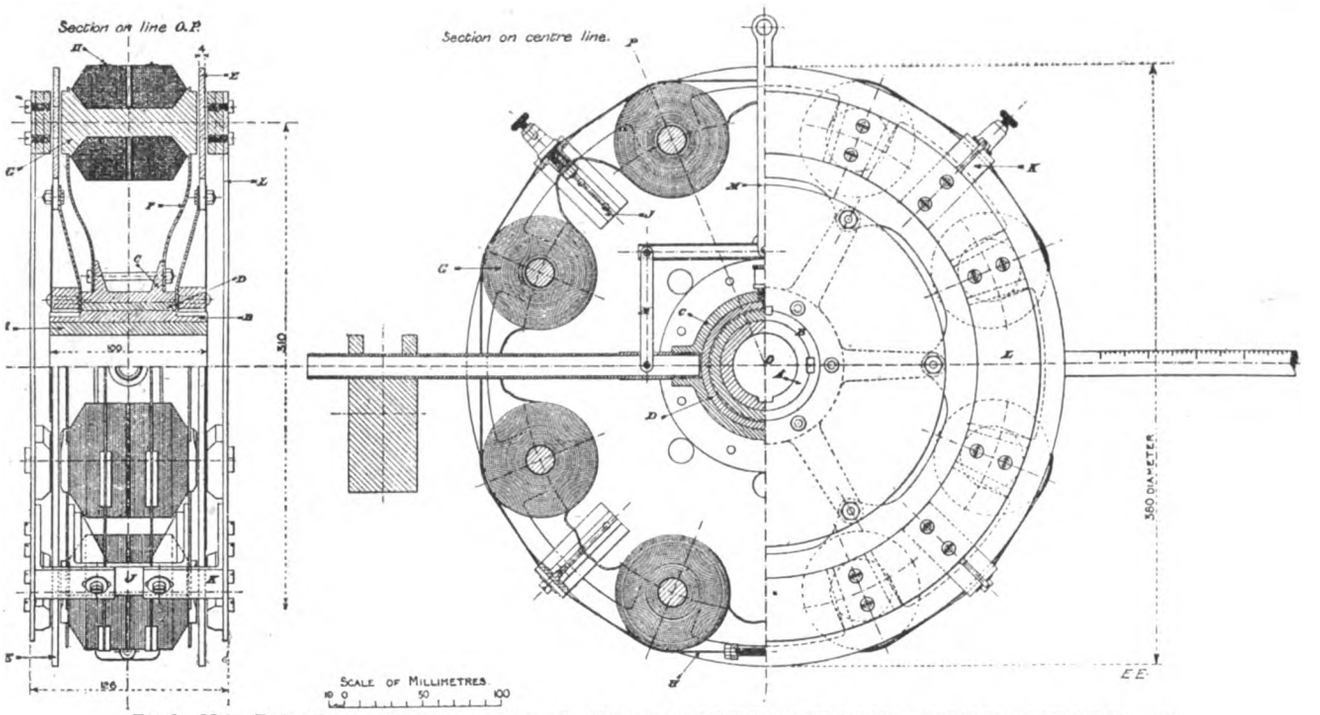

FIG. 1.—Motor-Testing Brake—Eddy Current Type. For Motors up to 5 B.H.P. at 1,000 R.P.M., or 7½ B.H.P. at 1,750 R.P.M., with overload capacity of 25 per cent. in each case.

The opportunities of applying methods in which the energy may be utilised are few. For, of these, mechanical and fluid methods are out of the question for general testing, and electrical methods necessitate the use of auxiliary machinery. Again, to test a motor by coupling it either directly or by belt to a generator of known efficiency is at the best but an indirect proceeding. Any variation of the conditions as regards speed, temperature, or state of bearings will alter the generator efficiency, and there is always a small, and usually unknown, loss in belt driving. The "Hopkinson" method in its various forms requires two exactly similar machines. Where these are available, this method has no rival, unless in the case of small machines, for which the parallel Hopkinson test may require abnormal conditions of running. Of the class in which the energy is dissipated, air friction brakes are cumbrous, while the water brake is expensive in construction and ill-suited for testing small motors, although excellent for large powers. Mechanical and eddy-current brakes are much superior for ordinary testing.

ADVANTAGES OF EDDY-CURRENT BRAKES.

The eddy-current brake has many advantages over the band or rope methods of motor testing. Among these are (*a*) sensitiveness combined with convenience of adjustment to exact balance; (*b*) uniformity of load and exact constancy after final temperature conditions have been reached; (*c*) heat produced in energy-absorbing element not conducted to bearing; (*d*) absence of wear; (*e*) retarding torque only occurs.

The first three arise from the nature of the friction employed, and from the simplicity and fineness of rheostatic control. The advantage referred to in (*c*) is one of great importance. The continual stream of air outwards past the copper disc carries away the heat in a remarkable manner, so that the copper disc may be very hot, indeed, for long periods, while the adjacent bearing remains quite cold. The nature of the stresses, too, permits of a relatively perfect thermal isolation of the disc as compared with a pulley rim. Methods based upon mechanical friction demand water cooling where *time* tests have to be made on motors above 1 h.p. or 2 h.p. With specially large pulleys this limit can, of course, be raised. No such limit exists with the eddy-current brake. With such apparatus, correctly designed, the absorption capacity appears to be determined only by the heating of the magnetising

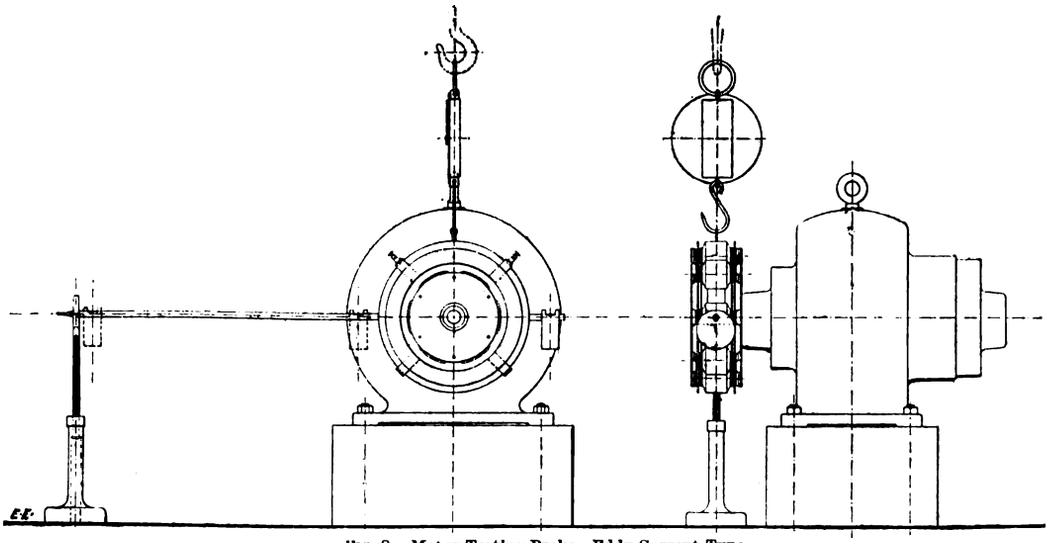

FIG. 2.—Motor-Testing Brake—Eddy Current Type.

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coils. The mechanical forms of brake combine great simplicity with considerable sensitiveness, but the advantages enumerated above have sufficed to direct attention to the construction of the eddy-current brake, several patterns having been produced.

New Design of Eddy-Current Brake.

The types of eddy brake on the market, however, have not been very widely used, mainly on account of the high initial cost and the difficulty of applying them to various sizes and types of motors. They are constructed on one of the following principles: (1) The revolving element is secured to a spindle, one end of which is coupled to, or belt-driven from, the motor shaft. This brake spindle revolves in bearings carried by an independent frame, which also carries by means of ball-bearings the floating portion of the brake. (2) The revolving element is secured direct to the motor shaft, the fixed portion being provided with knife-edges, and mounted on a separate frame. In the former case a correction of an uncertain nature arises on account of the friction of the bearings, and probably on account of air friction, while in the latter either the brake or the motor has to be specially mounted, that the centres may be brought approximately into line. In such brakes, also, end play should be minimised.

may be tested with this brake with an accuracy not hitherto possible. In cases where lifting gear is not available the suspension and balance could be carried by a special frame provided with screw and hand-wheel. For ordinary testing the whole brake can very well be carried on the motor spindle without suspension.

The construction described has, therefore, the following additional advantages without in any way sacrificing those enumerated: (*f*) apparatus self-contained, no separate frame required—an advantage over all other practical types of brake; (*g*) brake is completely astatic; (*h*) air-friction error is practically eliminated; (*i*) pressure on motor bearing during test may be adjusted to any desired amount, independent of the load.

Detailed Description.

The revolving discs, E, are made of high-conductivity hard-rolled copper. They are supported by a thin steel plate and steel arms on the outer and inner sides respectively, each hub being keyed to the bush B. Between these discs is the casting, C, which is fitted with a gunmetal bush D bored to suit the bush B. Into this casting are screwed two tubes, the shorter carrying the counterpoise, and the longer constituting the lever arm. This arm is marked with a scale of feet divided into tenths and

Fig. 3A. Flux in yoke ring with a constant magnetization of 3,500 ampere-turns per coil.

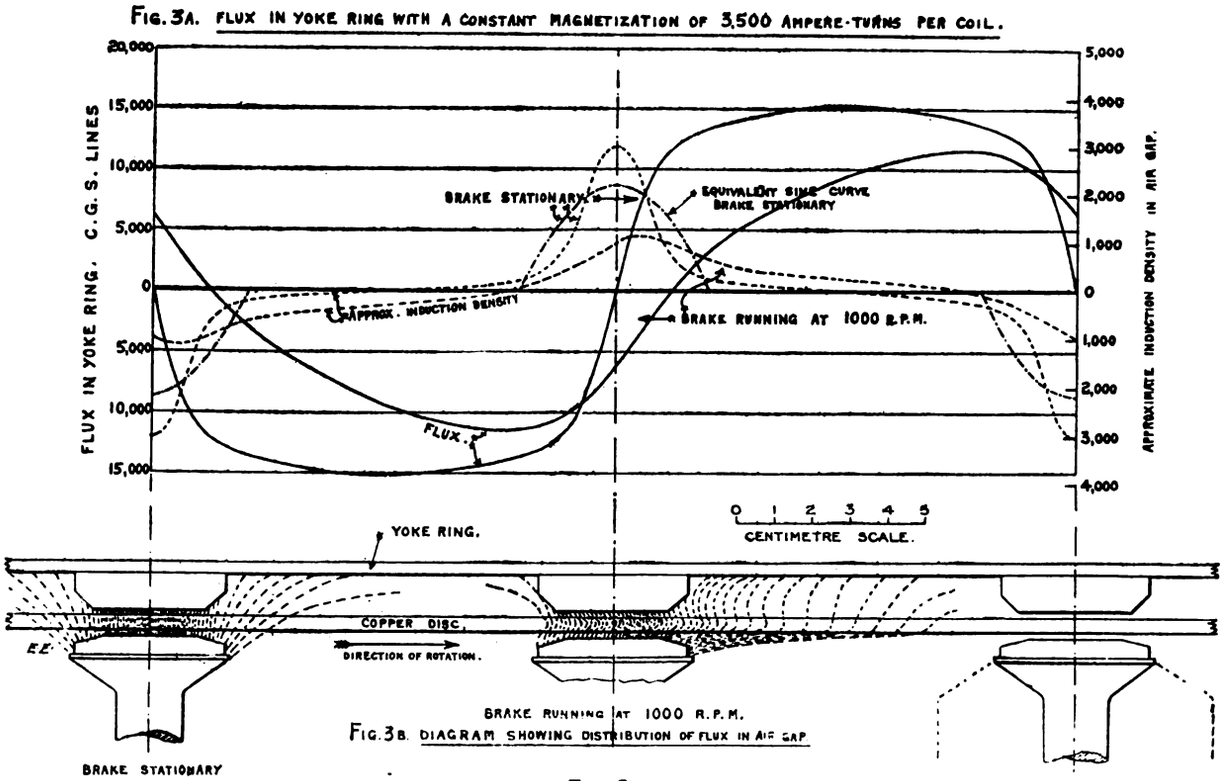

Fig. 3B. Diagram showing distribution of flux in air gap.

Fig. 3.

To surmount these difficulties, the authors, in designing a brake for the electrical laboratory of the University of Birmingham, decided to entirely dispense with separate bearings or frame. This brake is illustrated in Fig. 1. It is intended to be mounted on the motor shaft in place of the ordinary pulley. The fixed portion of the brake is carried by the revolving system, and though there is friction at the bushes, B and D, this small load is duly represented as torque on the brake lever. A similar argument applies to the air friction. Mechanical and electrical symmetry are insured by the use of two copper discs, one revolving on either side of the magnetising coils. This doubles the capacity of the brake for a given diameter, and incidentally renders it completely astatic. A multipolar design was employed, since in this case the weight is less than that for a two-polar design. Fig. 2 shows the brake mounted on the spindle of an electric motor, and indicates the manner in which the pressure on the motor bearing may be adjusted. The brake is provided with a link suspension, so that an upward pull gives rise to no twisting moment. This suspension is attached to a spring balance, which can conveniently be carried by the hook of the crane or blocks serving the testing bed. By means of the lifting gear the pressure on the bearing may be reduced to nothing, or it can be given any desired value. Bearing friction in motors

hundredths of a foot, the maximum leverage being 3ft. The brass plates, F, are bolted to the casting, C, and carry at their circumference the magnet coils, G. These coils, which are eight in number, are securely held in position by the steel wires, H. Each consists of a wrought-iron core wound with 1,400 turns of No. 20 S.C.C. copper wire. The resistance of each coil is 5·1 ohms when cold. There is a ventilating duct at the middle of the coil. The aluminium castings, J, act as distance pieces, the two upper ones being fitted with insulated terminals. Secured to these castings by set-pins are the aluminium castings, K, which carry the external yoke-rings, L. A slotted hole in the castings, K, allows the length of the external air-gap to be adjusted. The length of the internal air-gap is fixed, and in consequence of the rigidity and smooth running can be kept short. Steel bushes, A, are turned to suit the inside of bush B, into which they are keyed. They are bored out to various sizes to suit the spindles of the motors which have to be tested. The suspension links, M, are fitted to the graduated lever and to the counterpoise lever at equal distances from the centre. Accurately adjusted sliding weights of 2½lb., 5lb., 7½lb., and 10lb. are used. After completion the brake was supported on a central knife-edge, and the counterpoise lever loaded until an accurate balance was obtained.

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EXPERIMENTAL RESULTS OBTAINED.

1. A test to determine the result of reducing the number of magnets showed that the braking effect is practically proportional to the number of coils excited. The slight reduction observed was probably due to the increased length of the iron portion of the magnetic circuit. In other words, the braking effect depends only on the total flux cutting the copper, and is independent of the number of points at which it may be applied.

2 The removal of the external yoke-rings resulted in a reduction of the absorption capacity to about 50 per cent. of the normal for a given number of ampere-turns per coil.

3. The torque produced by bearing and air friction alone (the magnets being unexcited) was found to be about 0·3 foot-pounds at 500 r.p.m. This increased to 0·365 foot-pounds at 1,250 r.p.m.

4. At moderate excitations, such as 4,000 ampere turns per coil, the horse-power absorbed increases, except at first, nearly with the speed up to 1,000 r.p.m. Above this speed, however, there is a noticeable falling off. At low excitations, such as 1,500 ampere-turns per coil, the falling off occurs at about 600 r.p.m. This failure to reach proportionality is due to increased distortion of field at high speeds, and consequent reduction of resultant flux. Fig. 3A represents the flux (obtained ballistically) in one of the yoke-rings with the brake stationary, and also when running at 1,000 r.p.m., the excitation being constant at 3,500 ampere-turns per pole. The flux which usefully cuts the copper may be taken as that which actually arrives at the yoke-ring. The dotted curves, which are determined from the flux curves, represent the approximate induction density in the air-gap in each case. It will be seen that, on the average, the flux is shifted forward in the direction of rotation. This is represented in Fig 3B.

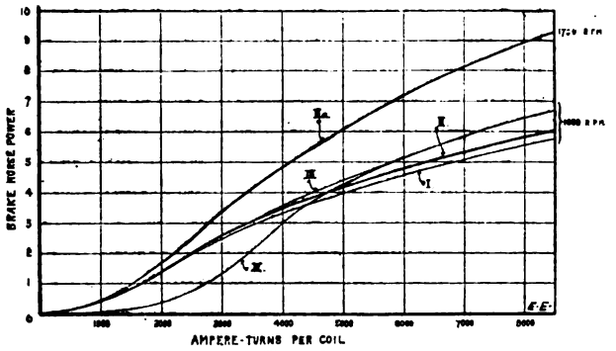

FIG. 4.

5. The brake was originally made with a plain yoke-ring without pole-pieces. Its performance under these conditions is shown in Fig. 4, Curve I, abscissæ representing ampere-turns per pole, and ordinates the horse-power absorbed. The addition of pole-pieces 1cm. deep, and having a radial length slightly less than the diameter of magnet core, somewhat increased the efficiency of the brake, as indicated by Curve II. The best position for the pole-piece was found to be 5mm. forward of the magnet coil, but the effect was not sufficient to warrant their being permanently placed in this position.

6. An attempt to prevent the flux from being dragged off the pole-pieces, and so prevent excessive lengthening of lines, and consequent reduction of field strength, was made by winding the yoke-rings with additional magnetising coils situated between the pole-pieces. There were 16 coils of two coils per magnet, each consisting of 25 turns of No. 18 D.C.C. copper wire. The effect was very noticeable, as will be seen on reference to Fig. 4, Curve III., which shows the effect of a constant current in the main coils giving 3,500 ampere-turns combined with increased excitation applied by means of these supplementary coils, up to a total of 6,000 ampere-turns. Curve IV. shows the result of a constant excitation of 2,000 ampere-turns maintained by the yoke-ring coils, supplemented by currents in the main coils. The result of these two curves is to show that up to an excitation of, say, 5,000 ampere-turns, the maximum effect will be obtained by using the main coils only. Above this figure, however, the strength of the eddy currents in the discs tends to cause excessive distortion of the field, and a great advantage will result by transferring a large portion of the energy supplied to the brake to the yoke-ring coils. The advantage, however, probably does not warrant the extra complication.

7. It was found that the braking effect for a given excitation is not perceptibly dependent upon the temperature of the copper discs. This shows that any decrease in the eddy currents due to increased resistance of path is counteracted by the consequently reduced distortion.

8. Experiments carried out with different lengths of air-gap emphasised the necessity of keeping this as small as possible. When absorbing 5 h.p. at 1,000 r.p.m., a reduction in the air-gap from 10mm. to 8mm. reduced the current required by 15 per cent., thus resulting in a saving of power of rather more than 30 per cent.

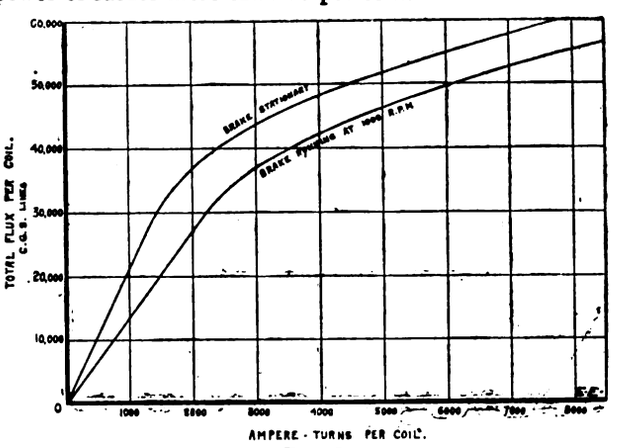

FIG. 5.

9. Fig. 5 shows the variation of flux with excitation both with brake stationary, and when running at 1,000 r.p.m. The thickness of the copper disc is 4mm., and the length of air-gap between pole-tips approximately 9mm. In each case the flux was measured at the centre of the magnetising coil.

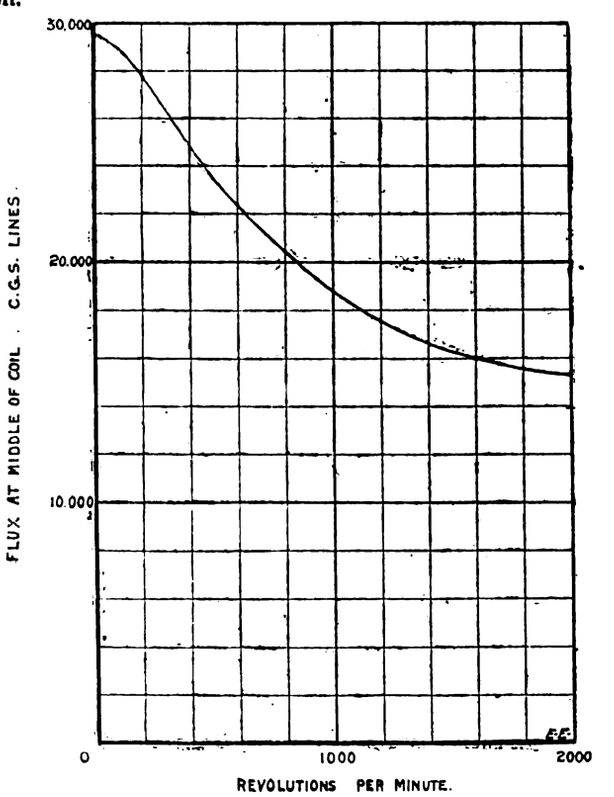

FIG. 6.

10. Fig. 6 shows the variation of flux with speed, the excitation being constant at 1,400 ampere-turns per coil. The measurements were taken at the centre of the coil.

11. As a result of theoretical considerations, the brake was tried with copper discs of section shown in Fig. 7. This section enables the length of the air-gap to be considerably reduced, while at the same time affording a high-conductivity path for the eddy currents in a circumferential direction. The results obtained are given in Curve V. (Fig. 4). *(To be continued.)*

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ELECTRIC TRAMWAY v. MOTOR OMNIBUS

Oxford Reports

In our last issue we published reports by Mr. Stephen Sellon and Mr. W. Worby Beaumont respectively as to the best system of replacing the existing horse tramways in Oxford. The town clerk sent to each expert a copy of the other expert's report, with a request for further details. These supplementary reports are remarkable for their conciseness, and also for humour. Mr. Stephen Sellon's further report to the town clerk is dated Aug. 17, and reads:

Dear Sir,—I have to acknowledge your letter of the 14th inst., with the enclosures mentioned. The tramway company's figures now sent might have enabled me to make a more detailed division of the probable future traffic between the various routes, but their consideration does not affect my general conclusions. Replying to your questions on my own report, I may say that I do not recommend a composite system of tramways and motor omnibuses In my view all the extensions mentioned will support a service of not less frequency than 15 minutes, and in such cases the tramway capital expenditure is justified. A broken service involving changing from one vehicle into another always involves the loss of a large amount of traffic, varying, in my experience, from 30 to 60 per cent., whether by transfer from tramway car to tramway car or from motor 'bus to tramway car. My figures for working cost provide fully all current repairs, and also for such renewals as will accrue during the period of repayment of the loan. They do not cover such an amount as will provide a new tramway and equipment at the end of the loan term It will be apparent that when an undertaking is charged with the repayment of loan capital during a fixed period that to charge it also with an annuity for the purpose of providing another equal, or nearly equal, amount, under the name of depreciation, is virtually charging the first generation of users with twice their share of the capital expended on the undertaking—a course neither equitable nor necessary. Any provision of the kind that may be prudent should properly be made out of the profits of the undertaking. For financial reasons I should recommend any municipality to devote a large proportion of the profits realised to making such provision—but I cannot class such payments with working expenses. I have come to the conclusion that the necessary capital expenditure to construct a tramway along Woodstock-road would not at present be justified.

I have carefully read and considered Mr. Worby Beaumont's report. A controversial criticism thereof is not in my intention, but the first point which strikes me as significant is the complete silence on the all-important point of working expenditure. I think I may usefully suggest certain considerations to the committee which seem to have been but slightly touched on therein. The cost of working the service and its financial results seems to me a matter on which the Council needs some guidance. It may be that there is no desire to make large profits, but I presume that neither is it desired that the undertaking should be a charge upon the rates. So far as present information goes, the cost of running a motor omnibus will be more than the probable earning capacity of the vehicle, certainly more than I have assumed that the tramcar will earn in such a town as Oxford. What motor omnibuses will really cost to maintain is not yet known, and will not be for two or three years to come, but it is certainly true that in some cases their use is being discontinued on account of the cost and the time out of service involved in repairs. The working costs put forward are not the whole of the cost. The capital expenditure in providing a suitable road surface and the cost of maintaining it in good condition should properly be charged in due proportion against the omnibus service as I have charged the capital and maintenance of the track to the tramway undertaking. It appears to me that the combination of motor omnibuses and macadamised roads in the city of Oxford would create an intolerable dust nuisance, and that some form of wood, asphalt, or stone pavement would be imperative. I need hardly point out that either of these will cost more than a tramway track along the same mileage of route. In fact, the paving of a tramway track is the most expensive item in its construction. The remarkable wear of all road surfaces by rubber-tyred motor vehicles is well attested.

I advise the Council that in considering Mr. Worby Beaumont's suggestions the additional capital and maintenance expenditure on their roads must be taken into account as a most important item. As regards the question of amenities. Exactly which of the world-famous charms of Oxford, which of its rich and varied historical associations, would be injured by a tramway car, but remain undamaged by a motor omnibus, I find it very hard to imagine. It will be well known to the Council that the electric tramway has not been thought incongruous with the conditions of many of the most ancient and picturesque seats of learning on the Continent, that cities like Rome, Milan, Dresden, and Munich, to mention the first that come to mind, have found such modern conveniences consistent with the maintenance of ancient traditions and modern charm. Such experiences suggest that the distinctive charms of Oxford will suffer no loss. On the ground of general comfort and convenience, I am quite clear that in any comparison the tramcar will take the first place if either the passengers or the residents on the route are considered. I have before me copies of memorials and letters from ratepayers addressed to the Town Council of Eastbourne, protesting against motor omnibuses being run on certain proposed routes, asking for a reduction in the number run on actual routes. The reason adduced being noise, offensive smell, and the insufferable nuisance of clouds of dust, troubles from which the electric tramcar is free, and which the Council will perhaps consider to be as destructive of the amenities and comforts of life in the city; and I suggest that an inquiry on this point might well be addressed to the Corporation of Hythe. After full consideration, therefore, of Mr. Worby Beaumont's report, I adhere to my own recommendation of the adoption of electric tramways. If Mr. Beaumont is correct, and that the population will be carried by a proper system of communication 100 times over in the course of the year, then the profits will be greater than I have estimated.—Yours faithfully, (Signed) STEPHEN SELLON.

In reply to a letter from the town clerk, Mr. Beaumont sent the following, dated Aug. 16:

I send herewith a supplement to my report on the above. I received the copy of my report and of Mr. Sellon's In the accompanying supplementary report I have not and need not refer to Mr. Sellon's report, but I notice that his estimated expenditure is £130,000, and net balance of receipts and expenses on this is estimated at only £3,229. If to the estimated cost is added the cost of acquisition of the existing tramways, and if some value be placed on the business and time losses resulting from breaking up eight miles of streets and roads, and, further, if the probable considerable cost of interference with pipes, etc, where conduit or surface-contact systems are used, be taken into account, there would seem to be grave reasons for thinking the tramway project an expensive one.

The supplementary report is as under:

Dear Sir,—I duly received your letter of the 14th inst., and in that which follows I now send replies to the questions raised by the Tramways Committee—namely, (*a*) cost of working and maintenance of motor omnibuses; (*b*) how soon they would need replacement; (*c*) how much they would earn at suggested fares. I base my estimates on the returns sent me from the City of Oxford and District Tramways Company, the following results from an examination of these returns and from the directors' report and accounts to Dec. 31, 1904. The time allowed for the double journey by the tramcars on the several routes varies from 30 to 48 minutes. The time allowed for the 'bus double journeys is 60 minutes. These respectively give about 36 and 24 single journeys per day for a 12 hours' day. Taking only 12 hours per day, and 365 days per year, this gives the following as the passenger-carrying results of the service hitherto in use.

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	Per day.	Per single journey.
Passengers carried in 1905 by tramcars	600	16·45
Passengers carried in 1905 by omnibuses	394	16·40
Passengers carried by Iffley-road 'buses	450	19·00

From this it will be seen that the average patronage of the 'buses per single journey is as great as that of the tramcars, although the number carried per car mile, as hereafter appears, is greater than that per 'bus mile. The returns show that the passengers carried by the 'buses on the Broad-street and Iffley-road route per journey exceed the average number carried per single journey by the tramcars, although the average number carried by the Cowley cars per journey is greater. It is thus shown by actual experience in Oxford that, large as is the traffic considering the service, the omnibus has proved itself capable of carrying more passengers per seat provided, or to have a larger percentage of paying load, than the tramcars. With the present service the average receipts per passenger have been apparently—by tramcar 1·16d. per passenger, by 'bus 1·26d. per passenger. From the returns of the tramway company it appears that the passenger receipts per journey have been: receipts per journey per car, 19d.; receipts per journey per 'bus, 20·6d. Apparently the receipts and expenses per mile run have been:

Receipts per car mile	13 2d. per mile.
Receipts per 'bus mile	9 6d. ,,
Receipts, average car and 'bus	12·7d. ,,
Expenses, average of cars and 'buses	10·5d. ,,
Profit per mile by cars and 'buses	2·2d. ,,

On these receipts and expenses and on this profit per car and 'bus mile the tramway company have apparently (with their very light cars, light on the permanent way) been paying about 5 per cent. per annum. A similar number (16) but of faster and more commodious motor omnibuses, which would not lose their time by waits at turnouts, would, I believe, meet the requirements for greater accommodation up to about 30 per cent. increase, when greater requirements would be met by simply adding to the number of 'buses. Based upon the experience now available, the average cost of running motor omnibuses would be:

Running Expenses—90 miles per day (per 'bus mile).	
Petrol (6⅝ miles run per gallon at 6d.)	0 90d.
Oil and grease	0·28d.
Tyres	2·06d.
Driver and conductor	1 75d.
Repairs and renewals	0 55d.
Depreciation at 20 per cent. charged to 300 days	1·35d.
Washing, stabling, gas, water, sundries	0·50d.
Total running expenses	7·33d.
Traffic Expenses.	
Licenses, ticket services, superintendence, compensation, lighting, and sundries	0·45d.
General Administration.	
Law, rates, taxes, office and building insurances, printing, manager, engineer, etc.	0·35d.
Insurance of 'buses against fire, accident, and third-party risks at £70 per year each	0·56d.
Total working expenses	8·69d.

Taking, then, 8·69d., or even 9d., per motor-'bus mile as the total working expenses of motor omnibuses, there should be a profit per 'bus mile of 3·7d., even on the receipts of the present company and its very slow service and old stock. With, say, 50 single journeys per day of the mean length of 1·78 miles, instead of the present average of 30 single journeys (about) of car and 'bus, and with, say, 16 omnibuses running, the profits per day would reach at least £20 per day, assuming that the travelling public in Oxford require so much travelling facility, and it will, no doubt, fully support at least 30 per cent. more than is at present provided. This is £140 per week, or £7,300 per year, after charging every cost to revenue, including a depreciation rate which provides for the entire renewal of the 'buses every five years, and thus leaves a profit of about 35 per cent. on the capital outlay of, say, £20,000. To this expenditure, however, has to be added the cost of acquisition of the existing tramways and some expenditure in a few places in improving the road and street surface where not good and where too much arched or hog-backed. This work, however, is equally desirable for every other kind of traffic. With regard to the fares to be charged, I am of opinion that these should be the same as those now charged, the passengers getting all the advantages of better service and more comfortable vehicles without extra charge for the same distances. The service from Carfax to the station should be extended about half a mile, and the fare remain the same as now. On such extensions and new lines of service as may be found desirable by experiment, the fares should, I think, remain at 1d. per mile or thereabouts more or less as at present.

(Signed) W. Worby Beaumont.

On Aug. 25 Mr. Beaumont wrote to the town clerk as under:

Dear Sir,—I send herewith the statement *re* estimates of motor-omnibus service and the results of examination of the returns of the tramway company for 1904. With regard to the amount deducted for interest and sinking fund, please note that this at 6 per cent. is with reference to the motor omnibuses an improper charge, and should be very much less than 6 per cent., because the costs of working of the motor omnibuses, as given in my estimate, include a depreciation already of 20 per cent. charged against revenue, in addition to maintenance charges. A large part of the £1,200 deducted from this is therefore irrelevant. Will you please say that the number of miles run by the existing system was, as pointed out by Dr. Cannan, much larger than I had estimated, and this very largely reduces the receipts per car mile as compared with the receipts I had assumed. This, of course, materially alters the difference between receipts and costs, as will be seen in the statement sent you.—I am, faithfully yours,

W. Worby Beaumont.

STIRLING ELECTRICITY ACCOUNTS.

The accounts of the Stirling electricity department for the year ended May 15, 1905, show a total expenditure on capital account to that date of £39,050. Abstracts of the revenue account, balance-sheet, etc., are appended.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	1,422	4	10
Distribution of electricity	79	5	11
Attending and repairs to public lamps	239	1	4
Rents, rates, and taxes	69	0	10
Management expenses, salaries, etc.	379	6	0
Special charges, insurance, etc.	53	2	6
	2,242	1	5
Amount carried to net revenue account	1,904	19	2
	£4,147	0	7

Cr. Income.	£	s.	d.
By sale of current to private consumers by meter	2,634	3	0
Ditto for public lighting	1,372	5	0
Rental of meters and other apparatus	46	12	5
Rental of motor apparatus	64	0	2
Rents received	30	0	0
	£4,147	0	7

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	39,000	0	0
	£39,000	0	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	38,518	8	0
Balance at debit of suspense account	353	19	4
Stores on hand	40	14	6
Sundry debtors for current supplied, etc.	18	0	9
Due by assessment accounts	68	17	5
	39,000	0	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			260,755
Quantity sold	Private consumers by meter	150,977	243,551
	By contract	566	
	Public lamps	92,088	
Quantity used on works			9,515
Total quantity accounted for			253,066
Quantity not accounted for			7,689
Number of public lamps			266
Maximum supply demanded (kilowatts)			201

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TRADE NOTICES AND NOVELTIES.

Motor-Driven Air-Compressors.

We illustrate herewith some of the latest designs of air-compressors introduced by Messrs. Reavell and Co., Limited, Ranelagh Works, Ipswich. The special feature in these machines is that they are arranged for direct coupling to electric motors without the intervention of any gears and with only two bearings in the compressor and motor complete. In

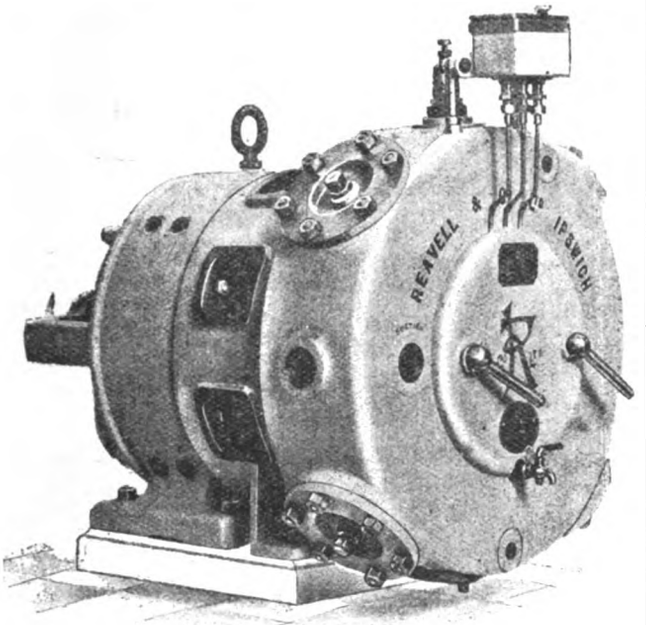


FIG. 1. Single-Ended Direct-Coupled Motor-Driven Compressor.

the machine shown in Fig. 1 the compressor shaft is passed directly through the armature of the motor into the motor outer bearing. A standard motor of the slow-speed type can therefore be used by omitting one end cover with its bearing and employing the studs for securing the bearing to attach the compressor to the motor. The compressor facing is spigoted so as to fit perfectly centrally in the field-magnet casting of the motor. The same construction is shown in section for double-ended machines (Fig. 2), which illustrates a polyphase motor-compressor combination similar to one of 80 h.p. included in Messrs. Reavell's exhibit at Liége. Referring to the illustration, it will be seen that this construction provides for the two compressor shafts being fixed directly into the spider of the rotor, while the through bolt, which is shown, enables the halves of the compressor shafts to be pulled up directly against the faces on the rotor. This illustration also shows how the compressor is directly bolted to the faces of the stator of the motor. An ordinary slow-speed motor of the alternating or direct current type can by this arrangement be directly coupled to the compressor. Another point of interest is that there is no need to provide a flywheel with this type of

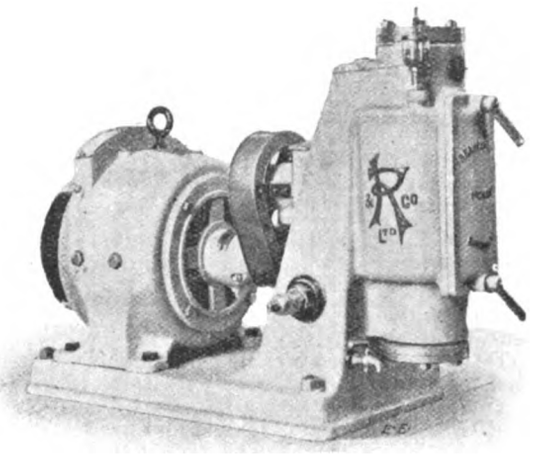


FIG. 3.—Motor-Driven Duplex Air-Compressor.

compressor, because the torque is almost perfectly regular. Fig. 3 illustrates the smaller duplex compressors which the makers have supplied in such large numbers to central stations

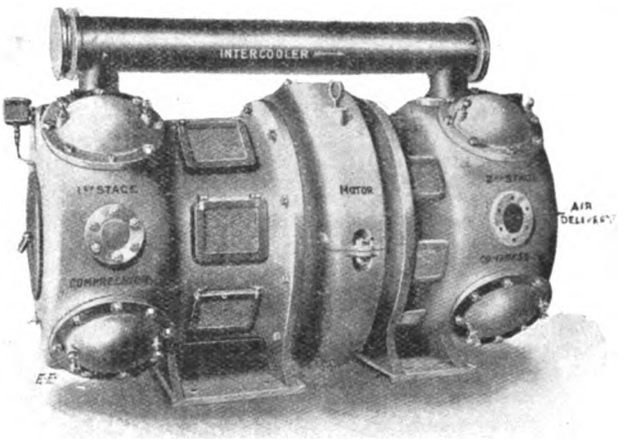
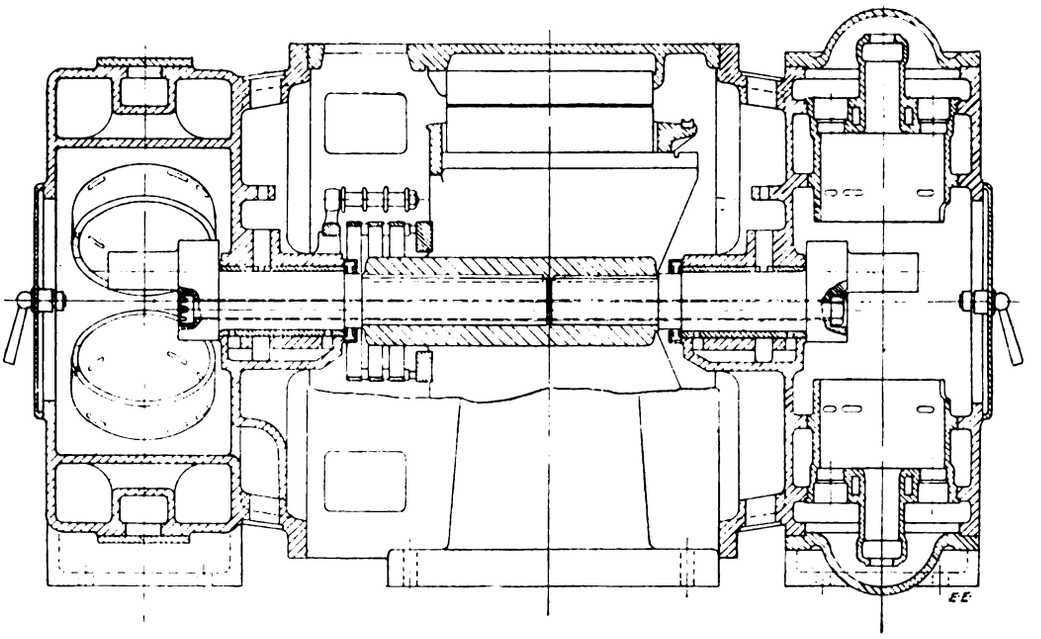


FIG. 4.—Two-Stage Motor-Driven Air-Compressor with Inter-Cooler.

and sub-stations for cleaning purposes. A portable type is also made. The latest design of the firm's two-stage compressor is illustrated in Fig. 4. Similar machines are in use in central stations in London and elsewhere, we understand, for supplying compressed air at high pressure for air-lift purposes. The design is of great interest to electrical firms who are interested



Section through Casing vertical centre line.

Section through Cylinders 45° to vertical.

FIG. 2.—Section of Direct-Coupled Air-Compressor with Polyphase Motor.

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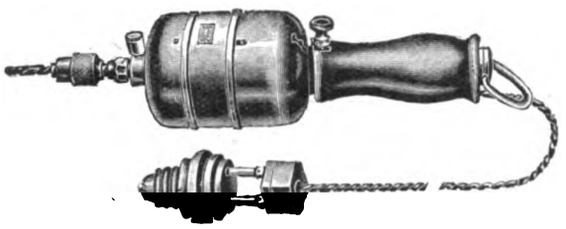
in the introduction of electricity into collieries, as it provides a means of supplying the pneumatic coal-cutting tools at the face with compressed air and at the same time to take advantage of the saving to be effected by using electrical energy for driving the compressors, the latter being placed "in bye." This arrangement, by virtue of the high economy of the turbo-generators or steam dynamos which are used for the production of the electrical energy on bank, and also on account of the high efficiency of electrical transmission, naturally enables the energy to be delivered to the motor on the compressor at a low price and avoids the losses due to leakage and pipe friction which are observed in older systems where the compressed air is all obtained from large compressors installed on bank.

W.B. Novelties.

The 1905 novelty list issued by Messrs. Wallach Bros., 57, Gracechurch-street, E.C., includes some electric drilling machines of exceedingly handy patterns. Type L can be supplied with or without wheel gearing, as illustrated herewith. This type is especially suitable for bicycle dealers and repairers, engineers' and mechanical workshops. It is supplied for different rates of speed according to the diameter of hole to be drilled. Minimum weight is obtained by casing the motor with aluminium alloy. This casing, being fastened with bayonet locks, is readily removable, and so permits easy access to the brushes, lubricators, and bearings. Several other useful types



W.B. Type L. Electric Drill without Wheel Gearing.

W.B. Type L. Electric Drill with Wheel Gearing.

are dealt with, also a variety of apparatus, such as machinists' vices, central gear grinders, hot blast melting furnaces, combination brazers and forges, illuminators, portable heaters, etc.

A New Fitting Connector.

The weak point of many electric lighting installations is the connection between the wiring and the fittings. Unfortunately, also, this fact is aggravated by the construction of some of the higher classes of fittings, and by the conditions laid down by the best decorators and architects. For instance, in a room where the artistic decorations are such that no wood blocks can be used on the walls, the fittings have to be supported directly against the draping material used to cover the walls. In such cases a joint has to be made in a very confined space and afterwards covered by the metal base of the fitting. In consequence the joint is made under most difficult conditions, and in a position where it is likely to meet with the maximum ill-treatment and to do a considerable amount of damage in the event of a short-circuit. Messrs. J. J. Smith and Co. have just put upon the market the new connector which we illustrate herewith, which

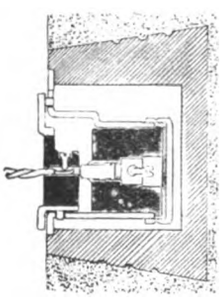


Fig. 1.

will not only render all joints behind the fitting unnecessary, but will also enable fittings to be easily removed for cleaning, or to be replaced by others. With this connector the mechanical support is obtained at the same time as the two electrical connections. As will be seen from Fig. 1, the wiring is led directly into the socket of the connector, which is sunk into a wood block, which in turn is cemented into the wall. The terminals (Fig. 2) for these wires are of ample size so that the looping-in system can be used, which avoids the necessity for any joints in the wires. The other part of the connector, which is attached to the fitting itself, has a projection which engages in the socket, and thus ensures that it can only be introduced in one position. Besides this guiding projection, which goes into the slot on the upper part of the connector face, there are two side pins which engage in the bayonet slots seen in the illustration. These form the mechanical lock as the pins slide down, the bayonet slots holding the fitting firmly against the connector, while the weight of the fitting is taken by the bottom surface of the projection. In its lowest position there is also a small screw, which can be seen on the left-hand side of Fig. 1, which engages in a hole in the socket and forms a further mechanical lock. The electrical connections are made between flexible contacts in exactly the same way as the connections in any lampholder.

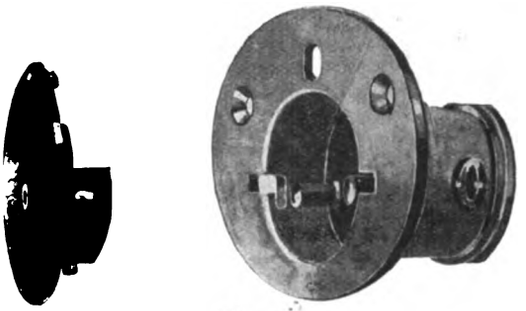


Fig. 2.

The wiring from the fitting terminates in substantial terminals, which are amply insulated. The whole device gives an excellent mechanical support, a good electrical connection, and its convenience will be as much appreciated by a householder as by electrical engineers of all classes. It reduces the fire risk from joints which can hardly be effectively protected, and at the same time renders the wiring of the building more complete. This connector can be seen at the showrooms of Messrs. J. J. Smith and Co., at 46A, Holborn Viaduct, which are well worth a visit by anyone needing high-class fittings.

Catalogues, etc., Received.

Cable Grip.—Messrs. Siemens Bros. and Co., Limited, have sent us a postcard illustrating their cable grip. This grip is fitted with a swivel and patent detachable link, and should be found of great use in drawing cables through pipes or conduits. The stock size is suitable for cables up to 2½in. diameter, but larger sizes can be supplied, we understand, at short notice.

Regulating Resistances.—The latest sheet from Messrs. Ernest F. Moy, Limited, deals with their shunt-regulating resistances type No. 92. The resistance frame is fitted with a nine-point switch connected to eight of the firm's standard resistance units mounted in a cast-iron frame, which is fitted with a perforated steel front and left open at the back for ventilation. The regulating switch is mounted on enamelled slate and fitted with a polished fibre knob.

PERSONAL.

The Colchester Town Council have granted £300 to the borough engineer, Mr. H. Goodyear; £150 to the electrical engineer, Mr. A. R. Siller; and £50 to the town clerk, Mr. H. C. Wanklyn, for their extra and special services in connection with the provisional orders authorising the tramways and intended extensions, the preparation of schemes, and the carrying out of the works of construction.

Mr. Ernest S. Colley has been appointed shift engineer to the Battersea Borough Council's electricity works at a salary of £104 per annum.

The Electricity Committee of the Southport Town Council recommend that the salary of Mr. A. S. Black, the assistant electrical engineer, be advanced from £200 to £225, rising next year to a maximum of £250, on condition that he gives an undertaking to remain with the Corporation for a period of three years.

The Electric Light Committee of the Coventry City Council decided on Monday to recommend the Council to increase the salary of Mr. J. A. Jeckell, manager of the electricity department, from £400 to £450 per annum. Some time ago it was proposed to raise Mr. Jeckell's salary, but at that time it met with a certain amount of opposition, the contention being that it would be better to wait until the results of the year's trading were known. It was, however, generally felt that Mr. Jeckell was entitled to some advance in view of what he had accomplished in converting a losing concern into a profitable one.

Prior to taking up his new duties as chief engineer at West Bromwich, Mr. W. A. Jackson, installation inspector of the Manchester Corporation electricity department, has been the recipient of a silver tea service, Mr. S. L. Pearce, chief engineer, making the presentation. Mr. L. H. Marlor, formerly assistant inspector, has been appointed Mr. Jackson's successor, with Mr. W. West as assistant.

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LEGAL INTELLIGENCE.

ELECTRICAL CARS AND ACCUMULATORS.

Under a compulsory winding-up order made against the Garcin-Renault Electric Cars and Accumulators, Limited, accounts have been filed showing liabilities £4,777 against assets £265, and a deficiency to the shareholders of £4,575.

THEFT FROM TELEPHONE BOX.

At Stratford Police Court on Tuesday, Frederick Johns was charged with breaking an automatic telephone box and stealing 9s. 1d., the property of the National Telephone Company. On Monday afternoon Detectives Matthew and Clifton were looking out of the window in the police office at the Royal Albert Docks, when they saw the prisoner in a railway truck close by. They went to him and found that he had a telephone cash box in his hand. It was afterwards found that the public telephone, which is situated but five yards from the police office, had been greatly damaged and the cash box stolen from it. The prisoner now pleaded "Guilty" to the charge, and it was stated by Mr. F. F. Macnaghten, who prosecuted, that during the past few weeks no fewer than 70 public telephones had been damaged in this way. The prisoner was sent to gaol for two months.

COMPANIES' MEETINGS AND REPORTS

KALGOORLIE ELECTRIC TRAMWAYS.

A joint meeting of the holders of the A and B debenture stock was held on Tuesday to consider a resolution to authorise the directors to enter into a supplemental trust deed with the Consolidated Trust, the trustees for the debenture stockholders, consequent on this Company having made an agreement for the working of their tramways with the Kalgoorlie Electric Power and Lighting Corporation.

Mr. ALLEN H. P. STONEHAM, who presided, stated that the agreement was the outcome of very protracted negotiations between the two companies, and the Board believed that the result of it would be of great benefit to both concerns. At the time of their last annual meeting they had determined, owing to their negotiations with the Power Corporation having fallen through, to put up their own power-house, but he was happy to say that shortly after that meeting the negotiations were resumed, and the present working arrangement was made. Things moved very quickly in Kalgoorlie, and a price which was a fair one three years ago had proved to be exorbitant to-day. The old contract had, therefore, been terminated, and the new arrangement was based on this Company being supplied with power at cost, the Power Corporation to have a percentage of the net profits earned by the tramways over £20,000 per annum. The tramways were doing so well that he had every expectation that there would be a considerable profit for the Power Corporation at the close of the present financial year.

The resolution having been unanimously adopted by the holders of the A debenture stock, it was then submitted to the B debenture holders, when a shareholder inquired in what way the new deed would affect the position of the debenture stockholders. The Chairman replied that the agreement would result in larger profits for the Company, and so the margin, after providing for the debenture interest and the sinking fund, would be greater. The shareholder stated that what he particularly wanted to know was if the Power Corporation were to be given any prior charge over the debenture stockholders. The Chairman said they were not.

The resolution was then unanimously carried.

LIENS REGISTERED.

N.S. Electric Storage Co., Limited (London). — Issue on Aug. 10 of £1,800 debentures, part of a series created same date to secure £20,000. Charged on the company's undertaking and property, present and future. No trustees. No previous issue of same series.

Bolckow, Vaughan, and Co., Limited.—Issue on Aug. 30 of £26,700 debentures, part of a series created by resolutions of Feb. 23 and March 20, 1905, to secure £1,000,000. Property charged: the company's undertaking and real and personal property, present and future. No trustees. Total amount previously issued of same series, £180,700.

Newcastle and District Electric Lighting Co., Limited. — A trust deed, dated Aug 8, 1905 to secure £150,000 debenture stock, created by resolution of June 2, 1905, has been registered. Property charged: freehold land and generating stations at the Close, Newcastle-on-Tyne, and at Lemington; leasehold land and generating station at Forth Banks, Newcastle-on-Tyne, any money resulting from compulsory sale under any contract prior to date of trust deed or under any provisional order or Act of Parliament, and the company's general assets, present and future, excluding uncalled capital. Trustees: W. Milburn, 130, Fenchurch-street, E.C.; E Waterhouse, 3, Frederick's-place, Old Jewry, E.C.; and W. Greenwell, 2, Finch-lane, E C.

Paris.—The Waterworks Department of the Municipality require tenders for supply and erection of motors, pumps, and generators for the proposed waterworks at Chantilly. For particulars apply to above authority. Tenders by Oct. 12.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Plasencia (Spain).—The municipal authorities require tenders for an electric lighting installation. Tenders by Sept. 15.

Olympia 1905 Exhibition.—The Executive Committee invite tenders for the loan or hire of 300-kw. direct coupled steam set.

Pontypridd.—The Urban District Council invite tenders for (Section B) overhead equipment for tramways; (C) cables for tramways. Tenders by noon on Sept. 30. See advertisement in last issue.

Bishop's Stortford.—The Urban District Council invite tenders for lighting such of the public streets as are at present lighted, for two or three years from Sept. 30. Tenders by 4 p.m. on Sept. 25.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of feeder cables, conduits, and other works in connection therewith. Tenders by noon on Sept. 25. See advertisement in last issue.

Alicante (Spain).—The Harbour Board (Junta des Obras del Puerto) require tenders for two electric cranes, capable of lifting 10 000 ko. and 1,500 ko. respectively. Tenders by Sept. 15. Estimate, 107,010·10 pesetas.

Pembroke (Ireland).—The U.D.C. invite tenders for electricity supply mains, arc lamps and pillars, house meters, and switchboard panels. Tenders to Mr. J. C. Manly, Town Hall, Ball's Bridge, Co. Dublin, by 10.30 a.m. on Sept. 22.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board require tenders for the supply, delivery, and erection at the Stalybridge sub-station of a 400-kw. motor-generator, together with the necessary switchgear for same.

Dublin.—The Lighting Committee invite tenders for the supply of (*a*) sub station switchboards, transformers, etc.; (*b*) extra high-tension and low-tension mains. Tenders to Chairman of the Lighting Committee, 3, Cork-hill, Dublin, by Sept. 18. See advertisement in last issue.

Langho (near Blackburn).—The Chorlton and Manchester Joint Asylum Committee invite tenders for the supply and fixing of the necessary telephones and electric bells at the new colony for epileptics at Langho, near Blackburn. Tenders to the Clerk, Chorlton Union Offices, All Saints', Manchester, by Oct. 3.

London County Council.—The London County Council invites tenders for the manufacture and laying of (*a*) 56 miles low-tension lead-covered, paper-insulated cables 20 miles dry-core telephone cables, cast-iron feeder pillars, etc.; (*b*) 24 miles extra high-tension three-core, lead-covered, paper-insulated cables, etc. Tenders to Mr. G. L. Gomme clerk, by 10 a.m. on Oct. 3. See advertisement.

Linlithgow (Scotland).—The Uphall and Broxburn District Lighting Committee invite tenders for the supply and erection of one suction gas-producer plant of 80 b.h.p. capacity; one 80-b.h.p. gas-engine; one 52-kw. dynamo; one automatically-reversing motor booster, two 280-ampere-hour storage batteries, switchboard, cables, meters, etc. Tenders to Mr. J. G. B. Henderson, county clerk, Linlithgow, by 12 noon on 18th inst.

London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of 34 steel single-deck tramcar bodies; maximum traction swing bolster trucks for 34 electric cars; complete electrical equipments for 34 cars; or, alternatively, 34 steel single-deck cars, with trucks and equipments complete. Tenders by 10 a.m. on 29th inst.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23.

RESULTS OF TENDERS.

Brighton.—The Town Council have decided to purchase a coal-handling equipment for the Southwick power station from the Transporter Co., 7, Great Winchester street, E.C., at a cost of £2 321.

Warrington.—The Town Council have accepted the tender of Johnson and Phillips, at £564, for the supply of cables; and that of Hadfield's Limited, of Sheffield, at £614. 9s., for the supply of junction and curves for Rylands-street

N.E.R. Stoker.—Messrs. Meldrum Bros., of Timperley, have received an order from Babcock and Wilcox for one of their mechanical stokers to consume a mixture of slack and locomotive smoke-box refuse under a large Babcock boiler to be installed at Gateshead-on-Tyne for the North-Eastern Railway Co.

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BUSINESS NOTES.

TRACTION.

Bournemouth.—A large public meeting last week pronounced in favour of Sunday trams.

Erith.—The Council having received several applications for season tickets, the matter is receiving the attention of the Tramways Committee.

Nottingham.—The Corporation have decided to extend the tramways so as to provide for the eastern district, the cost being estimated at £57,000.

Perth.—The municipal accounts for the year ended May 15 show that the revenue from the tramways amounted to £4,422, there being a deficit of £1,319.

Heywood.—The agreement arrived at between sub-committees of Heywood and Rochdale for the working of the trams has been approved by the latter Corporation.

Penmaenmawr.—The Urban District Council have decided to consider a scheme for an electric tramway up the Penmaenmawr Mountain at an approximate cost of £10,000.

Belfast.—It is probable that a compromise will be arrived at between the Corporation and the National Telephone Co. regarding overhead wires, to which we have referred in previous issues.

Leith.—At a meeting of the Town Council a proposal that the scheme of fares be remitted to committee for further consideration was rejected, and the action of the committee in conferring ½d. fares to Leith-walk was confirmed.

Woolton.—The Tramways Committee of the Liverpool Corporation have decided that they cannot recommend that the travelling facilities to Woolton should be increased by a motor 'bus service, as requested by the Rural District Council.

Bradford.—Application is to be made to the Board of Trade for sanction to borrow £30,079 for the construction of tramways at **Wyke.** After some discussion it was decided to refer the employés' application for an annual holiday to committee.

Weston, Cleveland, and Portishead Light Railway.—Mr. Justice Lawrence granted the company, on the 6th inst., a continuance for a week of the interim injunction restraining the Urban District Council from pulling up the rails connected with the plaintiff's line.

Darlington.—The receipts from the trams for the month of July as compared with last year showed that, although 51,019 more passengers had been carried, the receipts were £30. 2s. 11d. less, that 192·4 less miles had been run by the cars, and that the revenue per car mile was 1·6d. less.

North Staffordshire Light Railway.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation under the Light Railways Act, 1896, an order made by them authorising the working of certain branch lines of the North Staffordshire Railway as light railways.

London United Tramways Co.—The work of erecting the trolley poles in Kingston has been proceeded with very rapidly during the last few days. Plans for the sub-station are before the Corporation. A number of residents in the neighbourhood of Richmond are petitioning for a line to Ham.

Halifax.—At last week's meeting of the Town Council a proposition was submitted for the doubling of the tramlines from Hall End to Bedford-street at an estimated cost of £1 425. This was agreed to, as also was a proposal that a double line of tramway be laid from Gibbet-street along Thrum Hall-lane, at an estimated cost of £1,250.

Bolton.—The accounts for the year ended March 31 show that the income from the Corporation cars amounted to £95 766, and the working expenses to £55,202, leaving a balance of £40 564. Interest and sinking fund charges absorb £13 014 and £12,278 respectively, £11,599 is carried to reserve, and £3,941 is contributed to the relief of rates.

Caversham.—At the meeting of the Urban District Council the clerk reported that he had received a letter from the town clerk of Reading stating that the Tramways Committee of the Reading Town Council would be prepared to confer with representatives from the Caversham Council as to the proposal for the extension of the tramway into Caversham.

Wellington (N.Z.).—The returns of the electric tramways during the year ended March 31, 1905 show that the receipts from passenger fares were £36,534, from mails £163, and from repayments £8, making a total of £36,705. The working expenses were £27,643, and the interest paid on loans £9 625, giving a total of £37,268. The Municipal Council has, therefore, to face a small deficiency of £563.

Yardley.—At the meeting of the Urban District Council the following proposition was rejected by 10 votes to 2, as implying a reflection upon the Tramways Committee: "That an official letter be sent on behalf of the Council to the company, asking them definitely whether they intend to lay down the tramway to Shirley, and, further, when they intend to commence laying down the tramway to Acock's Green and Olton."

Burnley.—Considerable discussion ensued at the meeting of the Town Council in regard to the allocation of duties. It was proposed to give their new electrical engineer the control of the tramway repair shops in addition to the overhead equipment, but finally it was decided to adhere to the old arrangement. An excellent suggestion that the electrical engineer should have charge of the electric equipment of the cars received little support.

Longton.—At the meeting of the Town Council the plan of the proposed light railway in Anchor-road to Sandford Hill, as submitted by the Potteries Electric Traction Co., was approved, and the company were recommended to construct a long loop in Anchor-road, near to Market-street, which might be utilised for special cars running on Saturdays during the football season, in order to avoid the overcrowding of the Market-place.

Rating of Trams.—At the meeting of the General Purposes Committee, Gillingham (Kent) Town Council a letter from the town clerk of Wakefield was read with respect to the rating of light railways and tramways, giving a list of those corporations and urban district councils which had agreed to contribute towards the cost of the special case to be submitted to the High Court. It was recommended that the Council contribute a sum not exceeding £10 towards the cost.

Bradford-Dewsbury.—A proposal has been made to the Bradford Corporation by the company operating the Dewsbury tramways that a through tramway fare should be agreed upon for the journey by tramway between Dewsbury and Bradford. The matter has been brought before the Bradford Tramways Committee, who have given authority for negotiations with the company, on the basis of the fares received being divided in proportion to the respective route lengths of the two lines.

Birkenhead.—At the meeting of the Town Council a question was asked respecting the issue of the through tram and ferry tickets on the Higher Tranmere route. In reply, it was stated that the number of tickets issued during August was 5,723, which represented a percentage of 9 28, as compared with 4·43 in July. The chairman of the Tramways Committee added that the traffic was improving steadily, and he thought the figures rather pointed to the necessity of trying the same experiment on the other tracks.

London County Council.—In connection with the reconstruction of the existing tramways along the Theobald's-road for electrical traction, the Works and General Purposes Committee of the Holborn Borough Council recommend that the County Council be asked to meet the wishes of the Benchers of Gray's Inn—viz., that silent road paving be laid down outside the Benchers' offices—seeing that that body made a handsome concession to the public by the improvement of that thoroughfare in the neighbourhood of their garden.

Sydney.—An experiment is to be made on the city cars with the Raworth system of regenerative control. So prevalent has become the practice of standing up in the cars that the following regulation has been adopted: "No person, other than an employé of the Commissioners, shall stand on any platform or other part of a carriage when a seat is available, and any such person who continues to so stand after being requested by the conductor or other authorised officer to be seated shall be liable to a penalty not exceeding £2."

Macclesfield.—At the meeting of the Electricity Committee a letter was read from Messrs. Newton, Son, and Bayley, engineers, as to the Cheshire tramway scheme. The letter asked for the support of the Council for an extension from Hazel Grove to Macclesfield, with a branch line connecting Handforth and Wilmslow. Some members of the committee considered that a more desirable scheme would be a light railway connecting Macclesfield with Knutsford, but it was decided to give the promoters an opportunity of appearing in person before the committee at its next meeting, and of explaining in detail their proposal.

Spen Valley.—At the meeting of the Cleckheaton Urban District Council on Tuesday a letter was read from the town clerk of Bradford stating that the Tramways Committee of his Corporation had had under discussion a proposal that a tramway should be laid from the top of Odsal to the city boundary at Oakenshaw. The Corporation was desirous of learning what the Cleckheaton Council would be prepared to do as regarded the construction of an extension line in their district, so as to afford through facilities between Bradford and the Spen Valley. The letter was referred to the General Purposes Committee.

Metropolitan Railway.—One of the new electric trains on the Metropolitan Railway met with an accident at Moorgate-street Station on Wednesday. It was completing its journey from the west, and was leaving the Circle line in order to run into an outer siding, when it missed the points and struck on the end of the intervening platform. Fortunately it was running slowly, but the force of the impact was sufficient to smash the compartment in which the driver stands, and he was seriously injured about the head and neck by broken glass. Two of the passengers in the train were taken to the hospital suffering from bruises and shock. The accident caused considerable delay to traffic.

Dover.—The profit made by the trams during the year ending March 31, 1905, amounts to £231. 10s. 8d., which is a great falling off compared with other years. In 1901, when the number of passengers carried was 2 710 420, the net profit amounted to £1,067. 14s. 6d.; in 1902, 2,905,823 passengers, profit £991. 12s. 6d.; 1903, 2 862,590 passengers, profit £1,025. 14s. 9d.; 1904, 2,871,332 passengers, profit £920 9s. 9d. The apparent drop in the profit this year, however, is to some extent explained by the fact that in addition to the ordinary repairs and renewals of equipment, several items of exceptional expenditure, amounting to £821. 17s. 4d., have been met out of the revenue of the year.

Worcester.—At the meeting of the Corporation the Streets Committee recommended the acceptance of the offer of the tramways company to extend their tramways along the Malvern road as far as the Brunswick Arms on terms set out by them in a letter of March 14. The terms were: to construct the line to the Brunswick Arms with rails laid on concrete, and a single line of setts placed lengthwise along each side of the rail, the remainder of the paving to be of macadam; the Council undertaking to maintain the track, leaving the company

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responsible for the rails, etc., and offering to maintain the paving of the track for £20 per annum. After some discussion the matter was referred back. The Worcester Tramways Co. intend to apply to the Board of Trade for sanction to the transfer of the undertaking to the Worcester Electrical Traction Co. at the price of £6 500.

Sheffield-Rotherham.—A delay of 40 minutes' duration occurred on Tuesday to the through tramway traffic between Sheffield and Rotherham, owing to the breakage of an overhead wire. The service continues to be well patronised, the improved communication proving a distinct convenience. Later in the day Major Pringle, representing the Board of Trade, inspected the short length of newly-laid track necessary to connect the Rotherham and Sheffield systems. He journeyed from Rotherham by special car, being accompanied by Mr. Cross (electrical engineer and tramways manager), Mr. Jennings (borough surveyor), Mr. F. Renwick (assistant town clerk), and other officials. At Tinsley he was met by the Sheffield representatives, including Mr. Fearnley (tramways manager), Mr. Yerbury (electrical engineer), and Mr. Lancashire (deputy city surveyor).

Swansea.—At last week's meeting of the Tramways and Electric Lighting Committee, Mr. Sinclair presiding, a sub-committee was appointed to report upon matters relating to the working of the tramways—the allocation of the rentals to the tramways and the light railways, etc. A councillor raised the question of the fixed terms by which the Corporation were to get an extra 1 per cent. beyond the rentals. He inquired whether it was to come after payment of 6 per cent. dividend on the actual value of the company property, which he valued at £110,000, or upon the share capital of the company, estimated at £245,000? The latter would come to about £14,700 a year before the Corporation would be entitled to 1 per cent., whilst the latter would only mean £6 390. The chairman read the clause in the agreement, which was "upon the actual expenditure for the time being," and it was decided to include the point as one of the matters to be discussed by the sub-committee. The engineer is to report upon a proposal for a line to Foxhole and Pentreehwyth.

Colchester.—At the meeting of the Town Council it was reported that the Bill confirming the provisional order for the Military-road extension received the Royal assent, and it was decided that application be made to the Board of Trade for sanction to the borrowing of £7 334, the total estimated capital expenditure for carrying out the extension. It was resolved that school children be allowed to travel on the cars at half fares on Saturdays between 8 and 9.30 a.m. Mr. R. C. Bullough, the general manager and engineer, in his first annual report, gives some information supplementary to that contained in our last week's issue. The number of passengers was 2,801,085, being 70·02 times the population. Mr. Bullough estimates that during the months of August, September, and October last year at least 25 per cent. of the traffic was "novelty traffic," the loss of which will be felt in the ensuing year. To compensate in a measure for this loss, it will be necessary to curtail the number of early morning and up to noon cars during the coming winter. The working expenses per car mile show an economy as compared with several towns of a similar size.

Rhondda.—The contents of the report of the Board of Trade Commissioner with regard to the terms and provisions of the proposed agreement for the construction and working of the Rhondda tramways were made public at last Friday's meeting of the Urban District Council. The report was to the effect that the commissioner advised the Board to give its approval to the Council's scheme, subject to certain modifications and amendments, which the Council accepted. The commissioner accepted Sir Douglas Fox's figures as to the cost, which that gentleman estimated to amount to £258 000, which, after the deduction of a percentage in respect of depreciation, would mean a net amount of £193,875 at the end of 42 years, while the proposed rental of £2,250 per annum would amount to £196,035 in the period indicated. The commissioner, therefore, was of opinion that the Council's scheme was financially sound, subject to the insertion of a restrictive clause providing for increased rent in the event of expenditure on works of extension other than those contemplated by the present scheme being carried out. The commissioner also added that he had inspected the proposed route, and he was able to assure himself of the success of the scheme. Satisfaction having been expressed by members with the tenor of the report, the letter was then referred to the Legal and Parliamentary Committee to deal with.

Kirkcaldy.—Since the alteration of the tramway fares, about two months ago, when the halfpenny stages were very much shortened, there has been much dissatisfaction, and the receipts have considerably fallen. A meeting of the Tramway Committee of the Town Council was held last Friday night to review the situation. Mr. Francis, the burgh electrical engineer, submitted a report, which showed that the receipts for the past two months indicated a reduction at the rate of £1,800 per year, as compared with the same period of last year. On the other hand, they had been saving about £800 on working expenses, showing a net average loss at the rate of £1,000 a year as compared with last year. Mr. Francis suggested that instead of the present eight halfpenny stage scheme they should introduce a four halfpenny stage scheme. The only objection to a trial of this scheme was that in the event of it proving unsuccessful the fares would have to be raised, with possibly the same disastrous results as at present. The scheme, which he submitted, was on the principle of four halfpenny stages on the lower route and two halfpenny stages on the upper route, and that no reduction should be given to workmen. The committee approved of the scheme, but agreed that the workmen's fares should be continued, giving two halfpenny stages for a halfpenny. The matter will come up for decision at the meeting of the Council.

Dudley.—It is reported that at Tuesday's meeting of the Town Council it was decided, after considerable discussion, to refer the matters in dispute between the Corporation and the tramways company to arbitration. A letter was read from Mr. Garcke stating that the company had made every effort during the past few years to agree upon reasonable terms of settlement so as to avoid the unpleasantness, great expense, and other serious consequences to both sides of an arbitration, and it was with the greatest reluctance that they had decided that they were unable to accept the agreement as drafted on behalf of the Dudley Corporation. Ever since the tramways and light railways in the Dudley district had been under the control of the companies every effort had been made to carry on the business with a view to meeting the requirements of the public and the Dudley Corporation; and the town of Dudley had derived vast benefits during the past few years from the development of electric traction, while the average return on the capital invested had been only 4½ per cent. per annum. They thought, under these circumstances, it was a very great hardship on the companies that the Dudley Corporation should seek to impose upon them such terms as would effectually prevent the directors from carrying on the business with satisfaction to the public and the shareholders, and if the Corporation was determined to exact the proposed onerous and impossible terms from the companies to the full extent provided by the draft agreement, they had no alternative but to leave them the responsibility of having the matter decided by arbitration.

Dundee.—In the course of the debate upon the report presented by the tramways manager regarding the unfavourable position of Dundee as compared with Glasgow and other towns in respect of the percentage of operating expenses to receipts, Councillor Stevenson contended that the report missed the point, inasmuch as it did not show how the cost in Dundee could be reduced to the same point as in Glasgow. It was not enough to tell them that if the figures applicable to Glasgow were made to include charges for interest and depreciation, they would be in the same position as Dundee. If they had run as cheaply as Aberdeen, they would have saved £3,200 in 1904. He moved that the matter be remitted back for further consideration, so that they might arrive at the cause of the discrepancy between Dundee and many other towns. Councillor Brownlee, in reply said that when they considered that Mr. Richardson, the engineer, had brought down the coal consumption to such an extent that the cost was 1·881. per unit, they would see they could not go very much further in that direction. He contended that Dundee could not be compared with Aberdeen and Glasgow. These cities had no gradients like the Constitution-road of 1 in 11 up which to propel cars of 13 tons weight, and no lines which rose practically from sea-level to over 300ft., as they had in Dundee. The matter was remitted to the committee. The recent *plébiscite* upon Sunday running reversed the position caused by the first poll, and the new service was instituted last Sunday, when there was a big rush for the trams. The tramwaymen's association sent in an application for payment on Sundays at the time-and-a-half rate. During the discussion on this point a councillor proposed time and a quarter as a compromise, but finally the Council remitted the matter to committee.

Liverpool.—The foundation stone for the Corporation's new tramway offices in Hatton-garden was laid on Tuesday. The site is in a central position for dealing with the work of the department, and the plans which have been prepared by Mr. T. Shelmerdine, the Corporation architect and surveyor, suggest that a very handsome and commodious building will, in the course of the next year, be seen in Hatton-garden. The expansion of the tramway business rendered new offices imperative. Previously to the ceremony Sir Charles Petrie, chairman of the Tramways Committee, entertained a large number of councillors, officials, and others to lunch, and took the opportunity of reviewing the great progress made by the Corporation trams. The inscription on the foundation stone, which is of Swedish marble, is as follows: "City of Liverpool Tramway Offices. The Right Hon. John Lea, Lord Mayor. This foundation stone was laid Sept. 12, 1905, by Alderman Sir Charles Petrie, J.P., chairman of the Tramways Committee. Alderman Fred Smith, J.P., deputy-chairman; Councillor E. Lewis Lloyd, chairman of the Traffic Committee; Thomas Shelmerdine, Corporation architect and surveyor; Chas. R. Bellamy, C.E., general manager of tramways." The Lord Mayor was the recipient of a special souvenir of the occasion, which took the form of an 18-carat gold medal set with a large diamond of the finest water. At the meeting of the Corporation Sir Charles Petrie, in reply to a question, stated that the Tramways Committee had not yet considered the question of laying a tramline in Bootle to the north docks, but he would have much pleasure in bringing it before the committee. As to Cabbage-hall, they had now parliamentary powers to construct a line there, but before that could be done the Health Committee would have to widen the road. He added, in reply to a further question, that the Bootle Corporation would not allow them to lay the line unless they gave an undertaking that they would not carry anything but passengers on that particular line. The Tramways Committee could not see their way to do that, because under the Act of Parliament they had now got they were fully entitled to carry anything they liked over their lines.

LIGHTING AND GENERAL.

Wellington (N.Z.).—A large grain mart is to be erected, which will be equipped with electric hoists.

Wireless Station.—Mr. Marconi has opened a new station for wireless telegraphy service on Sable Island.

Paignton.—Sanction has been refused to the Town Council's application for a loan for an electric lighting scheme.

Hastings.—An inquiry has been held into the application of the Town Council for sanction to borrow £2,000 for electric lighting.

The Channel Islands.—The postal telegraph authorities have issued a statement that communication with the Channel Islands is restored.

Auckland (N.Z.).—The City Council have engaged Mr. W. Goodman to prepare a report relative to a combined electric light and dust destructor scheme.

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Aldershot.—The Local Government Board has held an inquiry into the application of the Urban District Council for sanction to a loan of £2,000 for electrical purposes.

Whitby.—The Council's engineer has been empowered to make the necessary arrangements for holding an electrical exhibition in the Temperance Hall to open on the 29th inst.

Harrington (Cumberland).—The Urban District Council have received an application from Messrs. J. Bain and Co. regarding an electric lighting installation at their premises.

Irvine.—After a considerable discussion upon a tender of £6 646 from a London firm for an electric lighting installation, the Town Council referred the whole matter to committee.

Dewsbury.—At the meeting of the Town Council it was reported that sanction had been obtained from the Local Government Board to the borrowing of £9 762 for electric lighting purposes.

Removal.—Messrs. Hughes and Lancaster notify that their offices will be removed to-morrow from 47, Victoria-street, S.W., to 16, Victoria street, where all communications should be addressed.

Rostrevor.—A public meeting is to be held at an early date, at the instance of the local authority, in order to ascertain the wish of the inhabitants regarding a company's offer to instal electric lighting.

Battersea.—The Borough Council have decided to support the Poplar Borough Council in urging the London County Council to reinsert in their next General Powers Bill the clauses relating to wiring rejected by the Lords.

Dividends.—The debenture stock transfer register of the South Metropolitan Electric Light and Power Co. will be closed from the 20th to the 31st inst. for the purpose of preparing the warrants for the interest payable on Oct. 1, 1905.

Wells.—At the monthly meeting of the Town Council a notification was received from the General Post Office that the scheme for the extension of the telephone system to Wells, Shepton Mallet, and Glastonbury had received the sanction of the authorities.

Filter Papers.—Messrs. A. Gallenkamp and Co., 19 21, Sun-street, Finsbury-square, E.C., have just issued a pamphlet containing particulars of the various filter papers in connection with which they have the sole agency for the United Kingdom and the Colonies.

Poplar.—At a recent meeting of the Borough Council the Electricity Committee reported that they had under consideration the advisability of taking steps to secure the establishment of a public authority empowered to supply electrical energy in bulk to authorised distributors.

Halesowen.—At the meeting of the Oradley Parish Council it was reported that the Empire Electric Co. had intimated their intention of applying for a provisional order for electric lighting but that no understanding had yet been arrived at between the company and the Rural District Council.

Newfoundland.—The new cable connecting the Commercial Cable Co.'s Transatlantic system with the island of Newfoundland has been completed by the cable ship "Mackay Bennett," and is now open for business. This cable will be worked in connection with the Newfoundland Government telegraphs.

Northampton Institute.—From the prospectus for the ensuing session we observe that the various technical classes, including electrical engineering, will commence on Sept. 25 for evening pupils, and on Oct. 2 for day pupils. Some particulars relative to the institute's courses will appear in our next issue.

Humber Pilotage Commissioners.—At the monthly meeting of the Commissioners the Finance Committee recommended that notice be given to the Corporation to terminate the contracts for the telephone installations, and that terms be obtained from the National Telephone Co. for reinstalling their system. The resolution was unanimously adopted.

St. Helens.—The electrical engineer, Mr. Hollingsworth, has reported to the Electricity Committee a gross profit for the year of £2,003. The income of the department was £19,211. 2s. 5d., and the expenditure £17,798 0s. 11d. Out of the balance £500 has been placed to the credit of the plant and machinery account, and £100 to the accident fund, leaving a net profit of £1,403. 1s. 6d.

Manchester.—At the meeting of the Electricity Committee the chief engineer, Mr. S. L. Pearce, presented a report of the recent additions to plant which have been made at the various stations and sub-stations. A sum of about £40,000 have been spent in making the equipment equal to the city's requirements. Of this amount quite £13,000 has gone in improving and extending the street mains.

Swansea.—At the meeting of the Telephones Committee the manager reported that there were 1,104 subscribers, 1,249 instruments and working lines, and 177 orders in hand. It was decided to apply to the Postmaster-General for "free intercommunication" with the National Telephone Co.'s system. The manager said that intercommunication would probably be established in about 10 weeks' time.

Maidenhead.—The report for August of the resident engineer, Mr. C. O. Milton, notes an improvement of 2 per cent. in the load factor as compared with last year. An extension main to Ellington-road has been connected up. Twenty-seven additional public lamps have been erected. Applications for lighting have been received from residents in Taplow to the extent of 106 lamps, and it has been decided to lay the necessary mains.

Brixham (Devon).—Electricity has scored here. The Urban District Council offered a subsidy of £500 per annum for street illumination, and Edmundson's Electricity Corporation tendered a combined arc and incandescent scheme yielding 10,825 c.p., or an all-incandescent scheme yielding 10,425 c.p., which was accepted, as against the local gas company's offer to instal a system of Kern and self-intensifying burners.

Alloa.—At the monthly meeting of the Town Council the provost reported that negotiations had been reopened with the British Electric Plant Co. and the Town Council, and the result of these negotiations had been that the parties had practically adjusted matters in such a way that the Town Council would, when arrangements were completed, be in a position to supply electric current consumers at an exceedingly moderate flat rate, something like 4 d. per unit.

Stock Exchange.—The committee has ordered the following securities to be quoted in the official list: Rosario Electric Co.'s 12,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 12,000, and 8,000 6 per cent. cumulative preference shares of £5 each, £4 paid, Nos. 12,001 to 20,000; Daimler Motor Co.'s (1904) 62,276 ordinary shares of £1 each fully paid, Nos. 1 to 62,276, and 64,200 6 per cent. cumulative preference shares of £1 each, 10s. paid, Nos. 1 to 64,200.

Crewe.—At the meeting of the Electricity Committee a letter was read from the Local Government Board requesting to be furnished with plans of the proposed works and detailed estimates showing how the amount of £2 100 (for which application had been made for sanction to borrow for the purposes of the electric light undertaking) was made up. The Electrical Engineer stated that he was supplying the information asked by the Local Government Board. It has been decided to erect a lamp in Collins-street.

Southwick-on-Wear.—At the monthly meeting of the Urban District Council a letter was read from the County of Durham Electrical Power Distribution Co., submitting, in accordance with the Council's request, terms for the lighting of the public streets in the district by electricity. The Council will give the matter their consideration. The Council granted their consent to the application of the County of Durham Electric Power Supply Co. to the Board of Trade for consent to the laying of overhead high-tension and distributing mains.

Lye and Wollescote.—At the monthly meeting of the Urban District Council a letter was received from the Midland Electric Corporation offering a reduction in their flat rate of from 4½d. per Board of Trade unit to 3½d. in the case of prompt payment, and stating that in order that consumers might receive the discounts it would be necessary for the Council to give an assurance that they would not insist upon the discounts specified in their agreement with the company. The Council agreed to waive their claim to the discounts mentioned for five years.

Wigan.—The Corporation have approved the following recommendation of the Streets Lighting Sub-Committee: "Street lighting in Pemberton—Moved by the chairman, seconded by Mr. W. Wilson, and resolved that in the opinion of this committee the cost of lighting the Pemberton part of the borough is much in excess of what it ought to be, and they recommend that the lighting should be converted from electricity to gas, and the change made by easy stages." The committee estimated that by substituting gas for electric light there would be at least £500 a year saved.

Brazilian Electricity Co.—The recent reports regarding the sale of certain electric undertakings in Brazil are now confirmed by the announcement that the principal assets of the Brazilian Electricity Co. of Berlin have been disposed of. These are the telephone installation at Rio de Janeiro and the Villa Isabel tramway in the same city, which have been taken over (according to the Berlin *Tageblatt*) by the Brazilian Securities Co. It is stated that the purchase price yields a considerable profit to the Berlin company as compared with the book value of the undertakings.—*Financial Times.*

Hamilton (N.B.).—Under the auspices of Edmundson's Electricity Corporation, the lessees under the Hamilton Town Council Order for the supply of electricity to the town, an electrical exhibition has been opened in the town hall. The object of the exhibition is to acquaint those interested in the subject as to the current taken from the mains and supplied from the company's electricity works. At the opening ceremony Bailie Meechan (convener of the Electrical Committee of the Town Council) presided. Mr. Wigham, chief engineer for Edmundson's Co., gave an interesting address descriptive of the various exhibits in the hall.

Edinburgh.—The Parish Council have decided to appeal to the valuation court against the valuation of the Corporation electric light undertaking. Hitherto the system adopted by Mr. Hay, the burgh assessor, has been to assess on the average principle, taking account of buildings, plant, etc., but now he intends to assess on the profits principle, which this year would mean the difference between £6,000 and £12,000 in the rates. The Parish Council are to be represented in the court by counsel, and the Electric Lighting Committee have resolved to oppose to oppose the Council, and to employ counsel for that purpose.

Ayr.—At the meeting of the Town Council the report of Mr. R. Marshall, the electrical engineer, for the year to May 15 last was submitted. This showed that during the year about two miles of additional cable had been laid. The total number of consumers at the end of the year had been 885 as compared with 776 the previous year. The capital expenditure was £32 234 5s. 6d., an increase of £4 709. 5s. 5d. The total revenue had been £12 251. 2s. 4d., showing an increase of £393. 3s. 9d. on the previous year. The total working expenditure had been £6 447 17s. 10d., and the interest and sinking fund £4,910. 12s. 10d.—total, £11,358. 10s. 8d., thus leaving a net surplus of £892. 11s. 8d., as compared with a net surplus of £627. 15s. in the previous year. Dean of Guild Fraser moved that the charge to private consumers be reduced from 5d. to 4½d. Provost Allan moved as an amendment that the charge remain at 5d. The amendment was carried by nine votes to seven.

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Pontardawe.—At last week's meeting of the Rural District Council a letter was received from the Brynamman and District Electric Lighting Supply Co., offering to light Brynamman, Gwaunceagurwen, and Cwmgorse, and the clerk was instructed to write and ask for terms per lamp. Councillor James wanted to know why terms were asked for from a private company when the Council had an electric lighting scheme for the whole of Swansea valley? Dr. Jones and Mr. Francis pointed out that the figures supplied would be very useful for the Council to compare with. The report of the electrical engineer on the Council lighting scheme is to be considered at the next meeting.

Faversham.—At last week's meeting the Town Council had before them the Electric Supply Sub-Committee's estimate of their expenditure for the next half-year. This showed a total of £1,095 for the six months, and credits amounting to £555, leaving £540 to be met from the district rate. It appeared that at the meeting of the sub-committee the deputy-mayor gave notice that at the next meeting he would propose that the gas-intensifying gas lamp be fixed, with a view, if the results were satisfactory, of substituting them for the electric arc lamps. Another member gave notice to bring forward the question of substituting some other description of electric lamp for the arc lamps.

Telegraph Facilities.—At the Liége conference of the Association of British Chambers of Commerce the following resolution was adopted: "That this association is of opinion that a continuous day and night and Sunday service, both for receipt and delivery of telegrams, should be established in all towns with over 50,000 inhabitants where such a service does not at present exist, and that the executive be desired to take what action they consider needful to bring about this improvement." Discussing telegraphic facilities and the opposition from many chambers of commerce to work on Sunday, the delegates declared that work on six days was enough, but they did not object to telegrams on Sunday in case of life or death.

London Gazette.—The partnership between George Septimus Hooker and Percy Stephen Harris, carrying on business as electrical and mechanical engineers at Paragon Works, Retreat-place, Hackney, London, has been dissolved by mutual consent. The first meeting in the estate of William Jefferson, electrical engineer, 3, Grainger-street, Darlington, will be held at the official receiver's offices, 8, Albert-road, Middlesbrough, on Sept. 22 at 12 30 p.m. Ernest Bowman Rawlinson, Halifax Commercial Bank-chambers, Bradford, has been appointed trustee in the estate of Albert John Harris, electrical engineer, Borough Mills, Bower-street, Bradford. David Sibbald, 23, St. James's-street, Derby, has been released from trusteeship in the estate of Benjamin George Hodges, electrical engineer, 21, St Luke-street, Derby.

Gomersal.—At a previous meeting of the Urban District Council Mr. Woodhouse, of Leeds, engineer to the Electrical Distribution of Yorkshire, had stated his company were desirous of obtaining a provisional electric lighting order for Gomersal and other districts, and requested the consent of the Council. At that time the matter was referred to the General Purposes Committee. A further communication stated that the company would be prepared to supply power for private lighting at 4d. per unit, and that they would give a guarantee to the Council that the charge for street-lighting should not exceed 2d. per unit. It was decided that before taking any action the Council should ask to be furnished with a plan showing which streets the cable was intended to go through, and any other necessary information.

Warrington.—At the monthly meeting of the Town Council the following letter, sanctioning a loan of £4,000 for electric lighting purposes, was read from the Local Government Board: "As regards the loan of £1,000, I am to state that, having regard to the time which has elapsed since the land was acquired, the Board have fixed a period of 53 years for the repayment of this loan in place of the usual period of 60 years. I am at the same time to state that if the Town Council intend to apply to the Board for sanction to any further loans to defray the cost of the acquisition of other portions of the land purchased from Fairclough, the application should be made at an early date, and should specify the purpose for which the land will be used. I am further to request that in any future case where it is proposed to acquire land by means of a loan, the Town Council will be careful to defer the completion of the purchase until the Board's sanction to the loan has been obtained."

Gas versus Electricity.—A conference of the Gas Managers' Institute of Wales and Monmouthshire was held at Cardiff last week. Mr. T. Canning, Newport, in his presidential address, said that, despite all opposition, their industry was more prosperous in this country than ever. While in 1882 there were only 500 gas undertakings in Great Britain, there were now 719 such undertakings, supplying 151,677,693 thousands of cubic feet to 4,351,125 consumers. The paid-up capital expended in these undertakings was £117,972,458. Their industry had undergone a transformation during the past 21 years. Costly improvements were introduced for cheapening the price of gas, and at the same time reducing consumption. The conflict with electricity was not over, but he had no fear of the issue if average energy was put forth by gas managers. Public lighting had more attention from electricians than private lighting, but electric lighting had failed to give satisfaction in the public streets.

Gillingham.—At the meeting of the Town Council it was reported that a memorial had been received from consumers in the borough asking the Council to reduce the price of electric light, and it was recommended that the Council reduce the price as follows: flat rate from 4½d. to 4¼d. per unit; maximum and minimum demand, from 7d. and 2d. to 7d. and 1¾d. per unit. It was also recommended that revised charges be made for street-lighting. The estimates for the half-year ending March 31, 1906, provide for a revenue of £6,706, and a net profit of £491 after allowing for capital charges. The engineer reported that the equivalent of 113 8-c.p. lamps had been connected to the mains since the last meeting, making a total of 45,496 8-c.p. lamps with 248 consumers connected; and that applications had been received for the equivalent of 394 8-c.p. lamps. The committee recommended that the four single-light standards in High-street, Old Brompton, be converted into three-light standards, and also that four single-light standards in Canterbury-street be converted into three-light standards. The recommendations of the committee were agreed to.

Dundee.—At the meeting of the Town Council a letter was submitted from Messrs. Gourlay Bros. and Co. with reference to the question of supplying energy for their shipyard. They stated that the committee recommended the Council to refuse to supply them with current at a penny rate, but would be willing to give them current on a sliding scale basis as drawn up by the electrical engineer. When this scale was designed it was never contemplated to apply it to such a large consumption of current as theirs would be, as was proved by the fact that the published scale only provided for a maximum demand of 50 kw., whereas they would need at least four times this for their shipyard only, and their intention was to introduce electricity also to their engine works as soon as they could make the necessary arrangements. As regarded the cost of laying the cable to their yard, they asked if it was not likely that it would very quickly tap other sources of supply. Mr. Charles Gourlay attended the meeting and made a statement supplementary to the letter. It was in March last that his firm decided to apply electricity to the driving of their shipyard machinery, and though they had not placed the contract for the generating power, they had selected their contractor. Mr. Richardson approached them with the view of getting them to take current from the Corporation, and as a result of a good deal of negotiation they were led to believe that the Corporation would favourably entertain the idea of giving the current at 1d. per unit. They had tried to reconcile themselves to a sliding scale, and, in case there should be any misunderstanding, he wished to state that they did not object altogether to a sliding scale basis. But they objected to a scale based on kilowatts. What they would agree to was a sliding scale on the amount of units used. He had in his possession telegrams from shipbuilders at other ports, and in no case was there a sliding scale, the charge varying from ¾d. to 1¼d. It was agreed to refer the question to committee, Messrs. Gourlay and Co. to give an idea of the quantity of energy they would take.

Dunfermline.—For some months correspondence relative to the electric lighting of Dunfermline has been proceeding between Provost Macbeth (on behalf of the Corporation) and Messrs. Bramwell and Harris, electrical engineers to the Fife Electric Power Co., whose generating station at Townhill was opened a week or two ago. The following are the heads of agreement proposed by the company: (1) The Fife Electric Power Co. to give a supply of electricity in bulk to the Corporation of Dunfermline at one point situated near the centre of the town. (2) The current to be transformed into continuous current by machinery supplied, maintained, and operated by and at the expense of the Fife Electric Power Co. The pressure of supply to be 460 volts, suitably arranged with the necessary balancers for use on a three-wire system at 230 volts each side. (3) The site and buildings for the necessary sub-station for containing the machinery before mentioned is to be provided by the Corporation, free of cost and free of rent to the company. (4) The price to be paid by the Corporation for the supply of current to be in accordance with the following scale for the first year during which a supply is taken, and to be ½d. less in each case on the same scale after the expiry of the first year—under 100,000 units per annum 1½d., 100,000 to 200,000 1¾d., 200,000 to 300,000 1¼d., 300,000 to 500,000 1⅛d., 500,000 to 750,000 1d., 750,000 to 1,000,000 ⅞d., 1,000,000 to 3,000,000 ¾d. (5) In the event of a coal strike occurring, or of any other unforeseen circumstances arising, which may make it impossible for the company to supply at the foregoing figures, these prices shall not be binding on the company, but such other prices as may be agreed between the parties, or, failing agreement, as may be determined by arbitration, shall be charged and paid instead thereof for such time as the increased cost of production shall exist. (6) This agreement to remain in force for five years, and to continue thereafter from year to year, subject to 12 months' notice being given by either party. Provost Macbeth replied to the effect that he did not think that the Corporation would be willing to enter into an agreement unless a clause were to be inserted to read that the Corporation as authorised distributors would supply all electricity in the burgh, the only exception being, say, the factories, where it would not be reasonable for them to expect to have a monopoly. As to the prices proposed under head 4, they, in his opinion, ought to be ½d. less, at least, from the commencement of the agreement. Clause 5 was an impossible clause. Messrs. Bramwell and Harris, in a subsequent communication, expressed their willingness to delete the words "or of any unforeseen circumstances arising," and to insert after the words "shall be charged and paid instead thereof" the words "not exceeding 2d. per unit." Alternatively, if the Council very much wished it, the engineers would be disposed to agree to the words "during the continuance of the strike," instead of "for such time as the increased cost of production shall exist." The whole matter will be discussed by the Town Council at an early date.

PROVISIONAL PATENTS, 1905.

SEPT. 4.

17814. **Improvements in apparatus for controlling or/and supplying current for power and light on consumers' premises during certain periods.** George Scobell Ellis and Alfred Mills Taylor, 12, Ashfield-road, King's Heath, Worcestershire.

17818. **Improvements in electric cable conduits.** William Higgins, 21, Villas-road, Plumstead, Woolwich.

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17826. **Improvements in electric clock systems and the like.** Isaac Hardy Parsons and Alfred Ernest Joseph Ball, 40, St. Saviour's-road East, Leicester.

17835. **An improved form of electrical contact breaker.** Ernest Payne, 6, Cambridge-road, Hove, Brighton, Sussex.

17838. **An improved trolley head for electric tramways and railways.** Alfred Thorneycroft Eardley, Ericville, Woods Moor-lane, Stockport.

17842. **Improvements in and relating to wire-coating machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17843. **Improvements in and relating to electric motors especially intended for hoisting and similar purposes, and in systems of control therefor.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

17873. **Improvements in signalling by electromagnetic waves.** Charles John Briggs, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17878. **Improvements in insulators for current-carrying rails of electric traction systems.** Alfred Watkins, 322, High Holborn, London.

17881. **Improvements in electric securing devices for doors and the like.** Otto Roeseke, 6, Lord-street, Liverpool. (Complete specification.)

17888. **Improvements in combined electric switches and automatic circuit breakers.** John Henry Holmes, 47, Lincoln's-inn-fields, London.

SEPT. 5.

17896. **Improvements relating to electrical ignition systems for internal-combustion engines.** The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

17897. **An improved electrical generator system for use in connection with automobiles and the like.** The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

17955. **Improvements in electrical relays.** Carl Gustaf Roos and Charles Bernhard Roos, 55, Chancery-lane, London. (Complete specification.)

17956. **Improvements in or relating to direct-current electric motors.** William Phillips Thompson, 322, High Holborn, London. (Gustavus McAlpine, Mauritius.)

17957. **Improvements in step-by-step electric switches especially applicable as line selectors.** Isidore Bernard Birnbaum and Herbert George White, 322, High Holborn, London.

17974. **Improvements in joints for electric cables.** Siemens Bros. and Co., Limited, and Edwin Montague Allman Neale, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

SEPT. 6.

17990. **Railway automatic or electrical danger signal to be worked by a treadle or electric bar.** Joseph Isaiah James Lee, 12, Brent View-road, West Hendon, London.

17996. **A new or improved device for use in supporting electric cables, pipes, rods, or the like.** Frederick Mitchell and Francis Gunn, 3, Brown-street, Market-street, Manchester.

17997. **Improvements in or relating to electric insulators.** Thomas Cushing, care of Union of London and Smith's Bank, Croydon.

18006. **Improvements in and relating to electric fans and the like.** Reginald Page Wilson and Arthur Grotjan Marshall, 18, Southampton-buildings, Chancery-lane, London.

18013. **Improved means of rectifying alternating electric currents.** Frank Stewart Povah and Sydney George Livett, 9, Warwick-court, Gray's-inn, London. (Complete specification.)

18016. **Improvements in connectors for electric cables.** Ernest Charles Lea, 18, Fulham-place, Paddington, London.

18037. **Improvements in receivers for the wireless transmission of signals.** Valdemar Poulsen, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 17, 1904, being date of application in Denmark.) (Complete specification.)

18044. **Improvements relating to electric lamp holders** James Paterson, 18, Southampton-buildings, Chancery-lane, London.

18051. **Improvements in and connected with current takers or trolleys for overhead wires of electric railways and the like.** Otto Hoffmann, 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Sept. 9, 1904, being date of application in Germany.) (Complete specification.)

18053. **Improvements in brush-rocking gear for dynamos.** Henry Leitner and Richard Norman Lucas, 4, Stuart-street, Finsbury, London.

SEPT. 7.

13093A. **Improvements in or relating to electric drills.** Alfred Julius Boult, 111, Hatton-garden, London. (William Obed Duntley, United States.) (Date applied for under Rule 5 of the Patents Rules, 1905, June 24, 1905). (Complete specification.)

13093B. **Improvements in or relating to switches for electric drills.** Alfred Julius Boult, 111, Hatton-garden, London. (William Obed Duntley, United States). (Date applied for under Rule 5 of the Patents Rules, 1905, June 24, 1905) (Complete specification.)

18076. **Improvements in accident preventing or life-saving apparatus for electric tramcars and like vehicles.** Thomas Arthur Bennett, 3, Brown-street, Market-street, Manchester.

18089. **Installations of electrical clocks for public, domestic, and general use.** Edward Leslie Hunt, Queen's Hotel, Ballyconvarna, co. Clare, Ireland.

18102. **Improvements in transmitters for automatic telegraph systems and the like.** John Gell, 34, Castle-street, Liverpool. (Complete specification.)

18118. **Improvements in crossover points for the overhead electric conductors of trolley traction systems.** Arthur Henry Holmes and Henry Walter Holmes, 111, Hatton-garden, London.

18121. **An electric regulator for incubators and the like.** Alfred John Gaunt, 12, Baldwin-terrace, St. Peter-street, Islington, London.

18126. **Improvements in electric train control systems.** August Sundh, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18144. **A thermo-electric generator.** Jules Lecoche, 42, Rue Sadi-Carnot, Armentières (Nord), France.

SEPT. 8.

18147. **Improvements in commutators for electric ignition of gases in internal-combustion engines.** George William Somerville and Oliver Hicks, 68, Owen-street, Accrington.

18148. **Improvement in self-propelled electrical motorcar or vehicle.** Louis Collender, Thornton House, Matlock.

18155 **Electromagnetic selective separator.** Selimo Romeo Bottone and Dirk Croese, 93, Manor-road, Wallington, Surrey.

18193. **Improvements in microphones or telephone transmitters.** Franz Treyer, 37, Essex-street, Strand, London. (Date applied for under Patents Act, 1901, Feb. 15, 1905, being date of application in Switzerland.) (Complete specification.)

18208. **Improved contrivance for truing the surfaces of commutators.** Edwin Barbridge Phillips and Thomas Cresswell Parkin, 22, Southampton-buildings, Chancery-lane, London.

18209. **Improvements in electric control systems and apparatus therefor.** Leonard Alexander Tirrill, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 8, 1904, being date of application in United States.) (Complete specification.)

SEPT. 9.

18264. **Improvements in gas or vapour electric lamps.** The firm W. C. Heraeus, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 14, 1904, being date of application in Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Sept. 28.

1904.

19326 **Electric hand switches for motor-cycles and other like purposes.** Janes.

19330. **Electrical systems of railway signalling.** British Thomson-Houston Company, Limited. (General Electric Company.)

20496. **Time-consuming mechanism for operating electric cut-outs and other devices.** Gardner.

20970. **Braking or stopping devices for electric motors.** Hultqvist.

21145. **Means for automatically compensating for changes in the voltage of electric circuits.** Leitner.

21211. **Method of regenerating negative accumulator plates of diminished capacity, or for avoiding the diminution in capacity of new plates.** Kieseritzky.

21903. **Electricity meters.** British Thomson-Houston Company, Limited, and Lloyd.

22157. **Dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

22246 **Distribution of electricity for electric traction.** Gibbs.

22818. **Systems of control for electrically-operated doors.** British Thomson-Houston Company, Limited. (General Electric Company.)

22819. **Alternating-current electric motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

22821. **Windings for alternating-current dynamo-electric machines.** British Thomson-Houston Company, Limited. (General Electric Company.)

23203. **Contacts for electric controllers, reversing switches, and the like.** British Thomson-Houston Company, Limited. (General Electric Company.)

23254. **Construction of trolley head for collecting electricity from electric trolley wires or the like.** Phillips.

23525. **Electrical radiators.** Dowsing.

23817. **Electric motor control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

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23573. Driving belts and the like for preventing electrification of the same. Leloup, Obernesser, Tenthorey, and Tenthorey.

24178. Manufacture of thermo-electric batteries. Johnson. (A. Wolf, jun., and Co.)

24181. Systems of electric distribution. British Thomson-Houston Company, Limited. (General Electric Company.)

25642. Space telegraphy. Stone. (Date applied for under International Convention, Nov. 25, 1903.)

1905.

66. Electric switches. Smith.

79. Protective devices for fragile vessels containing mercury or other heavy liquid. British Thomson-Houston Company, Limited. (General Electric Company.)

523. Electricity meters. British Thomson-Houston Company, Limited, and Holden.

2980. Electric light maximum demand alarm relay. Wills.

4529. Control of the electromotors on electric railway cars. Lydall.

8571. Systems of electric transmission. Hilliard. (Date applied for under International Convention, April 20, 1904.)

9257. Means for the electrical regulation of the speed of internal-combustion engines. De Dion and Bouton. (Date applied for under International Convention, Dec. 23, 1904.)

11353. Process for regenerating electric accumulators. Luckow.

14196. Rontgen tubes. Steizel. (Date applied for under International Convention, July 11, 1904.)

14317. Polyphase commutator dynamo-electric machines. Elektrizitäts Act.-Ges. vorm W. Lahmeyer und Co. (Date applied for under International Convention, July 11, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-101 xd
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	91-94 xd
—— 4½ per cent. 2nd Debenture Stock	100 ..	78-81
Callender's Cable, Debentures	100 ..	109-111
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	3 ..	1¾-2
—— 5 per cent. Debentures	100 ..	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1¼-1⅜
—— "A" Shares, 01-017,139	5 ..	2-2½
—— 5 per cent. Debentures	100 ..	89-94
—— 4 per cent. Deb. Stock, Red.	100 ..	83 88
Electric Construction, Nos. 1 to 112,100	2 ..	¾-1⅛
—— 7 per cent. Cumulative Pref.	2 ..	1⅜-2¼
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	12 13 xd
—— 5 per cent. Preference	5 ..	5¼-5⅜ xd
—— 4½ per cent. Debentures	100 ..	109-111 xd
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16⅛
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	33½-35½
—— 5 per cent. Bonds	100 ..	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	11⅜-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	9⅞-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red	100 ..	106-108
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	104-107
Brompton and Kensington, Ordinary	5 ..	9½-10¼
—— 7 per cent. Preference	5 ..	9⅜-10⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9¼-9⅜
—— Nos. 60,001-80,000	5 ..	9-9½
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13⅝
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	6¾-7¼
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5
—— ditto (1903) 40,001-80,000	5 ..	4¼-4⅝
Chelsea Electricity Supply	5 ..	6 6¼
—— 4½ per cent. Debentures	100 ..	108 110
City of London, Ordinary	10 ..	11-11¼
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	105 105
County of London Electric Supply, Ordinary	10 ..	8½-9
—— 6 per cent. Cum. Pref.	10 ..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent 2nd Debentures Prov. Certs	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100 ..	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2½-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90

Name.	Amount paid. £	Last price. £
Folkestone Electric Supply, Ord. Nos. 1-10 000	5 ..	5¼-5⅜
—— 4½ per cent First Deb. Stock, Red.	100 ..	99 102
Havana Electricity, 1-15 000	10 ..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5 ..	7¼-8¼
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	13/16-15/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	12-12¾
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10⅛
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	4¼-5⅜ xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-.02
Metropolitan Ordinary, 00,001-300,000	5 ..	10¼-11
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109 115
—— 4½ per cent. Cum. Pref.	5 ..	6⅜ 6⅝
—— 3½ per cent. Mortgage Debenture, Red	100 ..	89 101
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	100-102 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5 ..	7⅜ 8¼
—— do., 57,0 0-75,000	5 ..	7⅜-7¾
—— 5 per cent. Pref., 1-57,00	5 ..	6 6¼
—— do., 57,0 0-75,0 0	5 ..	6-6¼
Notting Hill Electric Lighting	10 ..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6¼-7
—— 4 per cent. Debenture Stock	100 ..	99 101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	101-104
Smithfield Markets Electric Supply, Ord 1-12,000	5 ..	2¼ 2⅜
—— 4 per cent. Debenture Stock	100 ..	76 80
South London, Ordinary	5 ..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16-15/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16xd
—— 4½ per cent. 1st Mort. Deb.	100 ..	106-109
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13½-14¼
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	87 99
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4¾ 5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5⅛-5⅜
Westminster, Ordinary	5 ..	12½ 13¼
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5 ..	6⅛-6⅜
Electric Tramways.—		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5 ..	5¼-6⅛
—— Ord.	5 ..	8⅛-9⅛
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	104-106
Barcelona Tramways, Ord., 1-20,000	10 ..	13½-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9 -10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101
—— 4½ per cent. Red Deb. Stock	100 ..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75 001-150,606	1 ..	27/32-31/32
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75 000	5 ..	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd.	100 ..	96-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	114-117
—— Ord. Pref.	100 ..	103-106
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	102-105
—— 4 per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c
—— 4 per cent. Vancouver Power Deb.	100 ..	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	8¼-8⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100 ..	123-125
—— 4½ per cent. 2nd Deb. Stock	100 ..	98-100
Buenos Ayres and Belgrano Trams	5 ..	3 -3⅛
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 9/16-5 13/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾ 5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	106-107
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	97-99
Calcutta Tramways, 1-102,268	5 ..	9¼-10
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-109
Cape Electric Tramways, Nos. 1-480,000	1 ..	1¼-1½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅞-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14½
—— 6 per cent. Cum Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14½
—— 6 per cent. Pref., Nos. within 1-60,0 0	10 ..	15-16
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4 per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref. Nos. 30,001-60,000	5 ..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9¾ 10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	99 102
Madras Elec. Trams (1904), 5 per cent. Deb. Stk., Rd.	100 ..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	7/32 9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	31/32-1 1/32
—— 4½ per cent. Deb. Stock, Red.	100 ..	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	105-107
Montreal Street Rail., Sterling 5 per cent (Mort.) Deb., 1908, 1-600	100 ..	101-104 xd
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum Pref	10 ..	9¼-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb Sk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 20 001-40,000	10 ..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9-9¼
—— 4½ per cent. Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,1-2 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 ..	90-92
—— 4 per cent. Pref.	100 ..	101-103
—— " " deferred	100 ..	77-80
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-100
Waterloo and City, Ordinary	100	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111-112
—— Deferred Stock	100	107¼-108¼
—— 6 per cent. Cum. First Pref	10	13¼-14¼
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5¼
—— 3½ per cent. Deb Stock, Red.	100	99½-101½
—— 4 per cent. Deb. Stock. Red.	100	104-106
Oriental Telephone and Electric Company	1	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d
Aberdeen Corporation	Sep. 9	1,467	1,489	- 21	- 425h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Aug. 26	424	403	+ 21	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sep. 10	1,066	1,094	- 28	- 418	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 9	366	360	+ 6	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 6	946	934	+ 12	+ 72	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 7	1,959	2,011	- 42	+ 883	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 9	1,031	1,118	- 154	- 844	16½	16½	Dec. 31	31,846	2,325 677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 10	1,832	1 918	- 86	+ 1,644	40	38	March 31	95 765	20,205.196	2,161,130	1·13	10·63	2,394	6·11
Bournemouth Corporation	,, 6	2,016	1,461	+ 555	—	16 82	16 82	,, 31	55,276	10,058,238	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 9	4,246	4,904	- 658	- 5,253	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 10	1,188	1,217	- 29	+ 785	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 8	5,116	5,285	- 169	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 9	1,051	1,137	- 75	—	10 60	10·60	March 31	—	—	—	—	—	—	
Burton Corporation	,, 10	322	371	- 49	- 912	8¼	8¼	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	Aug. 12	2,707	2,172	+ 534	+ 605	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	Sep. 9	172	211	- 39	- 440	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 9	5,673	5 881	- 208	- 1,346	6	6	,, 31	347,588	44,875,547	1,281,214	1 86	65 10	57,931	35·80
City and South London Railway.	,, 10	2,557	2,555	+ 2	- 330	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	Aug. 10	341	358	- 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	Sep. 7	543	503	+ 40	+ 737	15½	15½	,, 31	24,835	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 1	250	251	- 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Aug. 12	344	317	+ 27	—	4½	4½	,, 3	11,250	2,853,200	281,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Sep. 8	153	127	+ 26	+ 334	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 8	4,166	4,032	+ 134	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1 23	9 07	5,691	5·55
Dublin S. District, Electric	,, 8	1,111	1,039	+ 72											
Dundee City Tramways	,, 6	987	972	+ 15	—	22	21	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 11	819	748	+ 71	+ 1,828	23	23	March 3.	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 9	15,512	14,870	+ 642	+ 10,823h	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 6	1,501	1,591	- 86	+ 1,7 0	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 9	1,308	1,326	- 18	—	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 9	2,117	2,200	- 83	+ 488	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 6	118	148	- 30	- 614	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Aug. 30	225	256	- 31	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Sep 9	5,746	6,212	- 466	—	89	89	March 2	298,233	64,223,676	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 2	10 693	10,949	- 256	+ 8,650	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 10	1,492	1,521	- 29	- 519h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 2	14,537	13,703	+ 819	+55,709	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 7	150	165	- 15	—	2½	2	—	4,710	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 9	12,525	12,889	- 363	+ 11,521	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,293	6·99
Nelson Corporation	,, 9	135	130	+ 5	+ 304	—	2¾	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 9	3,829	3,673	+ 155	+ 2,893	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 11	1 511	1 142	+ 369	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 9	2,184	2,324	- 140	+ 1,624	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4¼	,, 31	14,881	2 837,110	336,517	1·24	9·24	1,102	7·92
Rotherham Corporation	Aug. 3	440	645	- 205	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	Sep 11	4,058	4,045	+ 13	+ 6,345	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 10	4,867	4,690	+ 177	+ 5,191	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 6	1,094	1,291	- 197	- 480	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 1	900	640	+ 260	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 10	1,363	1,391	- 8	+ 799	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	Aug. 30	213	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	Sep. 9	815	801	+ 14	+ 615	11·85	10 5	,, 31	38,768	7,412 881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6 33
West Ham Corporation	,, 7	2,207	1 133	+1,074	+16,195	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 6	844	777	+ 67	—	—	7½	,, 31	—	—	—	—			

† And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Self-Contained Electrical Locomotive.—Mr. Hugh Reid, the managing director of the North British Locomotive Company, proposes to solve the problem of electrical locomotion by installing generating apparatus on the locomotive, so disposing of the difficulties of transmission and transformation. This is rather on the lines of Heilmann's experiment, except that Mr. Reid proposes to use a Parsons condensing turbine instead of a Willans high-speed engine. He proposes to employ an air-cooled condenser of novel design. Several locomotives on Heilmann's plan were used on the Western Railway of France without success.

Armstrong College.—The syllabus of Armstrong College (late Durham College of Science) exhibits the usual comprehensive courses in civil, mechanical, mining, naval, and electrical engineering. There is a three-year diploma course for electrical and other branches of engineering, and students are prepared for the degree of B.Sc. The laboratories are equipped with up-to-date apparatus on a large scale. Compound steam-engines are used to drive the dynamo which supplies current for lighting the college buildings. As is to be expected, the college has a strong marine and mining engineering side. The session commences on the 25th inst.

Institution of Engineers and Shipbuilders in Scotland.—The fifty-ninth session of this institution will be opened on the evening of Oct. 24 in the institution rooms, Bath-street, Glasgow, when the president, Mr. James Gilchrist, shipbuilder, will deliver an address, which will be followed by the reading of a paper on "The Determination of the Principal Dimensions of the Steam-Turbine, with special reference to Marine Work," by Mr. E. M. Speakman. On the evening of Nov. 10 there will be an exhibition of inventions and objects of interest appertaining to shipbuilding and engineering, which will be held within the St. Andrew's Hall, Charing Cross, Glasgow.

The Telephone Service.—It is understood that the Post Office and the National Telephone Company have entered into an arrangement for the mutual development of the two systems so as to prevent overlapping. For natural expansion certain areas have been allotted to each. A joint deputation of the Post Office and the company, including Mr. John Gavey, engineer-in-chief to the Post Office, and Mr. Gaine, the general manager of the company, is visiting the United States to study the system there, the American Government placing all facilities at their disposal. On returning the deputation will present a report to the Postmaster-General and the directors of the company, and if any improvements are considered desirable they will be introduced simultaneously on each system.

Municipal Telephones.—The Brighton Corporation recently applied to the Local Government Board for sanction to a loan of £11,617 in connection with their telephone undertaking. The Board have replied according the necessary permission in respect of £4,208 and £1,936 for expenditure already incurred, but in regard to the balance they inquire whether the Corporation have considered the question of entering into negotiations with the Postmaster-General with a view to the absorption of their undertaking. Accompanying the Board's reply is an extract from the parliamentary proceedings of the late session, in which Lord Stanley stated, in response to some remarks by Mr. John Burns, that he was quite ready to enter into negotiations with any of the telephone-owning municipalities. It will be remembered that Lord Stanley also implied in his later pronouncements that he now considered it a mistake to encourage municipal telephony. Having regard to the present position of matters in the telephone world, it will be of considerable interest to see what view the Brighton Corporation takes of the matter when it discusses it at an early date.

Large Static Transformers.—The Stanley Electric Company, U.S.A., have constructed for the Niagara Falls works of the Pittsburg Reduction Company a static transformer of record size. It is to be used for the manufacture of aluminium, for which electrical furnaces are employed, and in order to obtain high temperatures it is necessary to transform the current so that the amperage is exceedingly high and the voltage relatively low. The primary current has a frequency of 25 cycles at 2,200 volts. The secondary current is 80,000 amperes at 25 to 50 volts. The transformer occupies a floor space of 86½in. square. The height over all is 11ft. 6in., and the gross weight 50,000lb. The secondary winding consists of 12 coils of one turn each, arranged so that by means of heavy switches they can be connected all in parallel, the several combinations giving a secondary current of 80,000, 40,000, or 20,000 amperes, the voltage in each case varying in an inverse ratio to the current. The primary coils have a number of taps brought out at several points in the windings, which taps provide connection to a special oil-type regulator, enabling the secondary voltage to be varied in suitable steps from maximum to minimum. Although the transformer is rated at 2,000 kw., it can be run for long periods at 4,000 kw. without overheating.

Canadian Telephony.—We have received report No. 36 of the Select Committee appointed to enquire into the Canadian telephone system, which brings matters down to July 13. This report deals with the evidence given by Mr. A. L. Têtu and Mr. J. B. Ware, two experts from the United States, who have been associated with the independent telephony movement. The general effect of their testimony in regard to the competition between the Bell and the independent companies was that the apparatus installed by the latter was quite equal or superior to that of their rivals, and much cheaper. Mr. Têtu considered that Government ownership of the trunk lines would be premature, but he favoured legislative restrictions when granting franchises. Asked what he considered the best means of ensuring an ample and continuous long-distance service to Canadian independent telephone systems, the witness replied that the construction of independent long-distance lines should be encouraged, as in the United States. He stated that of late the Bell Company had made overtures to certain independent companies for inter-communication on trunk lines. Mr. Ware traced the history of the independent companies' growth, showing that they had often been successful in resisting the efforts of the Bell Company to oust them. He saw no reason why the operation of trunk lines by the Government should not be a success.

The Magnetic Survey of South Africa.—An account of their survey regarding the magnetic features of South Africa was presented to Section A of the British Association by Profs. Beattie and Morrison. The survey was started in the summer of 1897-1898. The observational work has been carried on since that time whenever opportunity offered; naturally it was greatly interfered with by the war. Soon after the declaration of peace the various South African Governments each contributed to a fund for paying the expenses of a field party for a year's continuous work. This party observed during the whole of 1903 and part of 1904. Financial assistance has also been received from the Government Grant Committee of the Royal Society. The necessary observations have been made at about 400 stations, distributed chiefly along the various

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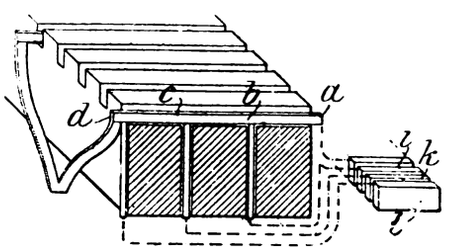
railways in Cape Colony, Rhodesia, the Transvaal, the Orange River Colony, and Natal, in the south of Cape Colony, the east of the Transvaal, the Basutoland border, and the north-west of Cape Colony. Observations have been repeated at 20 widely-separated stations for the purpose of determining the secular variations of the elements. The annual and the daily observations have been derived from the earlier work of Sabine in South Africa. It is hoped that the work of reduction will be sufficiently advanced by August to show isogonic and isoclinic maps of certain parts of South Africa.

Change of Pressure.—In our issue of July 28 we referred to the inquiry held on behalf of the Board of Trade into the proposed change of pressure in the municipal supply. It will be remembered that the Metropolitan Electric Supply Company had employed various pressures, while the Borough Council on taking over the undertaking desired to adopt a pressure of 240 volts. Certain consumers objected, contending that, in addition to the inconvenience and expense of the change, their insurance policies might be affected. The Board of Trade has decided to allow the change of pressure, subject to six conditions, the effect of which is that the undertakers shall pay the consumers an agreed amount for the alteration of apparatus, shall study the reasonable convenience of the consumers in effecting the alterations, and shall arrange matters with the insurance companies. It is also provided that the undertakers shall comply with the general terms imposed by the London County Council, who gave a conditional consent to the change. Any further differences between the parties shall be settled by an arbitrator to be appointed by the Board of Trade. The award impresses us as a very reasonable one, but, considering that the Borough Council were prepared in the first instance to do practically what is now directed, it is a little difficult to understand what need there was for an inquiry at all.

Reduction of Sparking.—A patent has been granted to Messrs. Siemens Bros. and Co. for a method of reducing the self-induction between adjacent commutator bars of a dynamo, thus reducing the sparking. Each turn upon the armature is tapped not only at the ends, shown in the



accompanying diagram (which we reproduce from the *Official Patents Journal*) as *a d*, but also at intermediate points, *b c*, by leads passing through the ventilating ducts or other passages in the armature core, and connected as shown to additional commutator bars, *i k*. This device may be serviceable in the case of large generating units driven at exceedingly high speeds, when the voltage per turn on the armature becomes high. The apparatus described practically divides the single turn into a number of sections, which are individually commutated. In this respect it is not unlike the method adopted in the large two-pole machines with which Messrs. Siemens Bros. held the market some years ago. In these machines parallel windings had to be adopted in order to give satisfactory commutation.

Northampton Institute.—The prospectus for the ensuing session shows that extensive preparations have again been made for providing instruction in electrical, mechanical, watchmaking, and horological engineering. The classes for the day courses commence on the 2nd prox., and for the evening courses on the 25th inst. The subjects are arranged in stages to suit all students from the tyro to the candidate for the B.Sc. degree of London University, for which there is a four-year day course and a five-year evening course. Instruction is provided for the various electrical examinations of the City and Guilds Institute, and the lectures are supplemented by work in the laboratories, which are admirably equipped. The advanced (C) section of the electrical engineering department should be of great value to those intending to enter the profession. The work is designed to bring the student into touch with the most recent developments in heavy electrical engineering. The complete course consists of lectures, design and laboratory work, and concurrent attendance at the corresponding mathematical classes is essential for all who have not previously studied the higher mathematics of electrical science. Experience has shown that the range of the subject renders it unwise to compress the work into a single session, and it has therefore been divided into sub-sections dealing with (1) the utilisation and (2) the design and manufacture of electrical machinery and apparatus. Altogether, the well-known Clerkenwell foundation bids fair to continue and increase its usefulness as a technical college.

Electricity in New Zealand.—An interesting hydro-electric plant of the three-phase type has recently been installed by a company at Inglewood, New Zealand, for a lighting and power supply, the engineers being Messrs. Steuart and Fenn, of Dunedin, who are the pioneers in the colony of this system, and who supplied the whole of the electrical machinery. The source of water power is the Ngatoro River, on which the intake and power-house are situated about 2½ miles from Inglewood. Observations of that stream for a considerable time during ordinary seasons and in droughts have demonstrated that there is very little danger of the volume of water diminishing to such an extent as to affect the power, and it is so steady as to render a dam unnecessary at the intake, an ample supply passing through the gates. The turbine, a twin machine of the "New American" type, develops 100 h.p. The alternator has a capacity of 45 kw., and energy is generated at 3,000 volts. As it is expected that there will be a considerable demand for power as well as lighting, the three-phase system was selected, this system being new to the colony with the exception of the installation at Hawera. The company have made provision for the installation of a second unit to meet the increased demand which they anticipate in the near future, by the construction of a second concrete main from the reservoirs to the power-house, and the provision of accommodation for duplicate plant. The poles supporting the power lines are of iron, and are remarkably straight and neat in appearance. The current for lighting purposes is transformed to 220 volts. The new illuminant has given great satisfaction to private consumers, and the demand is steadily increasing. It is expected that the dairy and manufacturing establishments in the town and neighbourhood will adopt electric power very shortly, and the additional machinery will then be installed.

New Publications.—The *Transactions* of the Faraday Society dated August contain papers on "An Application to Electrolytes of the Hydrate Theory of Solutions," by T. Martin Lawry; "Notes on the Rapid Electro-Deposition of Copper," by Sherard Cowper-Coles; "The Use of Balanced Electrodes," by Prof. W. W. Haldane Gee; "Electrolytic Oxidation of Hydrocarbons of the Benzene Series," by H. D. Law and F. M. Perkin; "Notes on Heat

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Insulation, particularly with regard to Materials used in Furnace Construction," by R. S. Hutton and J. R. Beard; "Storage Batteries and their Electrolytes," by R. W. Vicarey; "Refractory Materials for Furnace Linings," by E. K. Scott; and "Alternating-Current Electrolysis," by Prof. E. Wilson.—The *Journal* of the Franklin Institute (Philadelphia) dated September contains the reports of the institute's science and art committee upon electrically-welded screw caps and bolts and Goldschmidt's system of alumino-thermics; and papers on "Mica and the Mica Industry," by G. W. Colles; "Sources of Supply and Methods of Manufacture of Phosphates and Potash Salts," by E. B. Voorhees; and "Superheated Steam in Locomotive Service," by W. F. M. Goss.—"Elementary Manual of Magnetism and Electricity," by Andrew Jamieson (London: Chas. Griffin and Co. 3s. 6d.). The sixth edition has been revised so as to bring the contents perfectly up to date, and a plate has been included from the painting by Acland Hunt of Dr. Gilbert showing his experiments to Queen Elizabeth.—"Molecular Forces and Newtonian Laws," by Alex. Clark, M.A. (Glasgow: W. and R. Holmes). In this volume the author discusses in a concise manner various physical, and especially electrical and magnetic, phenomena.—Amongst the contents of the July-August number of the *Proceedings* of the Society of Civil Engineers of France we note the speeches made at the funeral of the late president, M. F. Reymond, and a long article by M. G. Semenza on the hydro-electrical installations in Upper Italy. A map and sectional plans of the Vizzola works of the Lombardy Electrical Power Distribution Company, of Milan, accompany this article.

The World's Iron and Copper Supply.—In a recent issue of the *International Quarterly* Prof. N. S. Shaler discusses the importance to humanity of iron and copper, upon the former of which, as he remarks, our civilisation may be said to have been built. Its cheapness forms a considerable element of its value to man. Iron is a very widely distributed element, and the amount of iron ores still available is very great, perhaps twenty times as great as has been won to use. Some of the best-known fields, however, are beginning to be exhausted, and it is evident that, at the present rate of consumption of iron, the European sources of supply are not likely to endure for a century. In the case of copper, the sources of supply are very much rarer than those of iron, and the total amount of the metal in the crust of the earth is probably not more than the thousandth part of that of iron. The professor predicts that its supply will be reduced to a point where its service to the arts will be seriously limited before there is a like reduction in the supply of iron. He proceeds to state, however, that we can look upon the approaching exhaustion of the sources of copper with less apprehension than in the case of iron, for the reason that, useful as the metal is in manifold ways, it is not indispensable, or even very necessary, in our arts, except in the transmission of electric power, and even in that substitution is possible. Aluminium, he observes, is admirably adapted to serve most of the needs now served by iron and copper. It is relatively very light, but for its weight is admirably strong, rigid, tough, and elastic; it is a good conductor of electricity, and it does not oxidise as readily as do iron and copper. The amount of aluminium lying almost at the surface of the earth's crust is enormous, probably many thousands of times as great as the amount of iron contained in the concentrated form of beds or veins. Every clay bank is a possible source of the metal. Aluminium is never found in the metallic state, but in the form of silicates. Before it can be put to the uses of man, its union with the silicon must be broken up, and the work of separating the elements is very costly. With any methods now conceivable the professor opines that, while aluminium is likely in time to take the dominant place now held by iron, it will do so at a cost in terms of labour far higher than what men now pay for their capital metal. Nevertheless, the difference is not likely to be so great as to prevent aluminium from coming to the rescue of the mechanical foundations of our economic civilisation.

Mica.—The first chapter of an interesting article on "Mica and the Mica Industry" appears in the *Journal* of the Franklin Institute (Philadelphia) from Mr. G. W. Colles. The author commences with a description of the various classes of mica, which are somewhat numerous, and then deals with their physical characteristics. The most striking trait common to all the micas is the quality of being easily cleavable into thin, elastic, and generally transparent plates, and in this characteristic they find their economic usefulness. That mica has a strongly characterised polarity can be readily observed by striking a mica plate with a dull-pointed instrument on a yielding surface, which will cause the mica to become fractured. The lines of fracture extend in one or more of three principal directions, which make angles of 60deg. with each other, and form a six-rayed star. Another indication of strong hexagonal polarity is seen in the ruling and striation which often occurs in one or more of the three secondary directions. Most kinds of mica are practically infusible in ordinary heats. Subjected to the blow-pipe some of them, especially the lithia micas, are fusible with difficulty, yielding up a portion of their water. A very intense heat, such as that of the electric arc, will cause the mica to whiten and crumble locally, and even a low degree of heat, sufficiently prolonged, as in a stove or furnace wall, causes the mica to lose gradually its elasticity, and become brittle and friable. The softer pyroxenic micas are more easily decomposed by water than the granitic. Besides blending with one another, the micas pass in like manner by indeterminate gradations into other related and similar forms. As silicates they stand midway between the anhydrous silicates, on the one hand, of which the feldspars are examples, and the hydrated silicons on the other, of which the zeolites are most characteristic. It is interesting to note that many of the principal varieties of mica have been obtained artificially. By fusing various natural silicates (hornblende, actinolite, glaucophane, andalusite, garnet, etc.) with the fluorides of sodium and magnesium, micas corresponding to biotite, phlogopite, muscovite, and zennwaldite were obtained. Khruschoff describes the formation of margarite, biotite, and muscovite by fusing various bases with the constituents of lepidolite and an excess of silica, alumina, and alkaline fluorides. Vogt, of Sweden, also describes the occurrence of mica in slags. Notwithstanding this, however, the author states that there is not the least likelihood of artificial mica being produced on a commercial scale at a profit. These experiments merely explain some possible modes of origin of natural mica.

Electrical Machinery Insurance.—The insurance of electrical plant against accidents is becoming common, the great value of the insurance being the periodical inspection of the plant by an independent authority. The result is that the supervision by the owner's staff becomes more efficient, and the interruptions in the working of motors, dynamos, or other apparatus are reduced. We recently received a report of the British Engine, Boiler, and Electrical Insurance Company, whose head offices are at King-street, Manchester, in which there are given some interesting figures as to those parts of dynamos and motors which most frequently give trouble. From the breakdowns

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which have occurred in machinery insured by this company the following tables have been compiled, showing the ratios in which the different parts of the damaged dynamos and motors are thought to have contributed to the total. The rate of breakdown among dynamos was 1 in 12, and among motors 1 in 9·3, excluding breakdowns of starting resistance switches, or 1 in 8·2 including them. The parts causing trouble, expressed in percentages, were as follow:

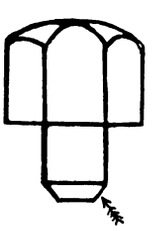
	Dynamos.	Motors.
Armatures and rotors	55	47
Magnets and stators	7	11
Commutators and brush gear	28	18
Miscellaneous	10	8
Switches and resistances	—	16
	100	100

The causes of the damage may be classified as under:

	Dynamos.	Motors.
Accidents	9	9
Dirt and neglect	13	19
Age and deterioration	38	25
Bad workmanship and design	20	16
Overloading	3	3
Causes not ascertained	17	28
	100	100

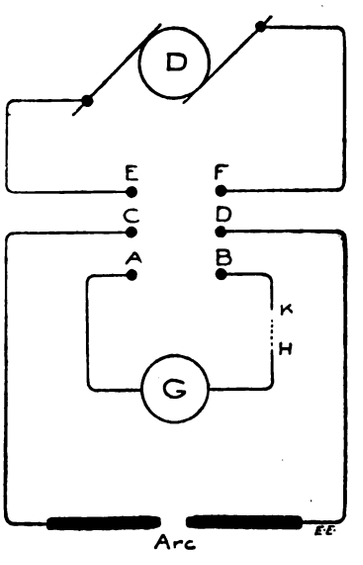
The report goes on to give a description of 23 so-called breakdowns, the majority of which could have been prevented with reasonable forethought and regular supervision and cleaning. An interesting case of an unexpected fault was the accident to the motor of a Blackman fan owing to the wind turning the fan in a wrong direction during a storm. This spoiled the copper brushes used on the commutator, and prevented the fan from working when it was next switched on. In a large number of instances the actual damage done before the inspector of the company was called in was exceedingly slight, and the breakdown was not such as to interfere for any length of time with the working of the apparatus involved.

Electrically-Welded Screws.—The *Journal* of the Franklin Institute (Philadelphia) for September contains a report by its science and art committee upon the wares of the Cleveland Cap Screw Company, the heads and bodies of which are welded together electrically. For the heads are used specially die-drawn stock, hexagon, square, or round, according to style of head required. This stock is drawn very accurately, with a variation not exceeding ·003. The heads are cut from the bar on automatic machines, which turn a projection or shoulder to the diameter of the



screw to be welded, as shown in the accompanying sketch. The heads and stems are placed in the moulding machine and held firmly by copper vices, which are clamped to gunmetal platens of large section, and to which are connected the terminals of the secondary circuit of the welder, which are moved on steel ways by hydraulic pressure. The sections to be welded are then brought together, thus completing the secondary circuit, the primary circuit being connected through a break switch operated by a foot lever. The current is allowed to pass through these sections until they are brought up to a welding heat, then released at the same time the pressure is applied, forcing the two together, expelling any possible slag or deteriorated metal and forcing up a burr. A transformer is built into the base of the machine, and is supplied with alternating current at 300 volts, which for 3in. bolts is about 97 amperes, and this is reduced to two volts and corresponding amperes—*i.e.*, about 14,500. As the two abutting surfaces are brought to the necessary heat the current is thrown on and off by a foot treadle operating the primary circuit, allowing the heat to become uniform over the section, and then when the proper heat is obtained the whole is forced together with a horizontal movement of the jaws holding the head, with a pressure of from 2½ to 6 tons, in some cases by hand power through the medium of gears or by direct hydraulic pressure. The placing of brass heads on steel-bodied bolts or any other combination of metals is quite as easily accomplished. The committee tested five of the screws on an Olsen machine by pulling the heads off, with the following results. The pieces tested were ¾in. screw bodies, with hexagonal heads, bodies 8in. long, without threads. The elongation was found to average ·23in. in 2in., varying from ·1in. to ·36in. The elastic limit per square inch was found to be 69,000lb, and the ultimate strength per square inch about 86,000lb. About 80 per cent. of the pieces gave way at the weld, with granular fractures. The conclusion reached, after testing the screws for torsion, was that at the welds or near them was the weakest point (not considering the bottom of threads of finished bolts), but that these points compare favourably with the tensile tests showing 80,000lb. per square inch, average angle about 90deg. In order to determine the structure of the welds, an all-steel bolt was cut longitudinally through the head and body to a point below the weld, then carefully polished and etched with acid solution. The surface showed a fibrous arrangement of the particles of the metal, and at the weld a line of about $\frac{1}{16}$in. wide of quite a different character with no fibre markings, but each side of this the lines of the fibre curved outward as would naturally occur in forcing them together when hot. The institute have decided to award the John Scott Legacy Premium and Medal to Mr. David J. Kurtz, the originator of the method.

Residual E.M.F. of a Carbon Arc.—Mr. G. G. Becknell describes in the September number of the *Physical Review* some experiments made to determine the E M F. between the carbon of an arc immediately after the arc is extinguished. In order to do this the circuit was so arranged that the dynamo and galvanometer could, by means of a double-pole three-throw switch, be alternately joined in series with the arc gap (see figure). It was found



at once that a current, which we may call the residual current, could be observed for more than 10 seconds after the interruption of the arc; and it was seen, upon replacing

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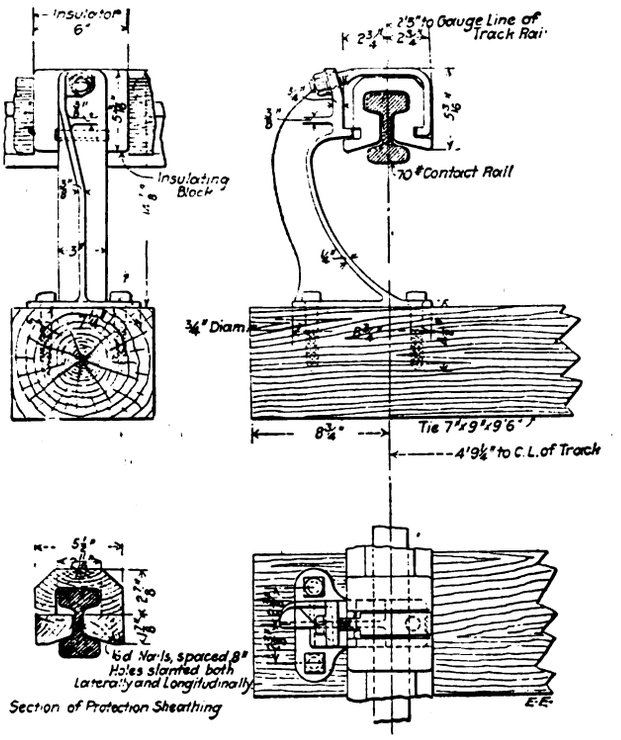
the galvanometer by a Weston voltmeter, that the residual E.M.F. was counter to that of the dynamo, and reached a maximum value of more than half a volt. In order to show something of the qualitative nature of the phenomena, the following simple experiments were tried: (1) A plate of either copper or mica—*i.e.*, a plate of material either conducting or non-conducting—when interposed between the electrodes without touching either of them, was sufficient to arrest the residual current entirely; but upon the removal of the plate the current was immediately re-established. This experiment with the copper plate shows that the residual effect can hardly be due to thermo-electric contact (whatever that may mean) between the heated carbon tips and the heated gases of the arc, for in such a case the interposition of a copper plate across the arc gap would tend to increase the current through the galvanometer, and certainly not to destroy it. (2) A short copper wire joining the positive and negative electrode was sufficient to stop entirely the residual current through the galvanometer, showing that the effect cannot be traced to a thermo-electric source existing outside the arc, for in this event the current would have been much increased by thus cutting out the resistance of the arc gap. We may fairly conclude then, perhaps, that the residual current is due neither to a thermo-electric effect in the arc nor to one external to it. (3) As a further test a gentle air blast was applied to the regions between the carbons at the instant when the galvanometer was thrown into the circuit. This, again, had the effect of removing nearly all traces of the residual current as long as the air current was continued, unless the poles were placed as nearly together as 1mm, and even then the effect was reduced to one-tenth. The failure at this point to completely destroy the effect was probably due to the partial inaccessibility of this small region to the current of air. It was found also that when the air blast was discontinued the residual current was set up again, provided the blast had not been applied for a time longer than four or five seconds. (4) It was observed also that if the galvanometer was thrown off and the dynamo thrown on to the arc gap for a few seconds, thus producing an electric field, but no arc, between the electrodes, a smaller residual current was re-established in the same direction as before—that is, counter to that of the dynamo. This effect could be detected if tried within a minute or two after the interruption of the arc. It would seem from these experiments—the interposition of the mica sheet and of the readily conducting copper, as well as the effects of the air blast and the renewal of the electric field—that we have here, not a case of ordinary electric conduction, but probably one of electric convection. This view is strengthened by the fact that the alternating arc gives a very small residual effect.

New York Central Third Rail.—In view of the numerous accidents which have occurred on electrified portions of English railways where a third rail is used to convey energy to the train, the following details of the construction adopted on the New York Central lines will be of interest. This construction is the outcome of extended trials on various methods of supporting the third rail on the Schenectady experimental track. The New York Central Traction Commission have finally adopted the under-contact type, as illustrated herewith. The system is the joint invention of Mr. W. J. Wilgus, fifth vice-president of the New York Central Railroad Company, and Mr. Frank J. Sprague, who is a member of the New York Central Electric Traction Commission. The working details of the system, including a complete system of crosses, switches, approaches, etc., have been developed under the direction of Mr. E. B. Katte, electrical engineer of the New York Central. The third rail is supported every 11ft. by iron brackets, which hold the insulation blocks by a special clamp. The blocks, which are in two pieces, are 6in. long by ¾in. in thickness, and are designed so as to be interchangeable. Experiments are now being conducted with insulators of reconstructed granite, vitrified clay, rubber, and indurated fibre to determine the relative advantages of these materials for the conditions under which they would be used. Between supporting brackets the upper part of the rail is covered by wooden sheathing. This sheathing, as shown, is applied in three parts, which are nailed together. At the joints where the third rails are bonded, and at the feeder taps, the wooden sheathing is mortised. The third rail is not mounted rigidly in the insulators, but is given a little play for expansion and contraction, except at certain central points, where it is anchored. It weighs 70lb. per yard, is of special section and composition, and has a resistivity between seven and eight times that of copper. The New York Central engineers have decided to place the rail 29in. from the gauge line. The under surface of the third rail is 2¾in



above the top of the service rail. The principal reason for adopting the under-contact rail is that it can be more thoroughly protected, and hence is safer than the ordinary type of contact rail. There are no projecting live edges or bolts, and no slot between the third rail and its cover through which an animal or any person ignorant of danger can make contact with the live conductor. The only possibility of reaching the third rail is from below and by an upward movement, and this fact, it is thought, greatly decreases the chance of injury from shock. Other advantages which it is claimed are possessed by this arrangement over the ordinary type of third rail are: (1) there is less strain on the insulators, as the pressure from the shoe acts against instead of with gravity; (2) the board protection, having a continuous support, is less apt to crack and warp; (3) the rail is more protected from the weather, and hence less liable to corrode; (4) the contact surface is more thoroughly protected from sleet and snow; (5) the construction is self-cleaning, and as there is a much greater space between the lower portion of the third rail and the tie, there will be less danger of an accumulation of snow, ice, and rubbish, and consequently less leakage. We are indebted for the above description to the *Electrical World*.

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MESSRS. VICKERS, SONS, AND MAXIM'S ELECTRICAL MANUFACTURING DEPARTMENT.

When this firm took up the manufacture of electrical machinery some three years ago, they were specially equipped with information as to what class of motor and generator was best suited for driving heavy machine tools. Their own equipments at their large works at Sheffield, Barrow-in-Furness, Erith, and elsewhere had then been running for a considerable time, and in connection with the same a great deal of most valuable experience had been obtained. This was freely given to the profession at large in the historic paper by Mr. A. D. Williamson read before the Institution, entitled "Applications of Electricity in Engineering and Shipbuilding Works." Not only were the costs of production given for each of the nine plants run by the company, but also data as to the power needed to drive various machines. The results given prove to the hilt the many direct and indirect advantages of electric driving. Thus at Barrow a saving of half the coal bill was shown, concurrent with an increase of 50 per cent. in the output of the shipbuilding yards. The firm thus had exceptional experience of the behaviour of electric motors

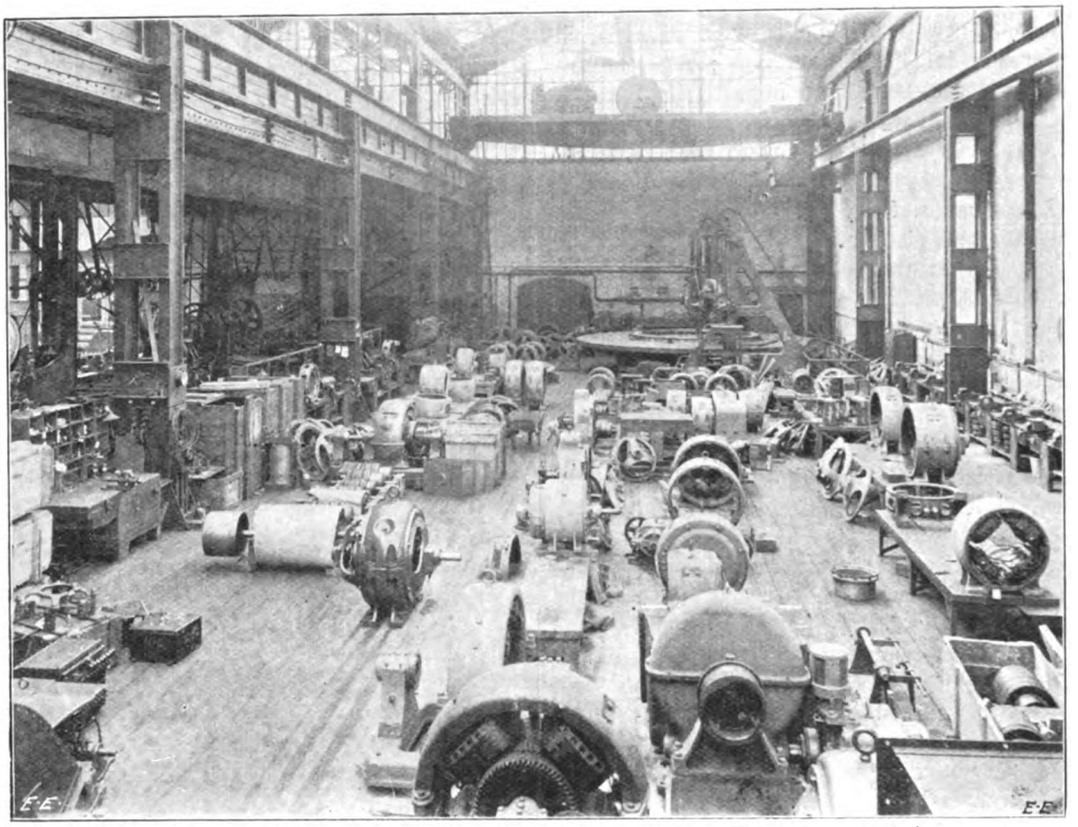

FIG. 1.—Part of the Electrical Machining and Erecting Shops of Messrs. Vickers, Sons, and Maxim.

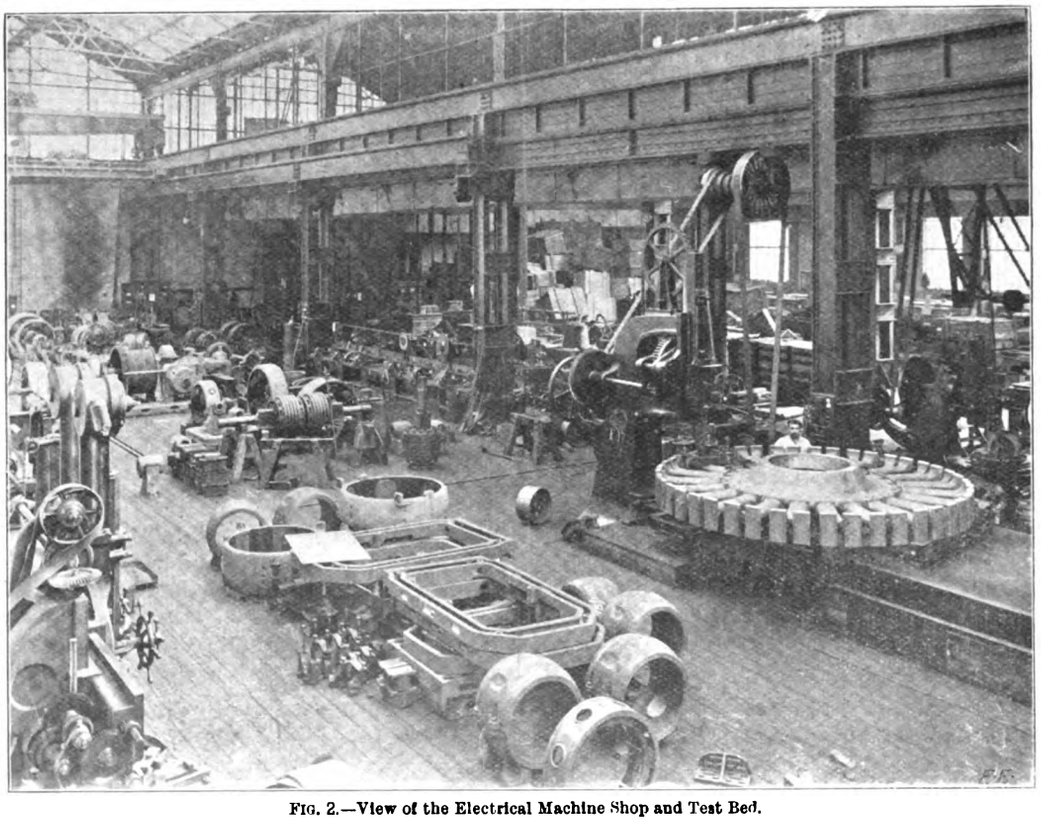

FIG. 2.—View of the Electrical Machine Shop and Test Bed.

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of various types, and started their manufacturing department untrammelled by any obsolete patterns of their own. They were, therefore, in an excellent position to place upon the market machines embodying the latest ideas.

The electrical manufacturing department (Figs. 1 and 2) at the present moment occupies a shop consisting of four bays, 480ft. long by 40ft. wide, served by powerful electric cranes, and equipped with the most modern machine tools. In the Sheffield works no motors smaller than 5 b.h.p. are built, it having been decided to leave the small manufactures entirely in the hands of the Birmingham branch. The machine tools vary in size from a fine 24ft 6in. diameter boring mill down to the small lathes for tool-room use. Amongst other features worthy of notice are the tool-rooms, in which all tools and dies for electrical stampings are prepared. The stamping plant (Fig. 3) is capable of dealing with all sizes of discs and segments from the 5-b.h.p. to the 2,000-b.h.p. size. The resources of the firm are such that it has to buy very little outside finished material, insulated wire being practically the only material not finished in one or other of the departments of the firm. In the winding shop there is a well-equipped vacuum drying and impregnating plant for waterproofing all the coils as they come from the winding machines. The whole of the

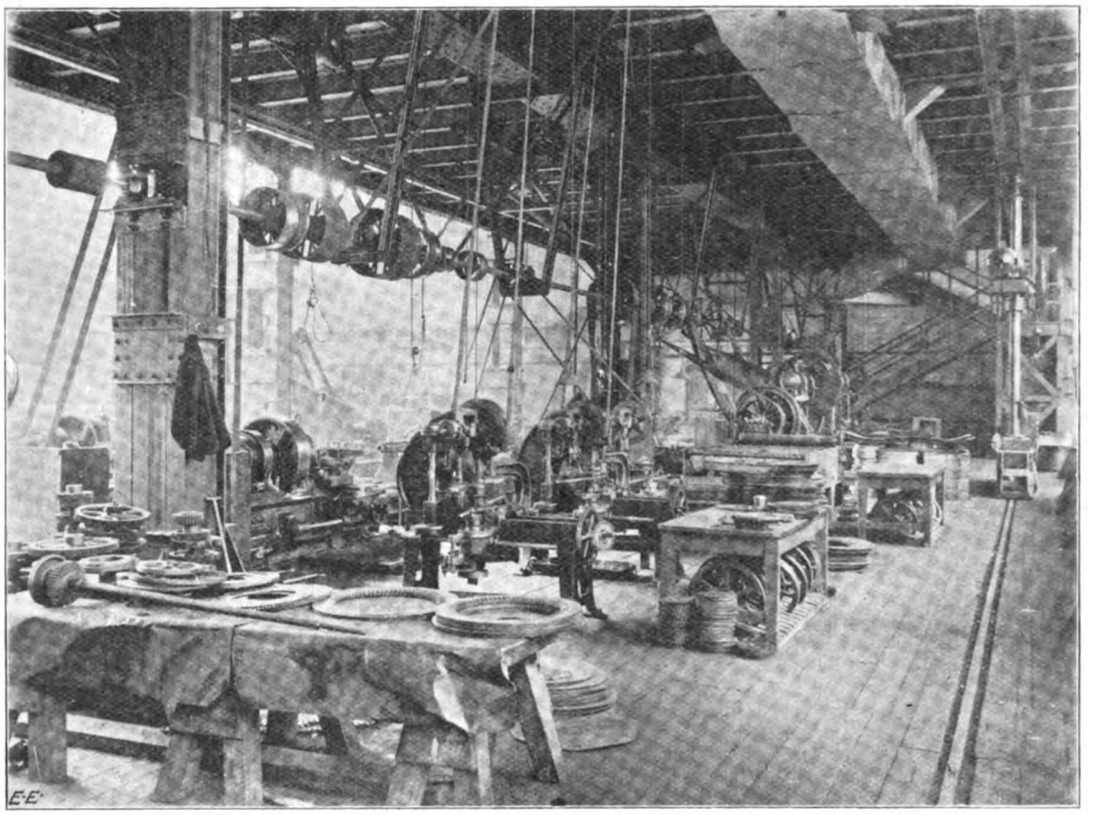

FIG. 3.—Messrs. Vickers, Sons, and Maxim's Core Plate Stamping Department.

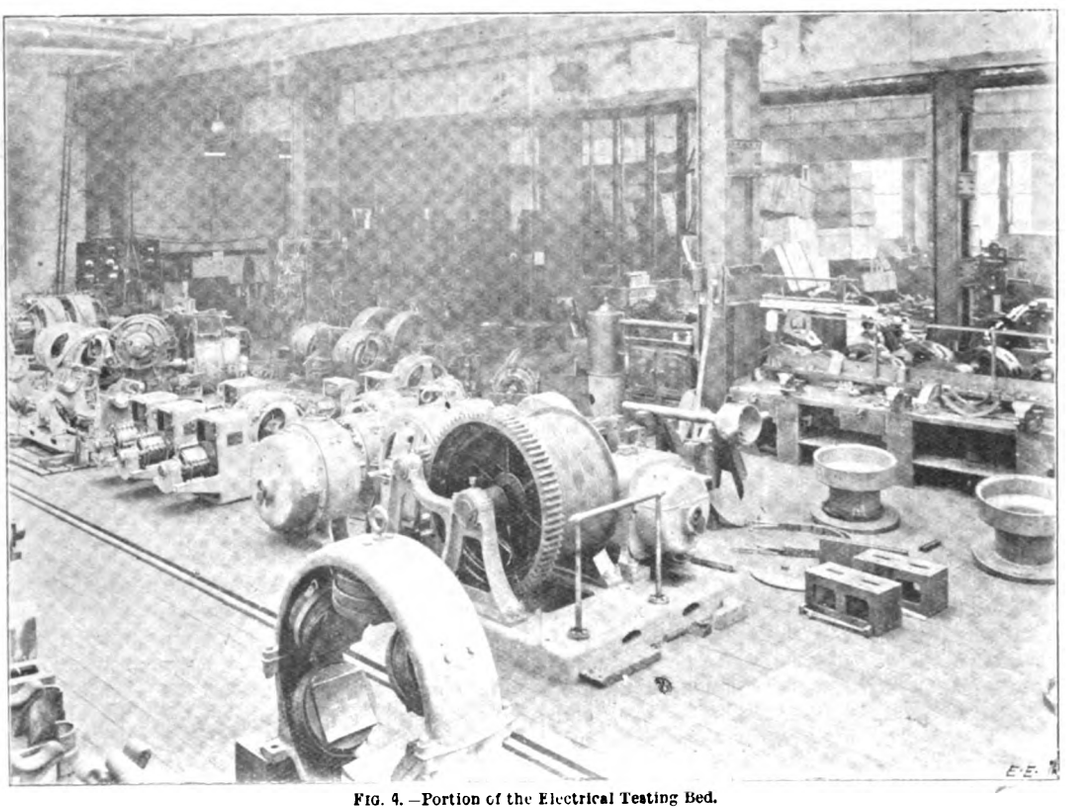

FIG. 4.—Portion of the Electrical Testing Bed.

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mica used in the electrical manufactures is worked up on the premises.

Of course, the steel for the shafts is manufactured by the firm, and is of the highest possible class that the knowledge at their disposal can specify. The motors and generators when finished are tested either on testing pits (Fig. 4) or on the large erecting bed, there being a special generating set for testing alternating-current motors, consisting of a generator giving single, two, or three phase currents, driven by a 90-b.h.p. direct-current motor of variable speed, which allows the frequency to be changed from 40 to 60 periods. In the shops the following machines were in course of construction when we inspected the same recently: one 2,000-b.h.p. dynamo for gas-engine driving of their direct-current type for 460 volts, running at 100 r.p.m.; one 1,000-b.h.p. ditto; 30 motors of 100 b.h.p. each, variable speed, 150 300 r.p.m.; six coaling winches of 25 b.h.p. (as illustrated in Fig. 5); one five-ton winch; one three-ton winch; 20 motors of 30 b.h.p; six motors of 60 b.h.p, variable speed, 3 to 1 range; one 800-kw. 220-volt generator at 250 r.p.m.; several motors from 100 h.p. to 150 h.p.; some hundreds of motors of the constant-speed, variable-speed, and crane type, as well as alternating-current motors of all sizes from 5 b.h.p. to 100 b.h.p.

The above list shows the general character of the work turned out, which is practically all concerned with power

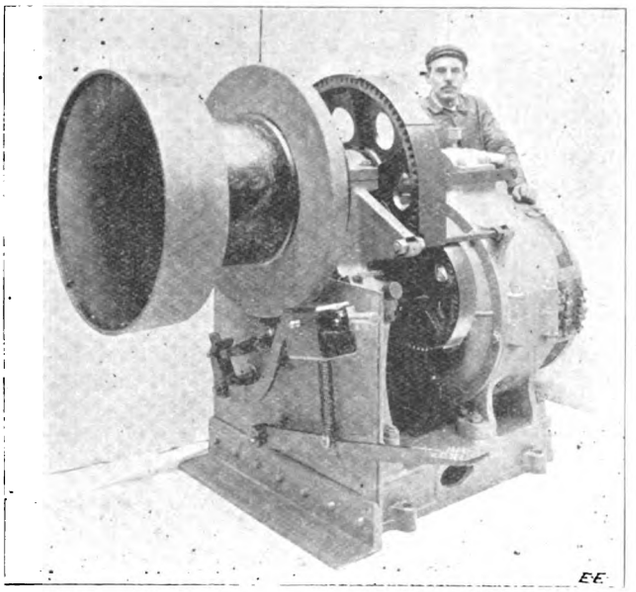

FIG. 5.—Vickers Electrically-Driven Coaling Bollard to lift One Ton at 200ft. per minute.

distribution. Messrs. Vickers, Sons, and Maxim have made a special study of variable-speed motors, and in their machine shops are several hundred motors to work with a 3 to 1 range of speed on shunt regulation. In several cases the motors have a speed range of 6 to 1; a good many are being made of 8 to 1 range for gun-training gears, and a motor of 15 to 1 range is being manufactured for a special purpose. A great deal of Admiralty electrical machinery is built at the Sheffield works, including electric light sets, winches, and hoists, training and elevating motors for guns, electric ventilating fans, etc. One special application of the variable-speed motor is that of driving planing machines by a method patented by the firm. A planing machine equipped in this way is to be shown at the Olympia exhibition next week. This type of planer is driven by a single motor with a range of speed from about 300 to 900, the motor driving the machine through spur or worm gearing. On the cutting stroke the motor runs at its slowest speed, and at the end of the stroke, the length of which is easily adjusted to suit the work, the motor reverses automatically. As soon as the reversal has occurred a resistance is automatically inserted in the field winding, quickly raising the speed to 900 for the return stroke. At the end of the quick return stroke, immediately before reversal, the field resistance is short-circuited, providing a strong field for reversing in, and the motor reverses and makes its slow cutting stroke, the cycle repeating itself. In order to start up or stop a planer driven by this gear, it is only necessary for the operator to throw over a simple switch.

The special switches for this control are illustrated in Fig. 6. The function of these switches are (*a*) to start the motor after it has come to rest at the end of the stroke; (*b*) to insert or withdraw resistance in series with the field coils, thus altering the speed after reversal; (*c*) to reverse the armature connections, and thus reverse the direction of rotation; (*d*) to retard the armature at the end of the stroke by strengthening its field prior to reversal. It should be particularly noted that the speed variation of the motor is produced entirely by varying the shunt current, and the efficiency of the motor is not less than 87 per cent. under any circumstances.

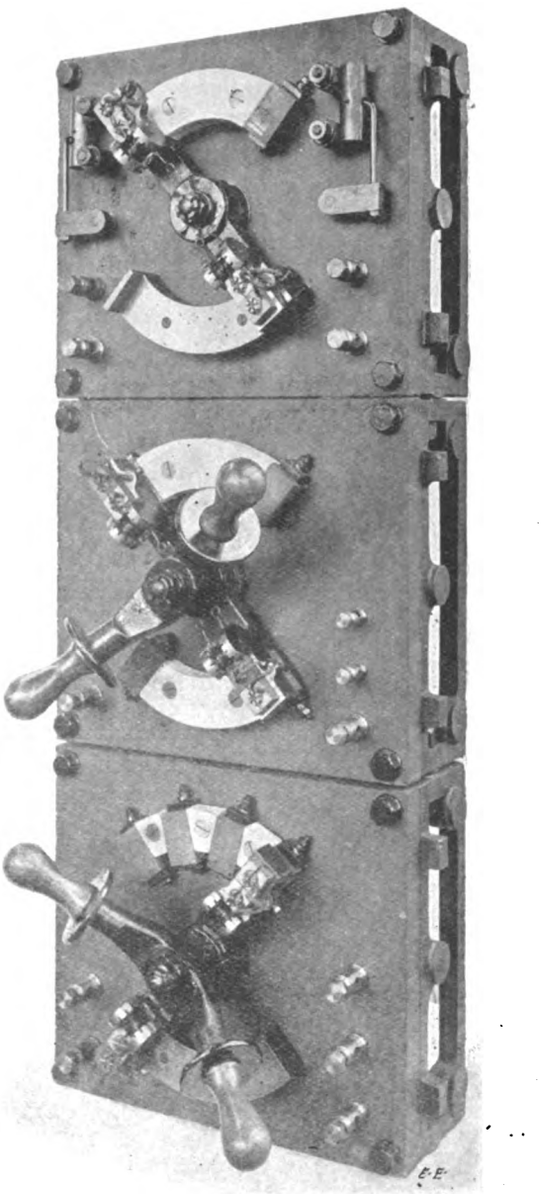

FIG. 6.—Switches for Controlling Electric Planing Machine by Vickers Patent System.

The advantages of this method of direct driving planing machines are many, and involve saving both of time and energy. The absence of belts is one great feature, which involves a great loss of saving in upkeep The cost of belts for a large planer averages from £30 to £40 per annum, and the rapid wear of the same is an indication of the energy wasted at the reversal of travel. As a rule the speed of cut is invariable with a belt-driven machine, which is not the case with the Vickers motor drive. This feature at once makes the planing machine of far greater value than it has been hitherto. The cutting speed can be instantly suited to the material from the hardest steel to softest steel and wrought iron, thus increasing the general output of the machine. The reversal is also more positive and quicker than that obtained by belt driving, and there is

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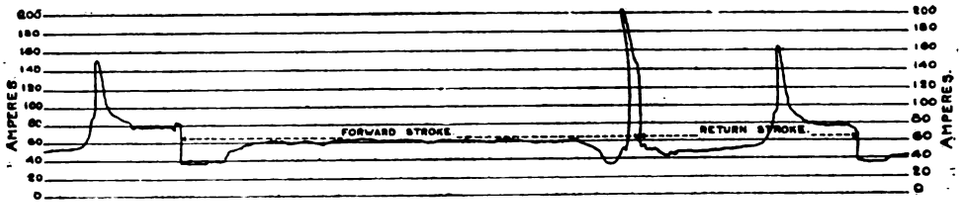
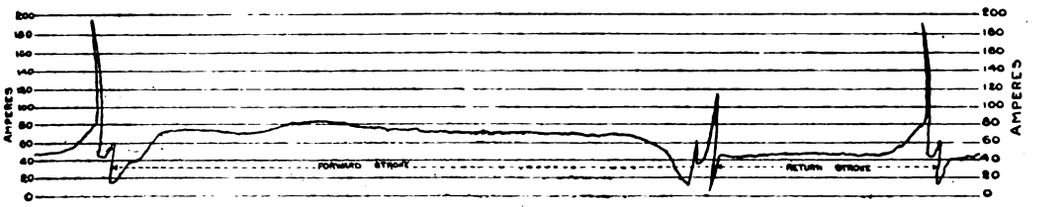
no loss of time at reversal such as is often seen with a belt which has become slack or worn. The shriek of the belts on reversal is caused by slipping, which wastes time and also energy. The question of the new method in the minds of electrical engineers will be as to the success of reversing the direction of rotation of a motor so often. This has been carefully gone into by the makers, who are so assured that their electrical department have in progress the alteration of 16 large planing machines in their Sheffield works alone. The decision to alter these machines was arrived at after very severe tests of the new system. One 12ft. by 10ft. by 24ft. armour plate planer, driven by a 20-h.p. variable reversing motor, was worked 24 hours a day for over six months. On short-stroke work it frequently had to reverse over 6,000 times each day, and at the end of six months the switches and motor had not deteriorated in the least.



POWER DIAGRAM.—ORDINARY BELT DRIVEN PLANER.

FIG. 7.

The two curves (Figs. 7 and 8) are power diagrams from two motors driving planers. Fig. 7 is from a test made on a Niles planer No. 106, size 10ft. by 12ft. by 25ft., which was belt driven in the usual manner by a 40-h.p. constant-speed motor. The travel of tool was 16ft. 6in., the average rate of cutting 13ft. 4in. per minute, and the average rate of return stroke 27ft. 6in. per minute. Fig. 8 is prepared from a test made on a Sharp-Stewart heavy planer No. 108, size 12ft. by 10ft. by 24ft., driven by a Vickers 20-h.p. variable-speed motor in conjunction with Vickers patent automatic reversing gear. The motor speed on cutting stroke was 370 r.p.m., and the speed on the return stroke 1,000 r.p.m. The travel of the tool was 20ft. 6in., the average rate of cutting 15ft. 5in. per minute, and the average rate of return stroke 41ft. per minute. These diagrams show the advantages of the direct drive most clearly.



POWER DIAGRAM.—PLANER DRIVEN BY VICKERS' SYSTEM.

FIG. 8.

Other special applications of variable-speed motors are being devised by the firm. We have, however, said enough to indicate the magnitude and variety of Messrs. Vickers's electrical output, and it is pleasant to note that the department is making such rapid strides.

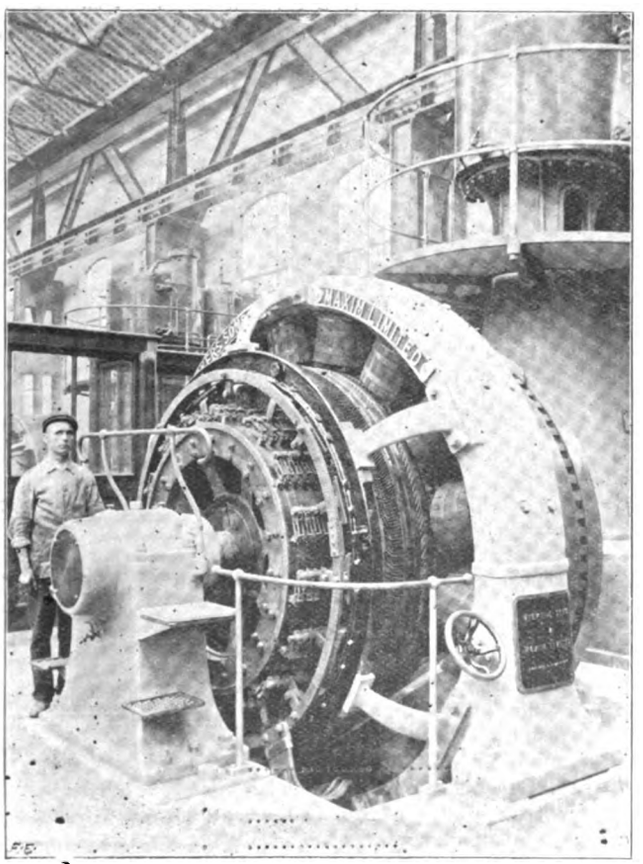


FIG. 9.—750-kw. 220-volt 250 revs. Vickers Dynamo, direct coupled to Bellis Engine.

THE EDDY-CURRENT BRAKE FOR TESTING MOTORS.*

BY D. K. MORRIS, PH.D., AND G. A. LISTER, ASSOCIATE MEMBERS.

(*Concluded from page 384.*)

WORKING OF THE BRAKE.

One of the characteristics of the brake is the steady manner in which the lever floats after the magnetising current has been adjusted. This is due to the fact that the centre of gravity of the sliding weights is slightly below the centre line. This feature is obtained without any material reduction in the sensitiveness. Another noticeable feature when using the brake is the absence of trouble due to end play of motor. This is extremely serious in the case of brakes in which the copper disc is mounted on the motor spindle while the magnet system rests on a separate frame. It is found that by the use of properly suspended flexible leads the magnet coils can be supplied with current without the use of mercury cups. The limit to the absorption capacity of the brake is determined by the heating of the magnetising coils. The fan action referred to is found to be an entirely satisfactory way of getting rid of the heat generated in the discs. Long-continued tests give rise to no difficulty at all on this account. The brake was originally designed to absorb 5 h.p. when running at 1,000 r.p.m., and it has been found to work most efficiently at speeds of this order. At speeds above, say, 1,500 r.p.m. the falling off of braking effect due to field distortion becomes noticeable, and at speeds lower than 500 the magnetising current required to brake, say, 5 h.p. becomes too great for the capacity of the coils. Fig. 4, Curve II., shows the absorption capacity of the brake for given

* Paper read before the Birmingham Local Section of the Institution of Electrical Engineers.

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excitations at 1,000 r.p.m., and Curve II.A under same conditions for 1,750 r.p.m.

The brake is found very convenient for testing motors as regards temperature rise and overload capacity. When temperatures have settled down, and the magnetising current is finally adjusted, the load remains perfectly constant. Motors may be tested for starting torque by locking the revolving discs to the fixed portion of the brake

Figure of Merit.—In any type of eddy-current brake it is important that the power absorbed in the magnetising coils be kept down as low as possible. The ratio $\frac{\text{absorption power of brake}}{\text{power absorbed in magnetising coils}}$ may conveniently be termed the "figure of merit" of the brake. This figure should be as high as possible over the whole range of the brake, but more especially at or near its full rated capacity.

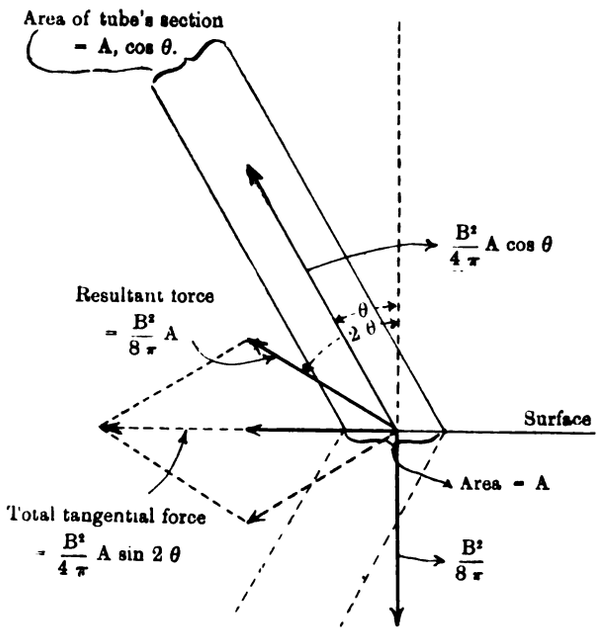

FIG. 7.

It is at this point it will be most frequently used, especially in connection with time tests. The figure of merit will, of course, rise with the speed.

THEORY OF THE EDDY-CURRENT BRAKE.

(*a*) *Introduction.*—The theory of the eddy-current brake is in many respects the same as that of the induction motor, with the additional simplification that inductance is absent from the rotor. The presence of poles, however, renders the ordinary induction-motor theory unsatisfactory. The theory here given is in many ways a very direct one. It takes account of the increase of reluctance of the air-gap due to the oblique path of the flux through the gap. This is not commonly done in dealing with the induction motor.

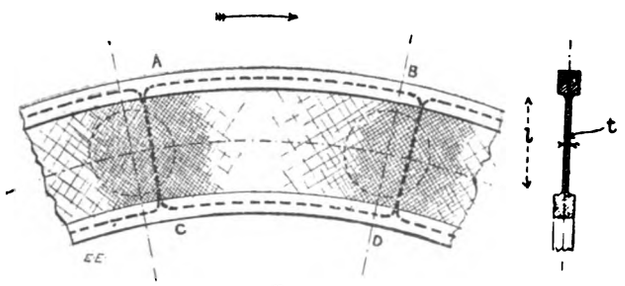

FIG. 8.

It is not necessary when the slip is small, but becomes an important factor when dealing with starting torque. Maxwell showed* that in air there is a tension along tubes of flux equal to $B^2/8\pi$ dynes per unit of area of the tube's cross-section, combined with a pressure in all the directions which are at right angles to the tubes of flux, also equal to $B^2/8\pi$ dynes per unit of area. This condition is equivalent, as he also states, to a hydrostatic pressure of $B^2/8\pi$ dynes per square centimetre combined with a longitudinal tension of $B^2/4\pi$ dynes per unit area of the tube's cross-section. Thus, if a tube of magnetic flux reaches a surface of area A at any angle θ to the normal, so that its section is A . cos θ, then the two forces acting on that surface are as shown in Fig. 7—namely, a tension along the direction of flux of $\frac{B^2}{4\pi}$. A . cos θ, and a simple pressure upon the surface of $\frac{B^2}{8\pi}$ A. The resultant force on the area A is, therefore, $B^2 A/8\pi$, and its direction is at an angle 2θ to the normal, so that the tangential force is $\frac{B^2}{8\pi}$ A . sin 2θ.

In the case of a brake disc, where the flux is bent so that it leaves at a similar angle on the opposite surface, the force is $\frac{B^2}{4\pi}$ A . sin 2θ, and since B cos θ is the flux density B_o as the flux crosses the surface normally, the force exerted by the magnetic field on the brake disc area, A, is $\frac{B_o^2}{2\pi}$. A . tan θ.* The flux produced in the air-gap by each magnetised pole can, if the latter are suitably shaped, be regarded as approximately sine-functional both when the brake disc is at rest and when it is in motion. In the latter case, however, it is dragged forward in the direction of rotation on account of the magnetic action of the currents induced by the motion. The width of this equivalent sine-functional flux-band may be less than the pole-pitch if the poles are not sufficiently wide, as in the brake described.

These induced currents give rise to a magnetomotive force tending to set up a flux lagging behind them in position by exactly half the pole-pitch. This magnetomotive force, however, operates upon a magnetic circuit of irregular and much greater reluctance than that of the original flux path, and the greater it can be made the less is the reaction caused by a given flow of eddy currents. The eddy currents are at any point coincident in position with, and proportional in magnitude to, the actual or resultant flux which crosses the disc at that point. The eddy-current paths remain fixed in space, so that the flux associated with them has not to be altered, and the energy corresponding to this flux is provided once for all. Only changes in this energy could give rise to inductive effects. The current flow will, however, be slightly hindered as it enters the thick rims on account of skin effect.

The following notation is employed†:

B_m = maximum value of original or main flux	2,200 lines per cm.²
B_r = maximum value of resultant flux measured perpendicular to disc in the disc itself	1,370 „ „
p = width of equivalent sine-functional flux in cms. measured along pole-centre line	3·8cm.
β = ratio of this width to the pole-pitch ($p \div \beta$ = pole-pitch)	0·31.
b = shift of resultant flux wave from position of main flux	0·55cm.
a = radius of swing of flux lines in cms.	0·7cm.
t = thickness of disc in cms.	0·4cm.
2 g = gap between pole-face in cms. ...	0·9cm.
ρ = specific resistance of material of disc in C.G.S. units per cm. cube (hot)	2,450.
l = radial length of average eddy-current path (see Fig. 7)	2·25cm.
α = resistance factor	2.

* "Treatise on Electricity and Magnetism, vol. ii., pp. 280 and 281 (third edition).

* The normal force can be similarly derived. Its value for an iron-cored armature—namely, $\frac{B_o^2}{8\pi} A . \frac{\cos 2\theta}{\cos^2 \theta}$, where θ is evaluated as explained below—is an important expression which should be used when dealing with bending stresses on the shafts of running armatures if placed unsymmetrically with respect to the poles.

† The values given on the right are approximately correct for the brake described in the paper when running at 1,000 r.p.m., and excited so that it absorbs 5·1 b.h.p.

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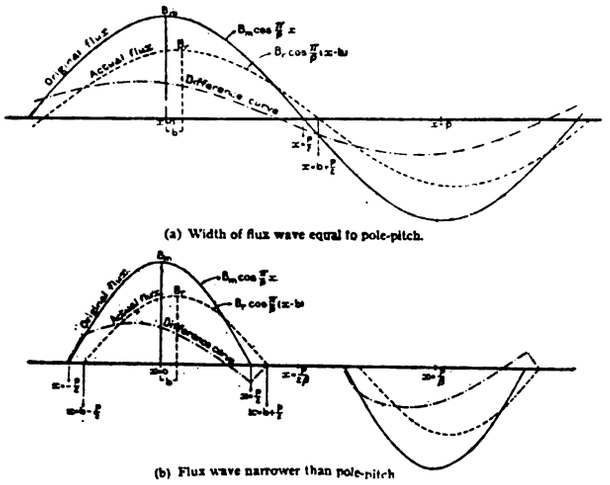
v = speed of disc at effective pole-centre line in cms. per sec. ... 1,520cm. per sec.
R = speed of motor in r.p.m. ..... 1,000 r.p.m.
D = diameter of disc at pole-centres in cms. ..... 29cm.
x = distance measured along disc at pole-centre line in cms.

It will be readily seen that if the bands of flux be developed along the line of pole-centres on the disc, as in



(a) Width of flux wave equal to pole-pitch.

(b) Flux wave narrower than pole-pitch

FIG. 9.—Approximate Flux Distribution—Standing and Running.

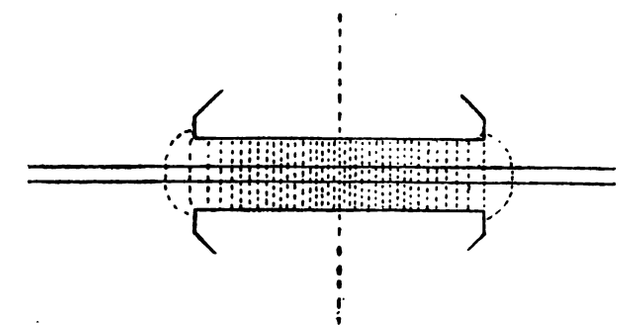
Figs. 9A and 9B, then the original or main flux can be denoted by

$$B_m \cos \frac{\pi}{p} x, \text{ between } x = -\frac{p}{2} \text{ and } x = +\frac{p}{2},$$

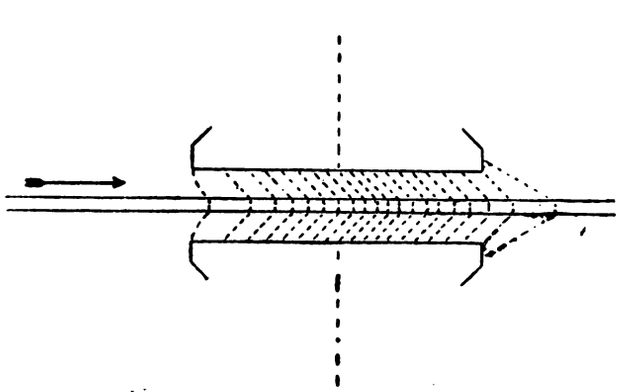
and the resultant flux by

$$B_r \cos \frac{\pi}{p}(x-b), \text{ between } x = b - \frac{p}{2} \text{ and } x = b + \frac{p}{2}.$$

(These limits need not be specified where the flux-band occupies the whole pole-pitch—*i e*, where $\beta = 1$.)



(a) Flux in gap when disc is at rest



(b) Flux in gap when disc is in motion.

FIG. 10.

(b) Flux Displacement.—The flux across the gap when the disc is at rest is depicted in Fig. 10A; and when the disc is in motion, the flux is dragged forward in the direction of rotation as indicated in Fig 10B, and is weakened in intensity owing to the increased length of the path in air. Thus a particular tube of flux meets with successive displacements with increasing disc speeds in the manner shown in Fig. 11. The shift of the tube along the pole-face is restricted in amount by the proximity of the forward edge of the pole. Thus, though the tube moves inside the pole-face nearly parallel to itself, the displacement of its path in the gap may be represented by rotations round fixed points, *o o'*, inside the pole-face, whose position is dependent upon the formation of the pole. The distance of these points within the pole-face is very small (1mm. or 2mm.), since it merely represents the excess reluctance of the whole magnetic path over that of the air-gap alone. In other words, the equivalent air-gap is greater than the actual. Assume that one such point, O, is a centimetres from the central plane of the disc, and that this centre of rotation is situate at a similar distance for every tube of flux. The displacement of the tube as it crosses the disc is b centimetres. Assume, further, that the reluctance of the whole magnetic path is dependent solely upon the length of its passage through the equivalent air-gap and the effective narrowing of the pole-surface due to forced obliquity of the flux. The density of the oblique flux is $B_m \cdot \cos \frac{\pi}{p}(x-b) \cdot \cos \theta$, which is further reduced to $B_m \cdot \cos \frac{\pi}{p}(x-b) \cdot \cos^2 \theta$ as it crosses the disc. Consider an element of the surface of the disc of radial

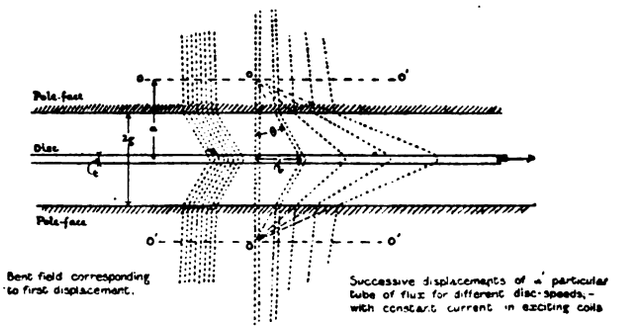


FIG. 11.

length l and with dx. The retarding force on this element is (see above)—

$$\frac{1}{2\pi} \cdot B_m^2 \cos^2 \frac{\pi}{p}(x-6) \cdot \cos^4 \theta \cdot l\, dx \cdot \tan \theta,$$

where $$\theta = \tan^{-1} \frac{b}{a}.$$

The force per pole is obtained by integrating this expression between the limits $x = b - \frac{p}{2}$ and $x = b + \frac{p}{2}$; and, if the flux falls on the disc with a uniform slope, as indicated in Fig. 10B, then the retarding force is $\frac{B_m^2}{4\pi} \cdot p\, l \cdot \sin \theta \cos^3 \theta$ dynes per pole. To obtain the total retarding force on the whole disc, this expression must be multiplied by the number of poles, n, and, since $n \cdot \frac{p}{\beta}$ is the circumference, πD, of the pole-centre line of the disc, the total retarding force on the disc is

$$\frac{1}{4} \cdot B_m^2 D\, l \beta \cdot \sin \theta \cdot \cos^3 \theta \text{ dynes}$$

exerted at radius $\frac{D}{2}$. The disc thus absorbs

$$\frac{1}{10^7} \cdot \frac{\pi}{4} \cdot B_m^2 D^2 \cdot \frac{R}{60} \cdot l \beta \cdot \sin \theta \cdot \cos^3 \theta \text{ watts,}$$

or, $$1{\cdot}76 \times 10^{-12} \cdot B_m^2 D^2 R \cdot l \beta \cdot \sin \theta \cdot \cos^3 \theta \text{ B.H.P.}$$

This can also be written as

$$0{\cdot}44 \times 10^{-12} \frac{N_t^2 R}{l \cdot B} \sin \theta \cos^3 \theta \text{ B.H.P.}$$

where N_t = total passage of flux across the disc when at rest $\left(= \frac{2}{\pi} B_m\, p\, l\, n\right)$.

(c) Slope of Flux for Maximum Torque a a Given Speed. The expression $\sin \theta \cos^3 \theta$ varies in the manner indicated

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in Fig. 12. It is easily shown that its maximum value, 0·325, occurs for $\theta = 30$deg. The curve is plotted to a base of tan θ, since $b = a \tan \theta$. Thus the best inclination of this flux in the gap is when $\frac{b}{a} = \frac{1}{\sqrt{3}} = 0{\cdot}577$, and this occurs only when the disc has a thickness to be determined below. The greatest amount of power that can be taken up in a given brake disc is, therefore,

$$5{\cdot}7 \times 10^{-13}\ B_m^2\ D^2\ R\ l\ \beta\ .\ \text{B.H.P.}$$

(*d*) *Best Thickness of Eddy Current Disc.*—The bands of flux which cross the disc were found to have a density (B) at the point of crossing of

$$B = B_m\ .\ \cos^2\theta\ .\ \cos\frac{\pi}{p}(x-b).$$

Consider a radial element of the disc (see Fig. 8) of length l and average section $t\ .\ dx$. The E.M.F. induced in it is $B\ .\ l\ .\ v$. But the resistance of the circuit in which this E.M F. has to operate is greater than $\frac{l\rho}{t\ .\ dx}$ by one-half the resistance of the portions A B and C D. Let the increased resistance be $\frac{a\ .\ l\rho}{t\ .\ dx}$, where a should have a value of 1·2 to 1·5. The actual path of the currents will be approximately radial only when the rims are thickened, as shown in Fig. 8. Since inductive back E.M.F. does not

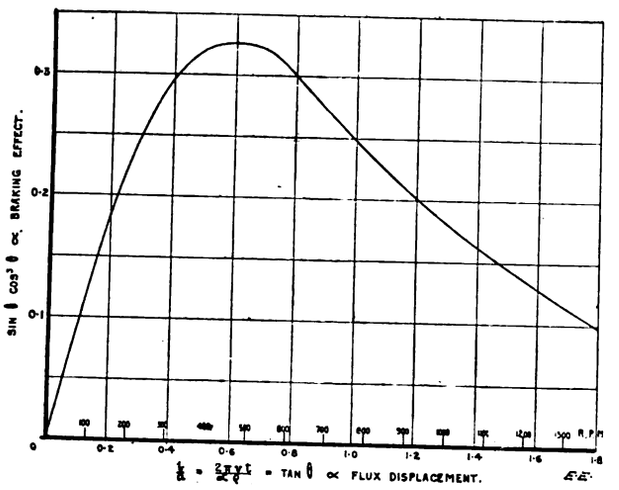

FIG. 12.—Variation of Torque with Flux Displacement.

arise in the eddy-current path, the current induced in the element is

$$dc = \frac{v\ t}{a\ \rho}\ B\ .\ dx,$$

and the current per centimetre width of disc is dc/dx. This will cause at the surface of the disc a flux of $2\pi\ .\ dc/dx$ lines per square centimetre parallel to the surface, and a similar flux oppositely directed on the other surface of the disc. The bend in the magnetic lines as they pass through the disc is effected solely by these two fields. In order that a flux of value B may be bent through an angle θ by a flux of $2{\cdot}\pi\ dc/dx$ at right angles to it, it is necessary that the former be related to the latter in the ratio 1 : tan θ (see Fig. 13), or as a to b. Hence, inserting the value of dc/dx, the flux displacement is given by

$$b = a\ .\ \frac{2\ \pi\ v\ t}{a\ \rho},$$

also $$t = \frac{a\ \rho}{2\ \pi\ v}\ .\ \frac{b}{a}\ \text{cms.} = \text{thickness of disc.}$$

Inserting the most advantageous value of b/a already determined, it is seen that the eddy-current brake disc should have a thickness between the pole-pieces of

$$t = \frac{a\ \rho}{2\ \pi\ \sqrt{3}\ v} = 0{\cdot}092\ a\ \frac{\rho}{v}\ \text{cms.}$$

Any greater thickness will result in *decrease* of torque.

(*e*) *General Expression for Brake Horse-Power Absorbed by Eddy Disc*—The power absorbed by an eddy brake disc with radial current flow is

$$1{\cdot}76 \times 10^{-12}\ B_m^2\ D^2\ R\ l\ \beta\ \sin\theta\ \cos^3\theta\ \text{B.H.P.},$$

where $$\theta = \tan^{-1}\frac{2\ \pi\ v\ t}{a\ \rho}.$$

The values of sin θ cos^3 θ are given in the curve (Fig. 12).

APPLICATION OF THEORY TO DESIGN OF EDDY BRAKES.

This theory leads to the following points of design:

1. The rims of the brake disc should be thick compared with the thickness between opposing pole-faces, so that the currents may flow approximately radially (Fig. 8).

2 When this condition is attained, the brake disc's thickness in millimetres should be about equal to the specific resistance of its material in C.G.S. units when heated — say, about 2,500 for copper and 4,000 for aluminium—divided by the average linear velocity of the disc. For the brake described in the paper, when running at 1,000 r.p.m. or a mean linear velocity of 1,600cm. per second, the best disc thickness is about 1·7mm. if the disc rims were thickened, and probably about 3mm. with a plain disc.

3. The pole-faces must be so designed that the point round which the lines of flux swing is but little within the pole-face. It is proposed to meet this condition by a series of radial cuts or narrow slots in the pole-face. The observations on the brake described in the paper show that this point of swing is at present on the average about 2·5 within the pole-surface (see Fig. 11), while the flux displacement with the 4mm. disc is about 0·6cm. Under these conditions it will be seen that the eddy currents' magnetomotive force is beginning to operate upon a better magnetic circuit,

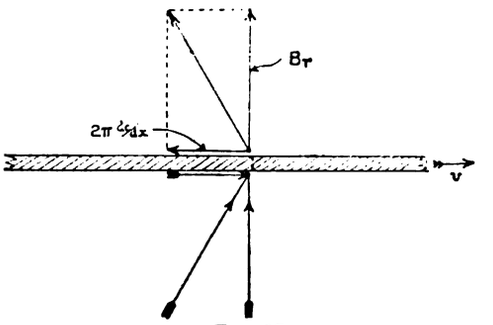

FIG. 13.

and not only to cause a reduction in the main flux, but also to give rise to a flux along the pole-surfaces tending to increase the flux displacement.

4. The radial lengths of the pole-faces should be as great as is convenient, the gap being made a shade less on the outside, so that the flux may not suffer radial displacement. And, generally, the polar area should be increased (making β nearly equal to unity), and the gap reduced as far as practicable in order to economise in magnetising energy. A limit to this increase arises, however, if the magnet cores are approaching saturation, on account of the diversion of the flux through the leakage paths between the sides of the poles without crossing the disc at all (Fig. 3). Approximate investigation seems to show that the best value of β is about 0·7, when the pole-faces have a width about equal to one-half the pole-pitch. If an allowance of 25 per cent. be made for the reduction in flux arising through leakage combined with core saturation, the following expression

$$3 \times 10^{-13}\ B_m^2\ D^2\ R\ l\ \text{B.H.P.},$$

would appear to represent roughly the *maximum* brake horse-power that can be absorbed in a given brake disc running at the speed which is most advantageous for the thickness of brake disc employed. Putting $l = {\cdot}15$ D, which represents as long a pole-face as is convenient, the expression becomes

$$4{\cdot}5 \times 10^{-14}\ B_m^2\ D^3\ R,$$

or, at 1,000 r.p.m., $$4{\cdot}5 \times 10^{-11}\ B_m^2\ D^3.$$

For a disc 15in. in diameter over all this becomes approximately

$$1{\cdot}35\left(\frac{B_m}{1{,}000}\right)^2,$$

or 6·5 b.h.p. per disc, with the flux densities occurring in the brake described in the paper. This brake, with its

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two discs, should, therefore, be capable of absorbing 13 b.h.p. at 1,000 r.p.m. if the best design could be followed.

CONCLUSION.

The authors have compared the theory here given with the results actually obtained on the brake described in the paper, and have found throughout as substantial an agreement as can be looked for, considering that the theory applies properly only to a copper disc with thickened rim. When it is remembered that this brake was designed before the theory as to correct proportions was worked out, and that by (*a*) reducing thickness of disc, (*b*) providing it with rims as in Fig. 8, (*c*) widening the pole-faces, and (*d*) slotting them, an increase of capacity amounting to over 100 per cent. should result, it will be seen that it may fairly be claimed for the eddy-current brake that besides being quite the most convenient and compact for ordinary motor testing, it will compare favourably, when correctly designed, with mechanical water-cooled brakes in all respects except that of initial cost. A brake embodying these improvements is being designed, and it is hoped that an early opportunity will be found of constructing it.

In conclusion, the authors wish to express their thanks to the council of the University of Birmingham, through whose action they have been enabled to carry out this work.

THE DISTRIBUTION OF POWER.*

BY PROF. AYRTON, F.R.S.

Twenty-six years ago, at the meeting of the British Association at Sheffield, August, 1879, a lecture on "Electricity as a Motive Power" was delivered to some thousands of working-men, and, for the first time, they realised that forks and spoons could not merely be plated with the electric current, but could also be polished with a brush made to spin with the same agency. The sea of upturned faces beamed with delight when Jack, their popular comrade, stepped on to the platform, took the newly-plated spoon in his hands, and burnished it—a pair of thin wires tied to a church steeple being the only connecting link between the dynamo machine in a neighbouring works—ordinarily used there for electroplating—and the electromotor driving the polishing brush in the Albert Hall, Sheffield. But an electromotor is only a toy, thought my audience; nobody could construct an electromotor that we could not stop with our hands. And at the end of my lecture they actually tried, and—wondered.

As far as I am aware, it was at that lecture that this composite suggestion was first put forward—viz, to obtain economy in electric transmission of power the current must be kept small, while to transmit much power the electric pressure between the conducting wires must be made large; and, lastly, to secure safety and convenience in working, this high pressure must be transformed down into a low one at the distant end of the transmission system. But what did high pressure—produced with a dynamo—mean 26 years ago? Why, three or four hundred volts—what, in fact, is called low pressure to-day—a pressure less than is now often used for lifts in buildings, pumps in mines, and tramcars in streets. And how was it proposed to transform this so-called high pressure into a low one? Why, I suggested mechanically coupling a 400-volt direct-current motor to a 50-volt direct-current dynamo—the device that has since been called a "motor-generator"—and such a combination was shown in operation at that lecture.

But it was in Paris, at the Palais de l'Industrie, the home of that electrical exhibition of 1881—which has now become classical—that modern electrical engineering was born, and shortly afterwards *Punch* exhibited the young infant thriving and imbibing liquid nourishment from a storage cell. "What *will* he grow to?" says the picture. What *has* he grown to? Aladdin's ring, Aladdin's lamp—whose slaves brought a fortune to him, and a fainting fit to his mother—were but poor magic makers compared with the ring evolved by Gramme and that boy Paccinotti—compared with the lamp constructed by those veterans, Edison and Swan. In the "Arabian Nights" it is stated that Aladdin's would-be uncle, the noted and learned African magician, knew that that within the wonderful lamp was not oil, and that he anticipated by many centuries the Johannesburg Municipality, who, to reconcile the inhabitants to having the electric pressure in their houses raised from 110 to 230 volts, offer—like that other African magician—to give "new lamps for old." It is also described how the lamp enabled Aladdin to carry off the Princess Badroulboudour, and the wicked uncle to transport the palace. But electric traction has carried off whole neighbourhoods out of cities into suburbs, and, by transporting hundreds of thousands daily, has helped to solve the problem of housing the working class. While electric distribution of power has discovered, not caves of buried jewels, but waterfalls of ever-flowing wealth. At the mines near Silver City, Idaho, for example, coal had reached 70s. a ton, wood 36s. a cord, for years the distribution of power was by donkeys, or long teams of horses slowly hauled the heavy loads of wood up the mountain road. Then the magician of this, the electric age, came to Idaho, and now the need of those mines, power—clean, dustless, weightless power—courses up the mountain side from Swan Falls on Snake River in the valley below. What fairy of old, from whose mouth fell jewels whene'er she opened it, ever worked such beneficent wonder? See how proudly those posts look down upon their conquest of the past. For have they not brought an end, not merely to wasteful extravagence in lifting fuel up to those mines, but also to needless toil for tired cattle? In 1886, when the boy Electricity was five, the babe Johannesburg was born, and the two youngsters have raced along neck and neck. Something of their lives I will tell you to-night.

Nine years after that first lecture the British Association honoured me by asking for another. In 1888, however, it was beginning to be realised that a pressure of 2,000 volts between electric mains might not make too great a call on the funds of life insurance companies. Alternate-current transformers had come into use; Ferranti was employing them for practically distributing electric current from the Grosvenor Gallery, Bond-street. A "transformation scene" Lord Kelvin called the apparatus at that lecture. The male white population of Johannesburg was now—2,000. But although current at 100 volts pressure was beginning to be distributed for electric lighting, the distribution of power for working electromotors was still but the dream of the future. In exactly a decade after the Paris Electrical Exhibition of 1881 came the Frankfort Exhibition of 1891. More than 10 times 2,000 volts was there used to transmit more than 100 h.p, more than 100 miles, with more than 75 per cent. efficiency. A death's head and cross bones were painted on every post along that 109 miles of railway line, Lauffen to Frankfort, for he who should touch these bare wires, with a pressure of 25,000 between them, secured electrocution. And a similar suggestion of mortality greets the wayfarer—in his own language, be he English or Dutch—on the posts of the Rand Central Electric Works. Table I. shows that the use of higher and higher pressures has enabled larger and larger amounts of power to be transmitted longer and longer distances, with greater and greater efficiency—that is, with less and less waste. Now, why is this?

TABLE I.

—	1882. Hirschau to Munich.	1883. Vizille to Grenoble.	1886. Creil to Paris.	1891. Lauffen to Frankfort.
Pressure at transmitting end in volts ...	700	3,000	6,000	25,000
Horse-power delivered by electromotor	5·8	7	52	114·2 to lamps
Distance in miles	3·5	8·75	35	108·7
Percentage commercial efficiency of transmission	36	62	45	75·3
Diameter of line wire in inches	0·18	0·079	0·2	3 wires each of 0·158
Material of wire	—	Silicium bronze	Copper	Copper

The electric current, as you know, is used for lighting buildings, driving machinery, propelling cars and trains.

* Lecture delivered on Aug. 29 at the meeting of the British Association at Johannesburg.

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But throw away the notion, if any of you still have it, that electricity is a kind of gas, or oil, or fuel that is used up in these operations. The common expressions: buying electricity, consuming electric current, are most misleading, for just as much electricity flows away per minute—through the return conductor—from your electrically-lighted house as flows to it through the coming conductor. If, therefore, it were electricity that you had undertaken to pay for, you must have made a very bad bargain, because you do not retain the smallest portion of what you would have agreed to purchase. The electric current is like a butcher's cart carrying round meat—you no more consume current than you consume cart. It is not the vehicle, but what it leaves behind that the consumers buy—meat in the case of the butcher's cart, and energy in the case of the electric current. And exactly the same considerations apply to the distribution of power with air at 70lb. pressure per square inch to the thousands of rock drills on the Rand, to the distribution of power with water at 425lb. pressure per square inch down the shaft of the Rietfontein Mine, and at 750lb. pressure in the workshops of the Central South African Railways at Pretoria.

The energy conveyed with air, with electricity, or with water is made up of three factors: (1) the current, (2) the time during which it flows, and (3) the pressure under which it flows; while power depends on the current and the pressure only. Few words are used more vaguely than this one "power." Before starting for South Africa some of us gave someone a power of attorney; we came on a ship of 12,000 h.p.; the voyage did us a power of good; at the concert on board we sang of the power of love. In engineering, however, power has one very definite meaning—the rate of doing work, and a stream of air, of electricity, or of water exerts much power—that is, works rapidly—when it quickly loses pressure, or head. Quickly losing one's head, however, is not characteristic of large brain power, and the power exercised by those who sit in high places is often much in excess of their rate of doing any kind of work. When water has but a few feet of head, the quantity flowing over a waterwheel must be large if much work has to be done. But since the water usually comes to a low-pressure wheel along an open stream, and flows away again also along an open stream, no expense has to be incurred in laying down large pipes. If, however, it were necessary to distribute much power over considerable distances through a pipe conveying such low-pressure water, the pipe would not only have to be long, but of large cross-section, and, therefore, very bulky and costly. For example, this model is a full-size representation of the transmission of only 1 h.p. On the other hand, if the water possesses considerable head, the transmission pipe may be of small diameter. In this second model the three-cylinder pump produces a pressure of 425lb. per square inch, exactly the pressure used in the hydraulic transmission of power down the shaft of the Rietfontein Mine, and with that pressure less than four gallons of water flowing per minute through this ¾in. pipe gives as much power to this turbine as would be delivered by 825 gallons pouring per minute over this waterwheel 4ft. in diameter.

The water pressures in these two illustrations bear about the same proportion to one another as the electric pressure in the Lauffen-to-Frankfort transmission bears to the electric pressure usually maintained between the terminals of a lamp in Johannesburg. The value of using pressure water is grasped when you realise that at the Rietfontein Mine, by circulating about 85 gallons of water per minute at 425lb. pressure per square inch through a pipe 16 square inches in cross-section, not only is the circulating water all returned to the top of the mine, but, in addition, 144 gallons are pumped up per minute from a depth of 546ft. through a pipe 38½ square inches in cross-section. The water supplied by the London Hydraulic Power Company at 1,700ft. head, although not filtered, costs nearly four times as much per gallon as the filtered water furnished by the Metropolitan Water Board. In England dirty pressure water is a relatively costly commodity, sparkling drinking water a relatively cheap liquid. In Johannesburg, on the other hand, until quite recently the charge for drinking water was 10s. a gallon, plus 2s. 6d. a month for meter rent, or exactly 20 times the London rate—the temptation to drink other things in Johannesburg must have been very great. Now, since the establishment of the Rand Water Board, it is 6s. a thousand gallons, or still 10 times the London price, so that liquid with a head in London is still cheaper than plain drinking water here.

In the distribution of power, current and pressure are equally important. It is not merely because, even this month after a phenomenally dry season, about 5,000,000 gallons of water are rushing per minute over the Victoria Falls, but also because this water thunders down about 380ft. that makes these falls a potential source of power. The Howick Falls, near Pietermaritzburg, have nearly as much head as the Victoria Falls and twice as much as Niagara, while a siphon of soda water, when the gas is first pumped in, holds its head higher than any of the three. But, although in Johannesburg you probably pay a shilling for a siphon of soda water as an energy producer in man, it is not worth one ten-thousandth part of a penny as an energy producer in a turbine, since there is so little of it, only a pint and a half. Probably, like myself, you have heard vague comparisons made between the power of the Victoria and Niagara Falls. Now, what is the true comparison? The flow at Niagara varies at different times of the year from about 62 to 104 million gallons per minute. At the Victoria Falls the flow can be one-twelfth of the smaller number, for it is so now; and some authorities, well acquainted with the spot, say that at the end of another three months the flow will be only half of even that. The mean available drop at Niagara is about 160ft.; at the Victoria Falls about 380ft. Hence, while the *minimum* Niagara flow represents about 3,000,000 h.p., the *present* Victoria flow represents about 580,000 h.p., or only about one-fifth of the preceding. Further, if those who predict the flow of the Zambesi sinking to something like 2½ million gallons per minute in November are true prophets, the Victoria Falls will then only give out about 300,000 h.p., or, say, one-tenth of the *minimum* that Niagara produces. In all that precedes I have taken the full power of the direct drop in each case—that is, I have assumed in each case the intake to be close to the main drop, and I have deducted nothing for inefficiency of machinery.

Now, how exactly does the efficiency in the electric transmission of power depend on (1) the pressure, (2) the power transmitted, (3) the length of the transmission line, and (4) the resistance of the conductors composing it? The very simple approximate formula connects these quantities:

$$\left.\begin{matrix}\text{Percentage loss of power on the road}\end{matrix}\right\} = \frac{\text{Horse-power transmitted}}{3\ (\text{thousands of volts})^2} \times \text{miles} \times \left\{\begin{matrix}\text{Resistance per mile of all the conductors in parallel.}\end{matrix}\right.$$

This formula tells us that as long as the electric pressure is limited to some ten or eleven thousand volts—a pressure boldly used as early as 1897 by the Rand Central Electric Works, and at the Moodie Mines, near Barberton, but the one that is still the maximum sanctioned in Great Britain—it will not be possible, even with a pair of conductors of good copper, and each as thick as the one I hold in my hand—viz., ¾in. in diameter—to transmit more than about 6,000 h.p., or to transmit that power more than about 10 miles, without the loss on the road exceeding 10 per cent. The actual efficiency will, of course, be less than 90 per cent., since there will be losses also in the machinery at each end of the transmission system. If, however, the electric pressure be doubled—that is, raised to 20,000 volts—then through this pair of conductors (which are those kindly put up by the Transvaal Technical Institute to bring power from their dynamo-room to this hall, and which are not much more than one-fifth of the cross-section of the former, and, therefore, not much more than one-fifth of the cost, as regards copper) we can transmit 2,700 h.p. 23 miles, and still only lose 10 per cent. on the road.

Now Brakpan, where is the generating station of the Rand Central Electric Works, is almost exactly 23 miles from Johannesburg—six wires come thence to Johannesburg, three of which may be likened to the going conductor and three to the return in a two-wire system like this, also any three of those wires have a joint cross-section

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rather larger than three times the cross-section of this. Hence with 20,000 volts about 8,000 h.p. could be sent to Johannesburg, from Brakpan, through the existing wires with only 10 per cent. loss on the road, or about 3,400 h.p., which is rather more than the entire maximum output of that generating station on any occasion last year, with only 4 per cent. loss. I should have liked to show you this experimentally, but Mr. Reunert, Principal Hele-Shaw, and Prof. Dobson, who since my arrival have so kindly put themselves to so much trouble to give expression to my wishes, might have thought me a little exigeant had I asked for a lecture hall big enough to include a transmission line from Brakpan. And so, instead of this pair of conductors connecting two places 23 miles apart, I am going to employ a pair of extremely fine wires, each less than one-hundredth of the diameter—that is, less than one ten-thousandth of the cross-section—so thin, in fact, that you cannot see them. Switch on the current, 100 lamps glow. Now think of a wall of lamps 10 times as high, then 10 times as wide, and then six times as big as all that, and you will have 2,700 h.p. And that is the power which, put into this pair of wires 23 miles away, say at Brakpan, with this pressure of 20,000 volts, will cause about 2,400 h.p. to come out at Johannesburg.

I drew your attention to the fact that in 1888 the male population of Johannesburg was 2,000 By 1896, according to the census taken that year, it had grown to 32,387. Now, curiously enough, in 1897 two transmissions were arranged for at 33,000 volts—the one at Crofton, California, and the other at Redlands, California. And no pressure higher than that used on the Lauffen-Frankfort transmission seems to have preceded this 33,000 volts anywhere in the world. Indeed, it would almost appear as if electrical engineers were waiting to use a higher pressure than 25,000 volts until the publication of the census of Johannesburg. In 1898 the highest working pressure in the world was 40,000 volts for a 34-mile transmission at Provo, in Utah, and the male white population in Johannesburg was also 40,000. Then came the war, and volts beat white man, for, according to the census of last year, while the white male population was 52,106, there were several examples of transmissions at 60,000 volts, as seen from Table II. But with the influx of the white members of the British Association doubtless the tide will turn, white man will make a spurt and catch up electric pressure, and in this respect, at any rate, the Witwatersrand will become a white man's country.

TABLE II.

Year	From	To	Country.	Transmission distance in miles.	Horse-power transmitted	Pressure at transmission end in volts.
1897	Crofton	—	California	—	—	33,000
,,	Redlands	—	,,	—	—	,,
	—	Bangalore	India	92	4,300	35,000
1898	Provo	—	Utah	32	—	40,000
—	Gromo	Nembro	Lombardy	22	3 300	,,
—	Logan	Salt Lake City	Utah	150	2,600	,,
—	Canyon Ferry	Butte	Missouri	70	5,700	50,000
—	Shawinigan	Montreal	Canada	90	15,000	,,
—	Moutiers	Lyons	France	112	—	57,600
—	Spokane	Washington	—	100	3,000	60,000
—	—	Guanaguato	Mexico	104	4,000	,,
—	Electra	St. Francisco	California	147	10 000	,,
—	Colegate	Stockton	,,	218	5,000	,,

Indeed, not only have various successful 60,000-volt transmission schemes been carried out, but the Kern River Power Company in California are constructing one for transmitting 4,020 h.p. over 110 miles at 67,500 volts. Transmission at 67,500 volts over 110 miles. Why, when the new railway—Brakpan to Witbank—is completed, 110 miles will be 20 more than will separate the Rand from the coalfields at Witbank—fields that produce such good coal that the Central South African Railways have contracted to purchase 84,000 tons during this year at 6s. per ton at the pit's mouth. Now, at a pressure of 67,500 volts, these two small wires could, without warming, bring about 9,000 h.p. from Witbank and deliver 7,600 of it to the Rand. Or if six wires were used like those now employed by the Rand Central Electric Works, then, at 67,500 volts, 9,000 h.p. might be put in at Witbank and only 5 per cent. lost on the road—that is, about 8,950 h.p. delivered on the Rand. But the insulators would have to be placed much farther apart than on the existing Rand posts to prevent the starting of a brush discharge between the wires—a subject to which I will return. You will now grasp why in 1895—10 years ago—it was a bold and pioneering policy to equip the Rand Central Works for 10,000 volts, and to use 13,000 volts during times of full load, but why in 1905 the recommendation of some advisers to distribute power at only 10,000 volts to the proposed sub-stations of the contemplated 57 miles of electrified railways—Springs to Randfontein—is most retrograde of those advisers to the railway.

In 1879 a firm of electrical contractors, well known then, and equally well known now, told me that they had been asked to tender for the construction of an electric transmission system to convey a comparatively small amount of power 10 miles. But since they considered that they could not possibly hope to deliver more than half, while, in practice, they feared that they would only succeed in delivering much less, the proposal had to be ranked with the exploits of Gulliver and Baron Munchausen, and so even that firm declined to tender. To-day, 26 years later, electric power is, from an engineering and from a business point of view, being successfully transmitted 232 miles—nearly as far as some of you took 15 hours the night before last in being transmitted from Ladysmith. Now, how are these electric pressures of ten, twenty, thirty, forty, fifty, or sixty thousand volts produced? Why, by means of the alternate-current transformer, which does for electric power exactly what the lever does for mechanical power. Exert a small force through a long distance at the long end of a lever, and you have a large force exerted through a short distance at the short end. Apply a small electric pressure with a large current at one side of a transformer, and you have a large pressure with a small current at the other. But there are no moving parts, therefore the arrangement is called a "static transformer." It requires no adjustment from day-to-day, therefore it may be kept entirely immersed in oil to improve its insulation.

Such statical transformers I used to step up the pressure from 100 to 20,000 volts at the transmitting end, and to step down the pressure from 20,000 to 100 volts at the lamp end, in the last experiment. Everything looked quite harmless until I intentionally brought the transmission wires into contact. So does the transformer, immersed in a huge cylinder of oil, now projected on the screen, although it regularly produces 60,000 volts, and can supply 1,000 h.p. at that pressure. So does the water-cooled transformer, the interior of which is seen in an X-ray picture, to the right, and the exterior to the left; although it can supply 2,000 kw.—that is, 2,700 h.p.—and the size of which is realised by comparing it with the tiny transformer by its side—the size of the one which I have on this table. Sixty thousand volts—well, what of it? some of you may say. It cannot start a discharge between even sharp needle points separated by a greater distance than about 6in., and some of you have produced such a spark with an electrical machine—I am producing such a one now. But each time that a spark passes between the terminals of the electrical machine the pressure is relieved, so no arc is maintained. Bring, however, the terminals of that transformer within 6in. of one another and a roaring arc of 2,700 h.p. will be kept up, dealing destruction around. Let me show you a spark started with a 70,000-volt transformer when supplied with only 1 h.p. What a banging is produced. Now, picture to yourselves what would be the result if the power were not of one but of 2,700 horses, such as that transformer can furnish. The photographs show the sort of discharge that may occur over the surface of an insulator 1ft. high—such as is used on a high-voltage transmission line—when the testing voltage is 80,000 in this case and 105,000 in that, and when there is plenty of power to maintain the arc. It is veritable lightning, not a mere flash, but a continued flame. And the sort of insulator that is used in practice for a 70,000-volt transmission is realised by looking at the specimens, which are only intended for 10,000 volts. There is nothing new in high voltage by itself—it existed

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in the period of the frictional electrical machine 50 years ago, but it was associated with only a very small current; next, dating from the development of the dynamo, came the low-voltage large-current period; and now we have entered on a third era, the high-pressure moderate-current period—that is, the period of high pressure combined with horse-power.

Next I come to a very important question, and one that merits far more consideration than it has yet received. There are two kinds of electric current—direct current and alternating current. Direct current is like a continuously flowing stream of water, such as, for example, the one that flowed through this pipe and drove this turbine. Alternating current, on the contrary, is like this band, which, although swinging backwards and forwards, also turns a wheel in one direction at the other end. Now, which kind of electric current should be used for the distribution of power over *long distances?* Practically, every electrical engineer will at once reply: alternating, of course. Well I am going to preach heresy. The alternating current has undoubtedly the great advantage that a motor can be constructed with no rubbing electric contacts, every wire may be permanently soldered in position—a condition of considerable importance in dusty places like mines. Here is such a motor—the first polyphase motor ever sent from America to Europe, the first ever seen in Great Britain, constructed 17 years ago by Tesla with his own hands, when he was too poor to employ a workman.

Another advantage possessed by an alternating current is that an alternating-current dynamo can be constructed to produce a large horse-power at a high voltage; and, further, as we have already seen, this alternating voltage can be transformed into a still higher one without the use of moving machinery. This is one of the five largest dynamos in the world. Its size you can better estimate by looking at the ring on end, now projected to the left. The latter is the stationary portion of a 5,000-h.p. horizontal-shaft dynamo, whereas the photograph to the right is of a vertical-shaft machine of double that power—viz., a dynamo that can develop 10,000 h.p. at a pressure of 11,000 volts. Fifteen years ago, Ferranti—the Brunel of electricity—spent a mint of money constructing some of the parts of a 10,000-h.p, 10,000-volt alternator, which were, however, never put together. This dynamo, with its four sisters, stands complete in the Canadian Niagara power-house, and the tests already made show that its efficiency reaches the extremely high value of 98·2 per cent.—that is, 1·8 per cent. of the power developed is sufficient to cover all losses. Ferranti's dream is more than realised, and the old story is repeated. We break up the pioneer leviathan, the "Great Eastern" steamship, as a great unwieldly giant very weak in its knees, we build the "Baltic," a third as large again, and with twice the engine power. Without any transformation at all these dynamos will economically drive machines some miles away, and with the pressure transformed up from 11,000 to 60,000 volts power will be distributed in Toronto, 85 miles away from the falls. Contrasted with this, no single large *direct*-current machine has ever been constructed to generate more than about 3,500 volts, and no means is known for efficiently converting a direct-current voltage into a higher or a lower one without the use of moving machinery.

So far, then, my case seems weak! The advantages of using great electric pressures we have seen. Are there any disadvantages? This is a disadvantage, the risk of piercing the insulation! See how thick the insulating material has to be on cables, how far apart the conductors have to be placed, even when the cable is intended for only 10,000 volts. But does this consideration supply any argument for or against the use of one kind of current rather than the other? Small current and high pressure must be used for the economical transmission of power over long distances, whether the current be alternating or direct, I agree, but, ladies and gentlemen of the jury, I submit that, while from the point of view of economic transmission 60,000 volts alternating means exactly the same as 60,000 volts direct, from the point of breakdown of the insulation, 60,000 volts alternating is as bad as 85,000 volts direct—indeed, may be worse than 100,000 volts direct. For an alternating current consists of waves like the waves of the sea. In a storm the waves may be running mountains high, and yet the average depth of the sea remains the same as in a calm. But what does it benefit the poor passengers, when tossed helplessly backwards and forwards in their berths, and feebly calling "Steward," to be assured that, although the waves be peaked and the maximum elevation large, the square root of the mean square of the amplitude of oscillation is quite consistent with perfect internal tranquility? And so feels the poor insulating material—the mean electric pressure may not be very large, and yet the crests of the waves may be so high, and the troughs so low, that its strength cannot stand the electric tossing. Each of those waves of electric pressure on the diagram gives the same reading on a voltmeter, but the peaked one has far more destructive action than the flat-topped one.

But there are other disadvantages in the use of alternating current. This coil of wire represents one of the conductors which, when unwound, might join two places—the one where glow lamps, for example, have to be made to incandesce, and the other, where is the water power which drives the dynamo that generates the current. If a *direct* pressure of 100 volts be applied at one end of the system, the lamps at the other end glow brightly, as you see; whereas, if now, I apply an *alternating* pressure, although of exactly the same value, the lamps are quite dull. The explanation of this striking difference is that, in such a case, only a fraction of the *alternating* pressure is used in making the lamps glow, the remainder being employed in maintaining a rapidly reversing magnetic field. This magnetic effect—this self-inductive effect, as it is called—is small, if the going and return conductors be straight, short, and near together. But, if the distance over which the power is to be transmitted be long, the wires obviously cannot be short, and, if to obtain economy high electric pressure be used, the wires cannot be put very near together, since that would lead to a brush discharge through the air from one conductor to the other, producing leakage. Indeed, the minimum distance that must separate the conductors has to be increased very rapidly with the pressure. Table III. gives this minimum distance for conductors $\frac{1}{10}$in., $\frac{2}{10}$in., and $\frac{4}{10}$in. diameter respectively. It is to be noticed that increasing the thickness of the wire greatly diminishes this minimum. For instance, at 80,000 volts, doubling the thickness of the wire from $\frac{1}{8}$in. to $\frac{2}{8}$in. diminishes the minimum distance from 6½ft. to 13½in. It must, of course, be remembered that these are minimum distances, and that the distances apart at which the wires have actually to be fixed in practice are much greater.

TABLE III.—Johannesburg. Elevation, 5,689ft. January, 1905. Barometer, 24·3in. Temperature, 91·5deg. F. Minimum distance that must separate two parallel wires to prevent the starting of a brush discharge.

Electric pressure in volts between wires.	Diameter of wires in inches. $\frac{1}{10}$	$\frac{2}{10}$	$\frac{4}{10}$
40,000	8·8in.	—	—
50,000	32·2in.	—	—
60,000	9·9ft.	14·7in.	—
70,000	35·7ft.	33·8in.	—
80,000	—	6·5ft.	13·6in.
90,000	—	—	23·0in.
100,000	—	—	38·0in.

But that is not the whole indictment against the use of alternating current for *long-distance* transmission. Leakage from wire to wire can be rendered small, but still, if the current be alternating, it always flows along the wires, even if all the apparatus at the distant end be entirely disconnected from them. Let me show you this: I apply a direct pressure of 100 volts, and no current enters the transmission line, for it is well insulated along its length and at its ends. I apply instead an alternating pressure of the same value, without making any other change, and you observe a very perceptible current. The very first thing that struck Ferranti when he commenced transmitting power with alternating current at 10,000 volts pressure from Deptford to London was that the current flowing into the system at Deptford was as large during the daytime, when practically no lamps were turned on in London, as during the evening, when many lamps were glowing. And in the case of the 150 miles transmission at 50,000 volts by the Bay Counties Power Company, in California, it was found that to charge

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even the aerial lines as a condenser required 40 amperes, so that the current flowing into the system remained practically unchanged when the useful load was decreased from several thousand horse-power down to nought.

(To be continued.)

ELECTRICAL CONTROL OF BULKHEAD DOORS.

On the new warships of the American navy there is installed what is known as the "Long Arm" system of electrically-operated bulkhead doors and hatches. The heart of the system is the central emergency station from which the doors and hatch plates may be closed by starting the motors with which they are equipped. The working parts of the station are contained in a two-part watertight case secured to the side wall of the pilot-house or other convenient place above decks. The apparatus of the station consists of three parts: (1) the mechanism for controlling the circuits running to each door or hatch gear

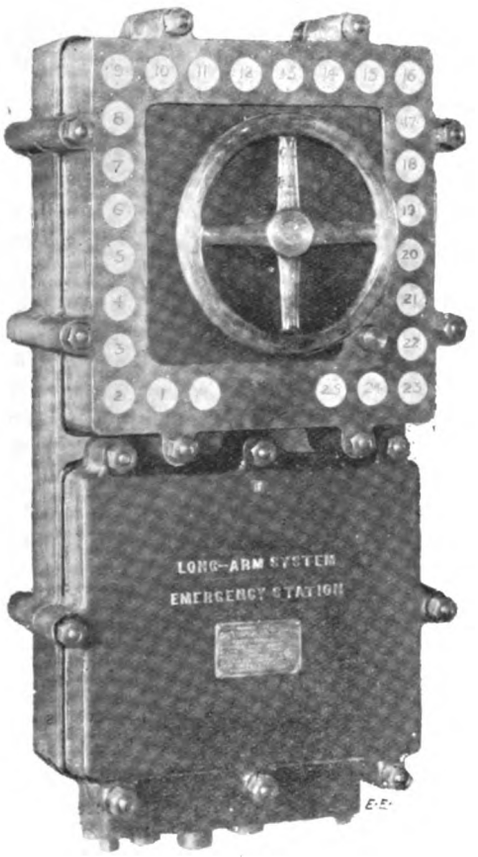

FIG. 1.—Emergency Switch Operating Gear.

for closing the same; (2) the lamps which indicate the closure of each door or hatch; (3) the fuse-box in which each entering wire is supplied with its proper fuse. The accompanying photograph shows the emergency station closed and with the protective covering removed.

To operate the emergency station, the officer in charge releases a hand-wheel (Fig. 1), which, in turn, releases a gear driven by a powerful spring (Fig. 2) and controlled by a suitable the escapement. This gearing closes the circuits for operating emergency switches located in the controller of each door and hatch gear. In performing this function the gearing does not start all the motors at the same instant, for the reason that this would demand a large supply of current from the ship's generators. It starts them one after the other at about a three-second interval, so that it rarely happens that more than four motors are in operation at any one time, although the entire closure of 24 doors and hatch gears controlled from one emergency station may be accomplished normally in about a minute and a quarter. When, however, an extremely quick closing of all doors is required, this time can be reduced to 30 seconds for 24 doors by simply using the hand on the wheel of the emergency station to hurry it; and this action does not alter the closing speed of any individual door or hatch. As each bulkhead door reaches its watertight seat, it automatically closes a circuit running to the emergency station, there connected with one of the small incandescent lamps. Transparent discs over these lamps bear numbers corresponding to the numbers of the various doors under control. The officer in charge, by pressing a button, can cause the indicator lamp of every closed door and hatch to glow, thereby assuring himself of the successful operation of the emergency action. If any door is prevented from closing by obstructions left in its path, this fact at once is apparent to the officer in charge, and no time need be lost in reaching the scene of the difficulty. The emergency station contains but one spring which furnishes the entire power for operating the device. This spring is of the helical type and of ample strength for the work it is called upon to do.

Although the experience of hard sea service has shown that the emergency station of the "Long Arm" system can

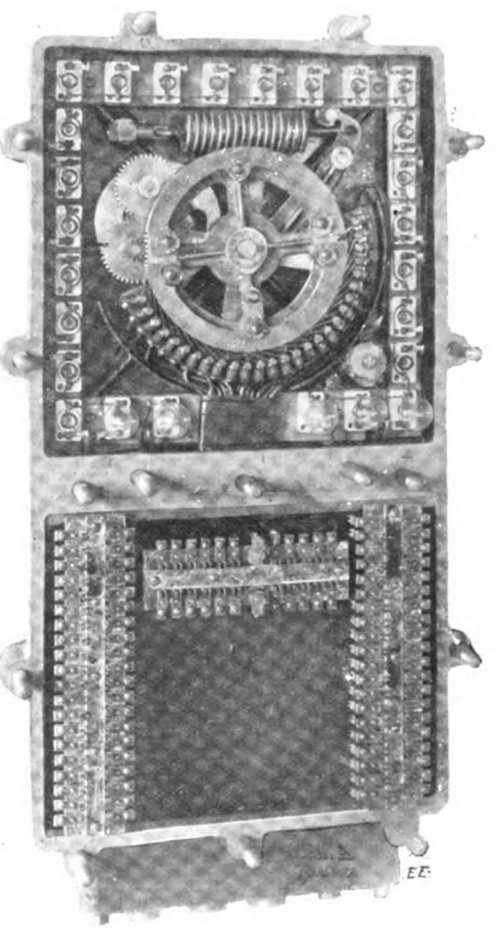

FIG. 2.—The Switchgear, with cover removed to show mechanism.

be depended upon for successful operation at all times, to guard against the possibility of failure, the mechanism can be actuated at any time by turning the hand-wheel located in front of the case should the station fail to act automatically by the power of the spring when released. During any emergency period a red indicator lamp glows continuously, so that a casual glance at the emergency station shows at once whether the emergency is "on" or "off." After a danger period is passed, and it is desired to again establish normal conditions below, the emergency may be thrown off by a hand reversal of the same operating device which is used to throw it on, so that the mechanism when not in use is always set ready to operate and always available in time of need.

TANTALUM LAMPS.—A price-sheet just issued by Messrs. Siemens Bros. and Co., Limited, York Mansion, Westminster, S.W., deals with tantalum electric glow lamps for the following voltages—viz., 50, 55, 60, 65, 75, 100, 105, 110, 115, 120, and 125—and candle-powers ranging from 10 to 25. The efficiency claimed is very high in comparison with the ordinary type of glow lamp, and is shown to more than compensate for the greater first cost.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE EXHIBITION.

Some of us, unfortunately, are able to speak from personal knowledge of the first great international exhibition held in 1851—a lifetime since. Electrical apparatus was not unrepresented then, but that which created wonder in 1851 has long since passed into the limbo of the forgotten. The decade following was an active one in electrical investigation, but in that great exhibition in the early sixties nothing hardly was exhibited which has persisted. In fact, not till the Paris Exhibition of 1878 did we really enter into what may be called the electrical era, and then only a dawn which revealed little or nothing of what would happen in 1881. The exhibition in that year—1881—was also held in Paris, and proved that the dawn of 1878 would usher in a brilliant and world-changing era. The idea of international exhibitions was originally a double one—ostensibly for education, practically for advertisement. The educational fallacy died a lingering death; indeed, sometimes it seems only moribund, and a whisper is heard that the aims of exhibitions are still mainly educational. That is an impossibility. Exhibitions always have been and always will be mainly for business purposes, and we welcome all the more heartily the exhibition to be opened at Olympia next Monday because its promoters are honest. We welcome it also because they are clear-sighted, earnest, painstaking, and energetic. They saw what was required, and they have not spared themselves in order to get it. In what may be termed the transition period—that is, the time between State-aided exhibitions and the really commercial thing—there have been a number of so-called exhibitions which we always considered were valueless for any good purpose. The present exhibition we recognise as the "real thing"—organised by business men for business purposes, and not run with State money for the private glorification of half a dozen officials. The general public, even with all the literature at its command, does not know and has not the faintest conception of the ramifications of electricity. The expansion in the use of electrical apparatus since 1881 is to the uninitiated one of the greatest wonders that has ever happened in the history of this world. The adoption of steam was slow compared with it. Electrical energy is being used over so widely a diversified field that its uses can hardly be enumerated, and it seems difficult to imagine where its utility will cease. This exhibition, if only its promoters succeed as well as they hope and ought to succeed in inducing the public to visit, will do more good to the industry than all the exhibitions that have gone before, for applications of the wizard power will be seen that will appeal as well to the meanest as to the most educated "imaginations." We well remember the scorn with which Sir W. H. Preece's statement that the electric lamp was the poor man's light was met. He, when he said this, saw far ahead, and, though the prophecy is not yet completely realised, a good many thinkers have recognised its underlying truth. When Volk, at Brighton, built an electric motor carriage and a little railway, few realised the development that would ensue within twenty years of that date. At this moment scarcely any proposition put forward by prominent electrical engineers concerning power distribution for traction or other purposes would meet with a single doubter. Indeed, prophets in increasing numbers are indicating that steam-engines will ere long be entirely superseded by electrical apparatus. All the newest applications and all the newest developments will be seen at Olympia, though it may be expected that the heavier machinery for power purposes will have to be taken some-

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what on trust. The greatest display will probably be of all that class of apparatus which will appeal to the general householder, and which will show him a hundred directions in which he may utilise current and introduce improvements. It is to be noticed that an excellent series of lectures descriptive of special phases of electrical work will be delivered by experts. These lectures should appeal to the public desirous of becoming acquainted with the subject. We sincerely wish the exhibition success.

STREET-LIGHTING.

The Croydon street-lighting report and the answer to the same by the local gas companies afford both useful and amusing reading. The later effusion clearly shows that the gas companies have acknowledged themselves beaten on their favourite ground, which is that of supplying the cheaper light. The flame arc lamps have effected this change of front, and now the companies decry the value of photometric tests. The alternatives offered are two: one, to compare the total cost of lighting a mile of street irrespective of the light provided; and the other is "a man's own test—that is to say, for a person to himself ascertain which illuminant is the best to see by." This quotation from the speech of a strong anti-electric advocate is valuable or otherwise according to what is read into it. Literally it is as valuable as a "woman's own test," in which opinions rather than facts rule the decision. The gas companies' figure as to the cost per mile of street is equally valueless, as it makes no distinction between the different class of the streets or the lighting provided. On this standard the Corporation of Croydon will be well advised to discard both gas and electric lighting, as luminous paint applied to the existing lamp-posts will cost much less than either illuminant, and will indicate the directions of the roads quite as well as some of the existing gas lamps. The final remarks as to the profits to be made by the Corporation hint that street-lighting is being supplied at a loss. This is denied by the Corporation, but we know of several cases where the gas authorities offer an unprofitable price to secure street-lighting. In business operations such offers are as well understood as is the present proposal by the Croydon Gas Company for experimentally lighting certain streets. We hope these experiments will be made, and that accurate records of cost and illumination will be kept from these and similar experiments with the latest forms of electric lighting. Then there will be no need for lobby work to decide as to the method by which the Croydon street-lighting shall be improved.

THE OLYMPIA ELECTRICAL EXHIBITION.

The arrangements in connection with the approaching exhibition are now nearing completion, and it is evident that, both from the magnitude and representative character of the exhibits, the exhibition will do credit to the industry it represents, and doubtless the result will be beneficial to the whole profession and to those indirectly connected with electrical engineering. The president of the exhibition, Sir Wm Preece, being unfortunately abroad, the Lord Mayor and Sheriffs, who will attend in state for the opening ceremony, will be welcomed at the entrance by the chairman of the executive committee, Mr. E Cunliffe-Owen, together with the other members of the executive; the City dignitaries will then make a brief inspection of the exhibits, and the Lord Mayor will then in a few words declare the exhibition open. The inaugural lunch will follow, to which the Lord Mayors of York, Liverpool, Manchester, and Birmingham, the Mayors of the metropolitan boroughs, and a large and distinguished company have been invited. The management are leaving no stone unturned to ensure everything being in readiness by the time of the opening, and they are being well backed up by the exhibitors, who in many cases find it necessary to work night and day in consequence of the elaborate preparations necessary in the way of foundations. Of the exhibits themselves we shall, of course, have a good deal to say in succeeding issues.

The syllabus of lectures arranged by the Institution of Electrical Engineers is as follows: Tuesday, Sept. 26, open; Friday, Sept. 29, "Wireless Telegraphy," by W. Duddell, member of Council I.E.E.; Tuesday, Oct. 3, "Development of the Use of Electric Motors," by Colonel Crompton, past-president I.E.E., M.I.C.E.; Friday, Oct. 6, "Domestic Lighting," by J. Swinburne, past-president I.E.E, M I C.E.; Tuesday, Oct. 10, "Meters," by S. Z. de Ferranti, vice-president I.E.E., M.I C E.; Friday, Oct. 13, "Telegraphy" (ordinary), by A. Martin; Tuesday, Oct. 17, "Arc Lighting," by Mrs. Ayrton, M I.E.E; Friday, Oct. 20, "Telephones," by F. Gill, member of Council I.E.E. In connection with the cooking utensil competitions, the executive committee have decided to allot the sum of £100 as prizes, to be appointed as under: for the best group of cooking apparatus on exhibit, first prize £50, second prize £20; for the best single piece of cooking apparatus on exhibit, first prize £20, second prize £10.

The number of firms who lay themselves out specially for this class of business is necessarily limited, but we are informed that the entries comprise the best makers, and that some novelties may be expected which will be of considerable interest. A portion of the building has been specially set apart as a kitchen, where an experienced lady lecturer will give practical demonstrations of cooking by electricity, ample accommodation being provided for the general public to witness the proceedings. This will undoubtedly form one of the most interesting features of the exhibition.

In the galleries (to which special access has been provided by means of a lift on each side of the centre of the ground floor, which has been erected as a working exhibit by the Easton Lift Company) will be shown the General Post Office exhibit, the Marconi stand, and a large number of interesting trade exhibits, including several rooms which will be wholly devoted to a display of fittings suitable for drawing-room, dining-room, etc. The Guards' bands will also perform from a specially erected stand in the centre of one of the galleries.

AUSTRALIAN TRADE MARKS.

We learn from Messrs. W. P. Thompson and Co., patent agents, Liverpool, that the new Australian Trade Marks Bill introduced by the Commonwealth Government is in many important respects similar to the new English trade mark law, amended slightly to suit Australian institutions. There are, however, the following special points in it. The proprietor of a trade mark registered in any State of the Union before the commencement of this Act is entitled to have his mark registered for the whole of Australia, but subject to the rights of other users or proprietors of a similar mark in any of the other States of the Union, and provided it could at the time when the Act came into force have been lawfully registered in the Australian State in which the trade mark was then registered and in use. If a mark has been publicly used by more than three persons or firms in any one State of the Union as a mark in connection with similar goods, it shall be held to be common to the trade, and, therefore, not registrable. There is a special section on trade union marks, by which any trade union of workmen or employers registered under any law of the Commonwealth or of any State may register a mark as a trade union mark, only to be used by members of that trade union, and any person wilfully infringing the same is liable to a penalty of £50. A clause is inserted by which Australia can enter the International Union for the protection of patents and trade marks. The measure appears to have been drafted upon comprehensive lines, and it is expected to be passed this session practically in its present form, as it meets with general approval.

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ELECTROMOTORS LIMITED NEW BRUSH-HOLDER

In spite of the large number of brush-holders which have been introduced since carbon brushes have been in vogue, Electromotors Limited have succeeded in designing a new patent brush-holder which contains several novel and useful features. This holder we are illustrating herewith, as the details will be of

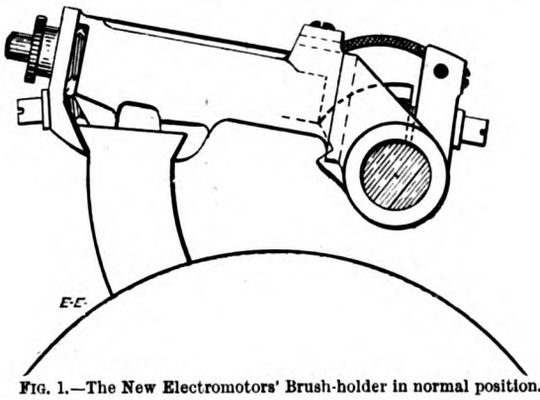

FIG. 1.—The New Electromotors' Brush-holder in normal position.

interest to all electrical engineers. We show the holder in Fig. 1 in its normal working condition with a new brush in position on the commutator. In Fig. 2 the brush-holder is withdrawn from the commutator, and a few more details of its construction are indicated. The detailed parts of the holder can be seen in Fig. 4, which is a photograph of the same arranged to show the position they occupy in the completed

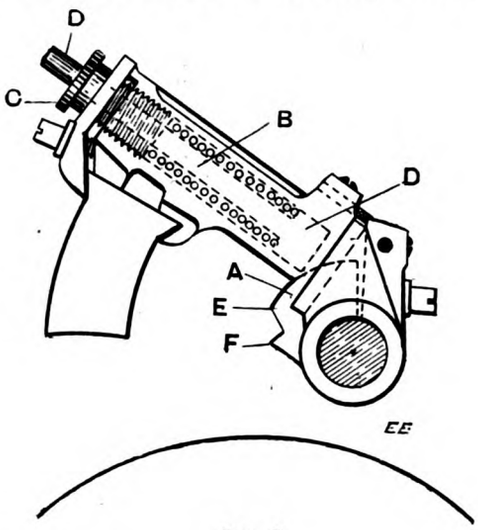

FIG. 2.

holder. Fig. 3 shows how much a brush can be worn down before it needs to be replaced. Following the construction through in detail, it will be seen that a fixed cam, A, is fastened on to the brush handle spindle by means of a screw. The arm of the brush-holder, which revolves radially round the spindle, contains a cartridge-shaped portion, B, in which there is a plunger, which is forced by a spring against the face of this

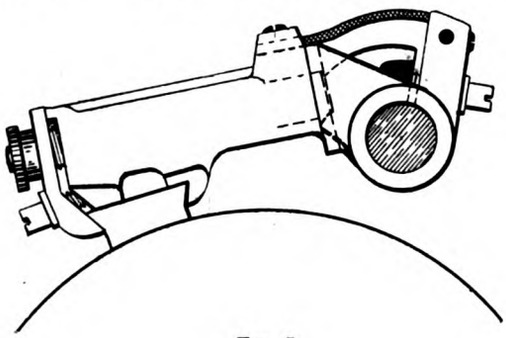

FIG. 3.

cam. This spring is worked in compression, in contradistinction to the majority of brush-holder springs now in use. Also the spring is completely enclosed within the brush arm instead of being below the arm, and in a position which may involve the parts of the spring falling against the commutator should it, or its attachments, break. The compression on this spring, which regulates the pressure of the carbon brush on the commutator, is adjusted by means of the milled head of the hollow screw, C, which also forms a guide for the stem of the plunger, D. In the normal working position and throughout the range of motion equivalent to the wear of the brush, the plunger, D, is bearing against the corner, E, of the cam. It moves slowly down this as the brush wears, and finally reaches the stop, F, which acts as a lock and prevents the brush holder from touching the com-

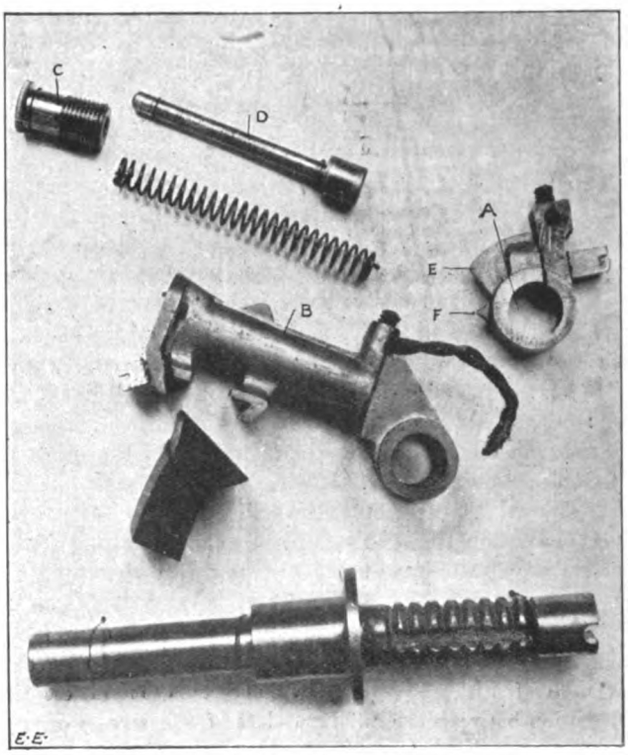

FIG. 4.—The Component Parts of the New Brush-holder.

mutator. This is the valuable feature of the design. If pulled pulled back from the commutator, the brush-holder revolving round the spindle brings the plunger over the point, E, of the cam, and then there is no tendency for it to move back again. This rounded portion of the cam thus holds the brush in the off position, but there is no locking device to be felt for

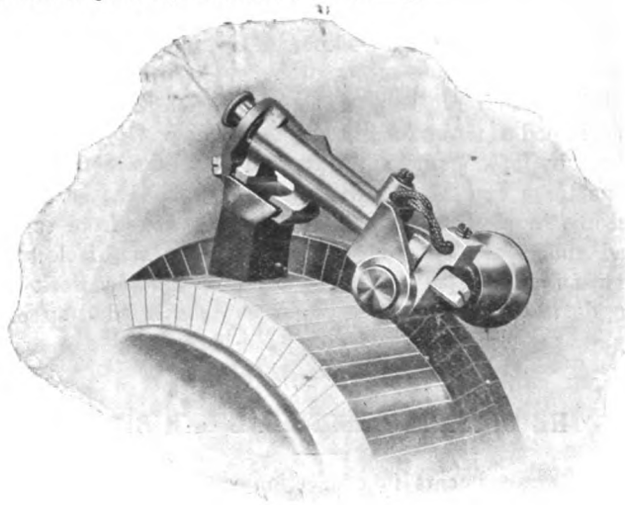

FIG. 5.—View of the Complete Holder.

when the brush has again to be put on to the commutator. It is sufficient instead to move the brush forward until the plunger slides over the corner, E, and brings the holder into effective use. This is a valuable feature where motors have to be handled by unskilled labour, as brush-holders are frequently damaged by being forced on without an attempt to release the locking-off device. It will be seen that the carbon brush is gripped in an efficient clamp by a single screw which is situated near the milled head, which adjusts the pressure of the brush. This is also convenient for an enclosed type of motor, and is superior to the arrangement which involves the pressure adjusting being done from the back and the clamping of the brush from the front of the holder. The carbon brush is so designed that its position on the commutator is not varied by wear. Finally, the working parts of the brush-holders are few, and they are entirely

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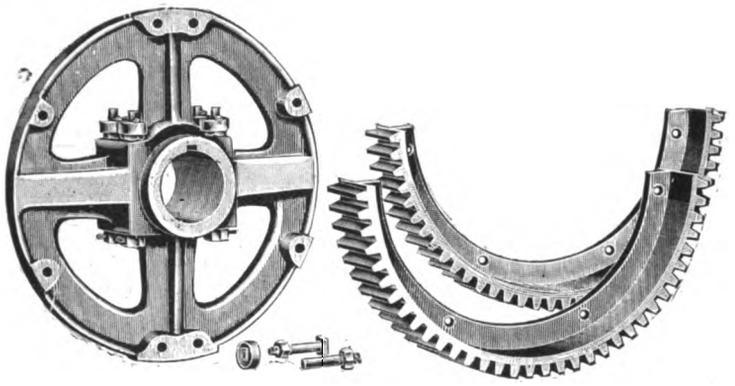
enclosed and protected from dust, which two points should ensure a freedom from the troubles often found in the sliding carbon type of brush-holder. There are other advantages in this brush-holder which will commend themselves to those responsible for the upkeep of continuous-current motors, which will be readily seen from the accompanying illustrations. Amongst these is the fact that the holder will work without adjusting or attention for a period equal to the whole life of the carbon brush. Should it be left too long without attention, the brush-holder will not come down on to the commutator and score the same, as too frequently happens with other holders. The firm are using this brush-holder on all their motors, and are showing the same on the "Electromotors'" stands at the Olympia Exhibition next week. The holders are protected by patents in foreign countries as well as in Great Britain.

TRADE NOTICES AND NOVELTIES

Gear Wheels with Renewable Rims.

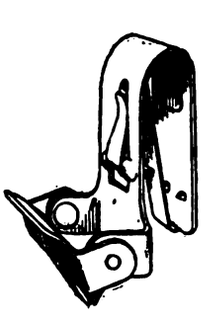
The Electrical Company, of 121-125, Charing Cross-road, W.C., are putting on the market a line of gear wheels with renewable rims, which should be found extremely serviceable in electric traction. As will be found from the illustration below, the rim is made in two halves, which are securely bolted to the hub of the wheel. This hub can either be one casting pressed upon the axle, or it can also be in halves as shown in the illustration. In the latter case the joints in the rim are placed at an angle 90 deg. apart from the joints in the hub. By using the split gear rims the time required to change the wheel is very much reduced; the makers also claim a considerable increase in the strength, thus, whereas the average tensile strength of cast steel is 28 to 30 tons per square inch, the rims can be made of a much stronger material. For this purpose first-class Siemens-Martin steel with a tensile strength of from 38 to 46 tons per square inch is used. It is evident from this that the rims and teeth must be far superior to those of ordinary cast steel. Again, when replacing the cost of a rim itself is considerably lower than that of a complete cast-steel gear wheel, which allows a considerable financial saving from the use of renewable rims. The firm have offered to let us have samples of these wheels in our office to try, but we have not accepted the same for want of testing facilities and space. We feel sure, however, that tramway engineers will receive equally courteous offers from the company.



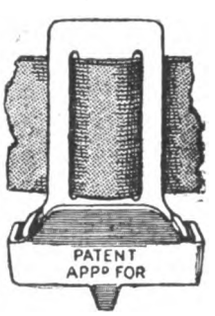
Gear Wheels with Renewable Rims.

A Useful Tool Carrier.

We have had brought to our notice an ingenious plier and tool carrier which is being introduced by Messrs. Alfred Castell, Gibb, and Co., 247, St. John-street, London, E.C. This little device not only carries the tool, but also guards it from accidental loss. In other words, any tool entrusted to the "Ideal" carrier is securely locked in position, but can be instantly released when required for use. Wiremen, especially, should welcome this carrier, which will thus enable them to have their pliers ever ready to hand. Accompanying are illustrations of two of the several patterns made, one being designed for use with a belt, and the other for hooking on to the pants of the wearer.



Tool Carrier for Fixing Direct.



Tool Carrier for Belt.

Switchboard Instruments.

Messrs. Siemens Bros. and Co., Limited, York-mansions, London, S.W., have just issued a comprehensive price list of their switchboard instruments and accessories. This list is divided into five parts, comprising electromagnetic instruments, moving-coil instruments, Ferraris instruments, instrument transformers, and various special instruments and accessories respectively. The electromagnetic instruments are intended for general switchboard use. They are practically dead beat. The moving-coil instruments are, of course, intended for use with continuous current only, and the types comprise flush cases and watertight cases, edgewise dials, and specially large circular dials. A large range of shunts for use with the ammeters is also listed. Other special instruments of the moving-coil type are combined ammeters and voltmeters (see the accompanying illustration Fig. 1) for searchlights and automobiles, and wattmeters built on the dynamometer principle. Ferraris instruments, for alternating currents only, are built on the well-known rotary field principle, and ammeters, voltmeters, and wattmeters are listed in a large number of sub-types, as is also the case with the moving-coil instruments. A special feature is made of wattmeters for three-phase currents with branches unequally loaded. A special type of universal station instrument is shown with dial 21in. in diameter, for reading station volts, amperes, and kilowatts. Current and voltage transformers are listed in a variety of types for working pressures from 1,000 to 50,000 volts. The special instruments comprise current-directing indicators, earth indicators, ohm-meters, voltage and power relays, and a safety relay for breakages of three-phase overhead lines. The last-mentioned device, the connections to which are shown in Fig. 2 herewith, is used in connection with high-tension three-phase installations for the purpose of completely breaking the circuit if a conductor falls at any distant point. This is achieved by the closing of the local circuit of an automatic cut-out which breaks the high-tension circuit feeding the fallen wire. The device has the advantage that it only comes into operation through the breaking of a conductor, and not under any other conditions, as, for example, by the reduction of the load below a specified point, or through unequal balancing (up to about 30 per cent.) of the load of the three separate conductors. It is similar in construction to the Ferraris measuring instruments, and consists essentially of a ring-shaped core carrying the coils, and whose three poles are in part provided with the necessary short-circuited windings; also a light revolving metal drum, on the axis of which a contact lever is secured for closing the exciting circuit. The windings round the three pole-pieces are connected to the mains through three current transformers. The operation

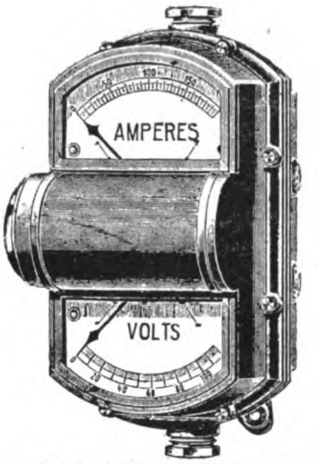


Fig 1.—Combination Instruments.

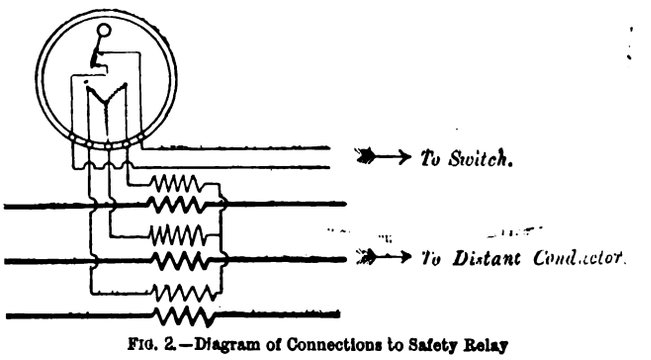


Fig. 2.—Diagram of Connections to Safety Relay

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of the safety device is principally due to the fact that under normal working conditions the three-phase current produces a turning moment on the drum of a definite value, which is slightly greater than the sum of the separate turning moments which are produced by the short-circuited windings, but which have a value of opposite sign. Consequently the drum with the contact lever moves in accordance with the direction of the three-phase field until contact is made, and remains in this position. When a break occurs in a conductor, the turning moment of the three-phase field disappears, whilst that which is produced by the short-circuited winding immediately comes into operation; consequently the drum with the contact arm turns backwards and closes an exciting circuit connected to an automatic cut-out device of the high-tension switch in the main circuits, which are in this manner disconnected. As little as 3 per cent. of the normal current will serve to operate this relay.

"Duplex" Tumbler Switch.

From Mr. A. P. Lundberg, Pioneer Electrical Works, London, N., we have a sample and particulars of his "Duplex"

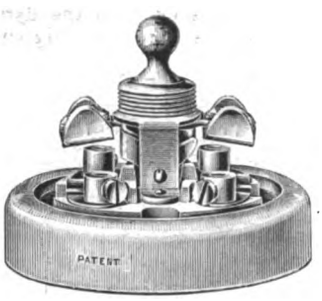

FIG. 1.—"Duplex" Tumbler Switch—Both Contacts "off."

tumbler switch, the most ingenious device of its kind we have seen for a long time. This switch is of the two-way type, with "off" position, all the positions of the knob being exceedingly well defined. A single spiral spring is used, which ensures equal tension on both contact arms. The action of the switch may be explained with the aid of the accompanying illustrations. Fig. 1 shows both contact arms in their "off" positions, while Fig. 2 shows contact arm A "on" and B "off." Referring to Fig. 2, it will be seen that when pin, I, of knob, H, is resting on its step on contact arm A, the horn of contact arm B locks B in its "off" position, as it is unable to pass by I until the

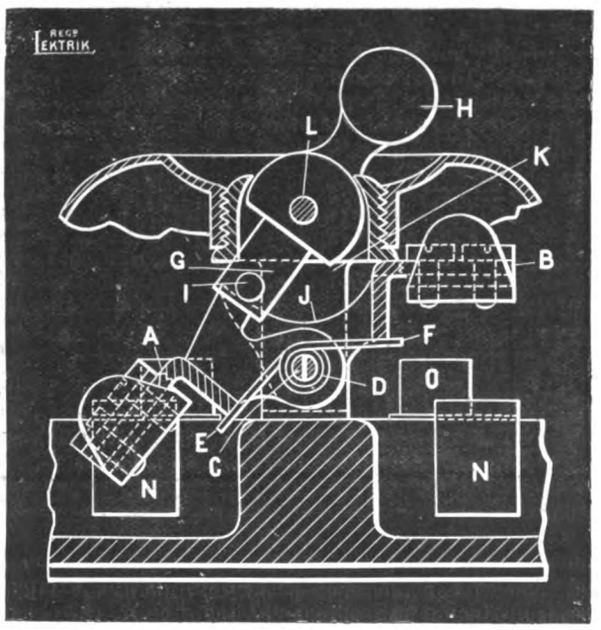

FIG. 2.—Diagram showing Action of "Duplex" Tumbler Switch.

knob, H, is moved; thus A is locked "on" and B "off." As the two contact arms, A and B, are identical in shape, a similar action results when B is "on" and A "off." F is the double-action spiral spring. Whether regarded from a mechanical or an electrical point of view, the design and construction of this switch seem equally satisfactory. Some of its many useful applications are illustrated in a descriptive pamphlet just issued by Mr. Lundberg. These include tramcar lighting, controlling a two-filament lamp, intermediate wiring, controlling arc lamps, etc.

Eversheds Leakage Indicator.

From Messrs. Evershed and Vignoles, Limited, Acton-lane Works, Chiswick, W., we have particulars of a leakage indicator for direct-current two-wire wholly-insulated circuits, which has been devised by them to fulfil as nearly as possible the requirements of the Home Office Rules for the use of Electricity in Mines, Section I., Clauses 6 and 7. The system, which is pronounced satisfactory by the Home Office, provides (1) a continuous indication of any inequality in the insulation of the mains; (2) means of determining in an instant the absolute value of the insulation of each main; (3) means of obtaining the value of the leakage current by a simple calculation. When the instrument in question is connected as shown in Figs. 1 and 2 herewith, the pointer will then rest in the middle of the scale if the insulation of the two mains be sensibly equal (see Fig. 2). But should an earth develop on either, the pointer at once deflects, and shows by the direction of its deflection on which main the failure has occurred. This indication may be supplemented by a bell if required to call the attention of the switchboard attendant. In order to find the absolute value of the insulation of each main, first the + and then the − key must be depressed, and the positive and negative deflections in degrees noted. From these two readings the value of the insulations may be seen instantly by the use of the table supplied with the instrument. Thus, if the + reading be 4

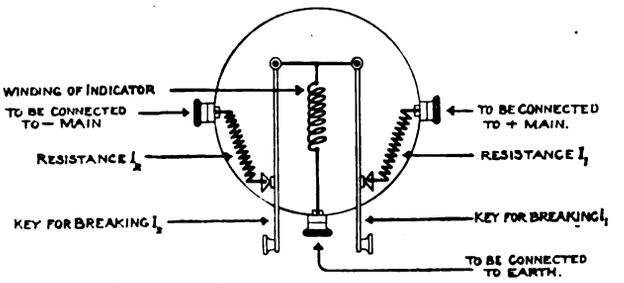

FIG. 1.—Evershed's Direct-Current Leakage Indicator—Internal Arrangement,

and the − reading 10, the insulation of the + main is 150 and of the − main 60 thousand ohms. The leakage current in milliamperes is calculated by dividing the voltage of the circuit by the sum of the figures obtained by the test (in thousand ohms). Thus:

$$\text{Leakage current in milliamperes} = \frac{\text{Volts}}{\text{Sum of insulations (in thousand ohms)}},$$

and, therefore, in the above case with a 500-volt circuit:

$$\text{Leakage current in milliamperes} = \frac{500}{150+60} = \frac{500}{210} = 2\,4.$$

Since the rule lays down that the leakage current shall not exceed one thousandth of the maximum supply current, it follows that the number of milliamperes of leak must not exceed the number of amperes of the maximum supply. Thus, if the full-load current be 500 amperes, the leakage current must not exceed 500 milliamperes. Any leakage beyond the

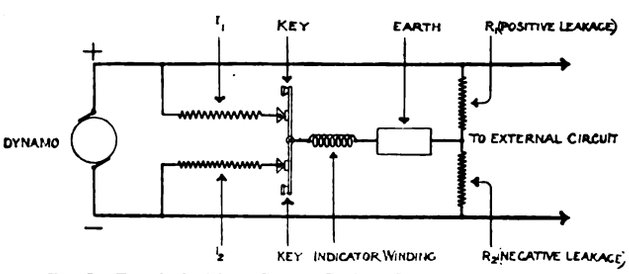

FIG. 2.—Evershed's Direct-Current Leakage Indicator connected as Continuous Alarm.

limits allowed must be located and remedied. Messrs. Evershed and Vignoles recommend the use of their now well-known "Megger" for this purpose. The introduction of leakage indicators is yet one more proof that necessity is the mother of invention, and it reflects great credit on instrument makers that they have been found so ready to meet requirements.

Veritys' Ventilating Department.

Messrs. Veritys Limited announce that they are opening a ventilating department at each of their various branches. This department will deal in "Aston" ventilating fans and blowers, and its services will always be available to the electrical trade where advice is required as to the best means of ventilating buildings and applying forced and induced draught. The department is under the superintendence of Mr. Oswald Stott, who has made a study of this work, and who has had great experience in the manufacture and application of blowers and fans.

Catalogues, etc., Received.

PATERSON PLANT.—A special leaflet which is being sent out by the Paterson Engineering Company, Limited, Amberley

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House, Norfolk-street, Strand, W.C., illustrates their gravity and pressure filters, softeners, heaters, and grease eliminators. Paterson plant has not been very long on the market, but the list of users is already a lengthy one, and may be taken as a measure of its recognised merit.

ACCUMULATORS. — Portable Accumulators Limited, King Edward's-mansions, 210, Shaftesbury-avenue, W.C., have sent us a copy of their price-list of single cells and complete batteries in glass, ebonite, or celluloid boxes, fitted with low discharge plates of the pasted type.

SIMPLEX CONDUIT.—From the Simplex Steel Conduit Company, Limited, Westinghouse building, Norfolk-street, Strand, W.C., we have a copy of a new price-sheet, which gives in a condensed form most of the prices contained in their 1905 catalogue. This list has been compiled to meet the wishes of the firm's customers for a compact and legible sheet which can be hung up in the office or folded for the pocket.

COLWYN BAY ELECTRICITY ACCOUNTS.

The accounts of the Colwyn Bay and Colwyn electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £21,032. Abstracts of the revenue account, etc., are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	1,065	3	2
Distribution of electricity	40	13	5
Attending and repairs to public lamps	114	3	6
Rents, rates, and taxes	125	1	6
Management expenses, salaries, etc.	248	10	0
Special charges, insurances, etc.	13	16	3
	1,607	7	10
Amount carried to net revenue account	1,283	14	3
	£2,891	2	1

Cr. Income.	£	s.	d.
By sale of current, etc.	2,701	6	10
Rental of meters	38	17	0
Sale and repairs of lamps, etc.	148	6	1
Fees for testing, etc.	2	12	2
	£2,891	2	1

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	19,714	0	0
Sundry creditors	81	17	2
Balance at credit of net revenue account	860	8	10
Depositors	28	0	0
Treasurer—capital and revenue accounts	1,436	2	11
	£22,120	8	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	21,032	7	9
Stores on hand	108	16	0
Sundry debtors for current supplied	979	5	2
	£22,120	8	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			175,836
Quantity sold — Private lighting	114,281		
Quantity sold — Public lighting	26,506		
Quantity sold — Prepayment meters	2,907		143,694
Quantity used on works			4,909
Total quantity accounted for			148,603
Quantity not accounted for			27,233
Number of public lamps (arcs)			33
Maximum supply demanded (kilowatts)			456

WIMBLEDON ELECTRICITY ACCOUNTS

The accounts of the Wimbledon electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £136,098. Abstracts of the revenue account, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	6,793	19	2
Distribution of electricity	106	2	8
Attending and repairs to public lamps	552	3	8
Rents, rates, and taxes	563	3	7
Management expenses, salaries, etc.	1,655	17	11
Special charges, insurance, etc.	135	13	8
Law and parliamentary charges	65	7	9
	9,972	8	5
Amount carried to net revenue account	10,647	2	4
	£20,619	10	9

Cr. Income.	£	s.	d.
By sale of current to private consumers by meter	13,778	18	6
Ditto for public lighting	6,010	8	6
Rental of meters and other apparatus	702	16	0
Sales and repairs of apparatus	15	10	7
Repairs to damaged street lamps and alterations	35	0	0
Sale of coal and clinker	68	8	2
General establishment charges, etc.	8	9	0
	£20,619	10	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	134,006	5	3
Sundry creditors	531	17	11
Reserve fund account	3,493	12	6
Due to treasurer on revenue account	5,820	13	8
	£143,952	9	4

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	122,506	3	3
Securities held, cost price	3,450	0	0
Stores on hand	162	15	8
Sundry debtors for current supplied, etc.	5,820	13	8
Cash with treasurer and in hand	12,013	16	9
	£143,952	9	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,499,968
Quantity sold — Private consumers by meter	801,459		
Quantity sold — Public lamps	507,769		1,309,228
Quantity used on works			29,982
Total quantity accounted for			1,339,210
Quantity not accounted for			160,747
Maximum supply demanded (kilowatts)			1,012

Number of public lamps: 42 arcs, 1,059 incandescents.

LEYTON ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., by the Leyton electricity department for the year ending March 31, 1905. The total capital expenditure to end of past year was £146,456.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5,454	10	1
Distribution of electricity	349	2	11
Attending and repairs to public lamps	1,337	17	6
Rents, rates, and taxes	420	0	8
Management expenses, salaries, etc.	1,416	14	3
Insurance, bad debts, etc.	272	12	8
Law and parliamentary expenses	2	1	0
	9,252	19	1
Amount carried to net revenue account	10,141	5	1
	£19,394	4	2

Cr. Income.	£	s.	d.
By sale of current per meter	13,505	5	11
Public lighting	5,138	12	5
Rental of meters and other apparatus	439	12	1
Profit on repairs and work done	149	5	4
Rents receivable	10	10	6
Bank interest on deposit account	6	19	2
Sale of old material	143	18	9
	£19,394	4	2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	145,478	0	0
Sundry creditors	876	5	3
Amount due to treasurer	768	15	7
Self insurance fund	451	0	0
Consumers' deposits	553	4	3
Amount advanced from general district rate	12,110	8	6
	£160,237	13	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	146,456	5	1
Sundry debtors for current supplied, etc.	5,821	6	9
Stores on hand	347	6	0
Cash in hand	625	0	0
Net revenue account	6,987	15	9
	£160,237	13	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,590,670
Quantity sold — Private consumers	854,714		
Quantity sold — Public lamps	504,083		1,358,797
Quantity used on works, etc.			85,453
Total quantity accounted for			1,444,250
Quantity not accounted for			146,420
Maximum supply demanded (kilowatts)			917

Number of public lamps: 75 arcs, 989 incandescents.

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GLASGOW TELEPHONE ACCOUNTS.

The telephone department of the Glasgow Corporation has recently issued the accounts for the year ended May 31, 1905, from which it appears that the total expenditure on capital account to that date amounts to £350,273. Abstracts of the revenue account, balance-sheet, etc., are appended.

BALANCE-SHEET.

Dr. Expenditure.	£	s.	d.
Inspection and repairs account—wages, materials, etc....	8,958	5	0
Reconstruction account—wages, materials, etc.....	313	12	8
Post Office commission account.....	27	15	4
Post Office royalty account	5,538	15	5
General expenses, salaries, wages, and allowances.....	12,991	18	9
Printing, stationery, and advertising	1,183	15	9
Rents, rates, and insurance	4,626	1	4
Fuel and light	351	7	11
Terminal fees paid and outstanding.....	673	18	4
Trunk and terminal fees written off.....	14	17	9
Balance carried to net revenue account	20,746	0	6
	£55,426	8	9

Cr. Revenue.	£	s.	d.
Exchange rentals account	52,038	10	2
Private rentals account	1,013	5	1
Local tolls received and outstanding	228	5	2
Public telephones account—fees collected	1,137	8	1
Shifts and sales account.....	280	5	5
Post Office commission account.....	142	3	7
Directory insertions received and outstanding	69	11	0
Commission received on insurance	20	6	10
Terminal fees received and outstanding	473	17	1
Trunk and terminal fees recovered	17	16	4
	£55,425	8	9

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Amount of capital account.....	350,273	16	10
Stores	7,686	6	1
Tools	1,508	19	3
Stationery.....	72	3	11
Insurance	85	10	3
Fire-escape suspense account.....	42	0	0
Change of system suspense account	60	10	6
Sundry debtors for exchange rentals, etc.	4,789	2	7
Union Bank of Scotland.....	1,067	13	3
Cash in hand	56	1	2
	£365,642	3	10

Cr. Assets.	£	s.	d.
Corporation of Glasgow loans fund	302,936	13	4
Sinking fund	26,163	6	8
Retention account	498	0	0
Sundry creditors	4,399	6	2
Unpaid interest	409	9	0
Unpaid Post Office royalty.....	987	10	11
Unpaid terminal fees	74	13	9
Wages, etc., payable	283	14	6
Rental suspense account.....	22,641	16	1
General depreciation fund	7,247	13	5
	£365,642	3	10

SWITCHROOMS AND STATIONS IN OPERATION.

Switchrooms in operation.....	20
Direct lines to the exchange, unlimited.....	8,563
Direct lines to the exchange, toll	348
Party lines	289
Public telephones	362
Service telephones.....	72
Extensions outside	1,013
Extensions inside	1,270
Private lines	408
Sundry lines	37
Junction lines	910
Mileage of metallic circuits.....	20,798

APPOINTMENTS VACANT.

Electrical Fitter and Repairer, West Africa. Salary, £20 per month. See advertisement.

Estimating Clerk for electric cable manufacturing company. Applications to Cable, *Electrical Engineer* Office.

Charge Engineer, Willesden Urban District Council. Salary, 35s. per week. Applications by Oct. 4. See advertisement.

Winders for direct-current and alternating-current work. Apply to Bruce Peebles and Co., East Pilton, Edinburgh. See advertisement.

Engineering Instructor, the Technical Education Board of Wellington, New Zealand. Salary, £300 and £40 passage allowance. See advertisement in last issue.

Assistant Engineer to act as station superintendent at one of the Edinburgh Corporation's electric generating stations. Commencing salary £180 per annum, rising to a maximum of £270 per annum. Applications by Oct. 2. See advertisement.

ELECTRICITY v. GAS FOR STREET-LIGHTING.

The Croydon Fight.

We have referred several times to the attempts being made at Croydon to discredit the electric lighting of the streets, and in view of the most recent move by the gas companies think it well to reproduce in full the report of the Lighting and Electricity Committee on the matter. The report is dated July 13, and reads:

In accordance with the resolution of the Council passed at the meeting held on May 15, 1905, the committee submit the following report:

THE QUESTION OF REVERSION TO GAS IN OTHER TOWNS.

1. A large number of inquiries have been sent out by the committee, and the inquiries and answers have been tabulated.

2. With the exception of one district in London, where high-pressure gas is being used, no town appears to be reverting to gas, and in this case gas has not superseded electric lighting by arc lamps. On the other hand, the committee find that lighting by electricity is considerably on the increase, and several towns have now no gas lighting in the streets. In reference to Paris the committee find that electric lighting is not making satisfactory progress. It has been found that the prices charged are very high, and as the concession for electric lighting expires in two or three years, when the electricity company have to hand over their entire property to the Municipality without payment, it can hardly be expected that much progress will be made until a new order of things is established.

3. With reference to the city of London, the committee have made careful inquiry on the reported reversion to gas by the City, and find that the City Council have decided to light the following streets by gas—viz.:

4. Queen Victoria-street, part of Queen-street, and Fleet-street. The chairman of the committee stated (*Electrical Engineer*, May 12) that these three schemes were in the nature of an experiment, and nothing further would be done until they were thoroughly tested.

5. The committee cannot discover that there has been any attempt to compare the proposed gas lighting with the more modern systems of electric lighting. The comparison was made (*Electrical Engineer*, May 12) between the suggested gas lighting and the existing arc lamps. The committee consider this a most unreasonable basis on which to make a comparison. It is well known that the existing arc lamps were some of the earliest erected in the country, and the lanterns about as unsuitable as could have been chosen. There are now two electric supply companies competing in the city of London, and the relations between the original company and the Corporation have not been altogether of a harmonious nature. The committee, as a result of enquiries, believe that they are correct in stating that neither electric supply company were asked to submit a formal tender for comparison as to the cost of street-lighting, and under the circumstances, and apart from the fac that the present installation is an experimental one, they do not consider that any importance whatever can be attached to the action of the City Corporation. Taking the estimated cost of the alteration at £2,042. 5s., and the saving anticipated at £323. 11s., it will take 6½ years to repay the initial cost. The committee suggest that the price of £26 per arc lamp would have been considerably reduced on a new tender, and the amount of light increased several fold.

Summary of Particulars relating to Street Lighting in 1894.

Type of lamp.	No. of lamps.	Miles of streets lighted.	Distance apart (yards).	Total cost.	Average C.P. per mile.	Cost per C.P. per annum.	Average C.P.
Gas— Batswing 5 c.f.	1,933	130	118	£ s. d. 6,554 14 5	223	54·25d.	15

6. There can be very little doubt that the above-mentioned average distance between lamps is too high, as it includes certain roads not constructed as well as any roads not lighted. Price of gas: Croydon Gas Company, 2s. 9d.; Crystal Palace Company, 2s. 8d.

7. Between November, 1899, and May, 1902, the Council ordered the conversion of the batswing burners to incandescent at a cost of 4s. 6d. each, the total cost of the 1,997 lamps then existing amounting to £428. 10s. The streets were, however, lighted with lamps of about three times the former candle-power. Price of gas: Croydon Gas Company, 2s. 8d.; Crystal Palace Company, 2s. 5d. The latter company are now increasing their price to 2s. 6d.

8. In the fourth column of the table below "distance apart" the figures are misleading. All the electric lamps have been added during the last few years, in which time the distance

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TABLE B.—CROYDON AND DISTRICT STREET-LIGHTING. TESTS ON STREET LAMPS (GAS AND ELECTRIC), WITH STATEMENT OF COMPARATIVE COSTS.

Description and position of lamp.	Number of lamps in use of class specified.	Average C.P.	Total cost per lamp per annum.	Total cost per C.P. per hour.	Total cost per C.P. per annum.	Average total cost per C.P. per annum, including all tests up to date.
			£ s. d.	d.	d.	d.
1. Elec. arcs. D.C. 520 watts. Alabaster globes, centre of town	63	494	18 0 0	·00232	8·70	8·70
2. Elec. arc. A.C. 650 watts. Half opal globes at intervals along London-road	80	438	18 0 0	·00239	8·96	8·96
3. Elec. arcs. A.C. 450 watts. Half opal globes, London-road, etc.	218	295	18 0 0	00389	14·59	14·59
4. Elec. arcs. A.C. 500 watts. Half opal globes, Brighton-road	65	270	18 0 0	00425	15·94	15·94
5. Elec. arcs. D.C. 690 watts. Alabaster globes at Greyhound and Arcade	2	500	18 0 0	·00232	8·70	8·70
6. Nernst lamps, half ampere. Type A, St. James's-road, Torridge-road, etc.	53	56	3 8 6	·00391	14·66	14·66 (*a*)
7. Incandescent gas lamps	—	—	2 18 4	·00332	12·45	12·45 (*b*)
Croydon Gas Co.	1 632	52	3 8 6	·00421	15·79	15·79
South Suburban Gas Co.*	505	44	2 18 4	·00422	15·82	15·82
8. Electrical Co.'s A.C. Flame arc, 550-watt. Opalescent globe, Brighton-road	1	1 400	18 0 0	00082	3·075	3·075
9. Katharine-street, Santoni lamp, 430-watt	1	1,175	18 0 0	·000978	3·688	3·688
10. Reason incandescent lamp	—	57	3 8 6	·00384	12·403	14·403 (*a*)
			2 18 4	·00326	12·228	12·228 (*b*)

* The lamps in South Suburban Company's area were all newly cleaned and with fresh mantles put on. The tests are therefore much better than if they had been taken after a few days' use of the mantles. (*a*) Croydon area. (*b*) Crystal Palace area.

apart of the lamps has been reduced. The average distance apart given in the table for gas lamps is arrived at by taking the number of miles of streets in the borough after deducting streets lit by electric lamps and dividing the number of gas lamps. This includes several roads not yet lit or only partly lit, and also many outlying roads in which the distance between lamps is excessive.

Summary of Particulars relating to Street Lighting in 1904.

Type of lamp.	No. of lamps.	Miles of streets lighted.	Distance apart (yds.).	Total cost.	Average C.P. per mile.	Cost per C.P. per annum	Average C.P.
				£		d.	
Incandescent gas	2,137	127·375	80	7,062	839	15·862	50
Nernst and incandescent	90	3·67	66	288	1,373	13·71	56
Electric	428	14·5	65	7,212	10,537	11·328	357

9. Again, the above summary is not a correct comparison, as by placing the arc lamps at cross roads 150 gas lamps are saved, or a sum of £513 per annum, which should be subtracted from the cost of arc lighting.

COMPARATIVE COSTS OF PRESENT SYSTEMS.

10. The committee have, for the purpose of comparison, taken (1) the results of tests made by the city engineer of Westminster as being an independent expert; (2) results of tests carried out to their own instructions.

11. Tables at end of report give (A) Westminster results,* (B) Croydon results.

12. The results of the committee's investigations show that very exaggerated claims appear to be made by various interested parties as to the particular type of lamp which they favour, and they feel, therefore, that considerable discretion is necessary in forming an opinion as to the relative costs of the various systems of lighting.

13. The correct basis on which to compare the relative costs of different types of lamps is *the average total cost per candle-power per annum.*

Westminster Tests.

14. The table (A) and the remarks at the bottom of same explain fully the relative cost values of the different systems of lighting.

15. The committee would call attention to the remarks made by the Westminster engineer with reference to the great variations in candle-power due to the condition of the mantles, and that what to the eye appeared to be a slight diminution in intensity results actually in an enormous loss of candle-power. This is a point which requires careful consideration when dealing with the question of gas lighting by mantles.

Croydon Tests.

16. With regard to the Croydon tests, every effort has been made to procure an accurate result, and the committee believe that the same as set out in the table can be taken as such on the working conditions, and there is no doubt that the results for comparative purposes are quite reliable. The electric Nernst lamp for side-street lighting in the South Suburban Company's area are charged at the same rate as the gas lamps in that area, and in the area of the Croydon Gas Company at the rate charged by that company. With reference to the former company's area, these prices will be increased owing to the fact that notice of an increase in the price of gas has been given by them.

17. The present lighting is mainly divisible into four sections: (1) direct-current electric arcs; (2) alternating-current electric arcs; (3) Nernst lighting; (4) incandescent gas lighting.

18. With reference to (1)—direct-current electric arcs—it will be noticed that this works out at an average total cost per candle-power of 8·7d., which is only half the cost of similar lighting by means of Nernst lamps or incandescent gas.

19. It will be seen that the present system of electric lighting by means of direct-current arc lamps in the centre of the town is far more economical than by means of gas lighting. The committee feel, therefore, that the lighting by means of these lamps as carried out in the centre of the town has proved a satisfactory method to the Corporation.

20. (2) It will be noticed in the table of tests that there are three kinds of alternating-current arc lamps at present in use (Nos. 2, 3, and 4).

21. With reference to 650-watt lamps (being No. 2 in the table) it will be noticed that these lamps are almost as satisfactory as the direct-current lamps, and the tests came out much cheaper than the gas or Nernst lighting.

22. (3) With reference to the 450-watt lamps (No. 3 in the table), these work out at approximately the same cost as the Nernst lighting, and are slightly cheaper than gas.

23. With reference to the above alternating-current lamps, although in the case of No. 2 (650-watt lamps) they are satisfactory on the question of cost, and (3) (450-watt lamps) came out cheaper than gas, still, from a lighting point of view, they are not relatively as satisfactory as the direct-current arcs, owing to their not being so efficient—*i.e.*, they will not give the same candle-power for the same amount of energy used—and, further, the colour of the light is not so satisfactory.

24. Street-lighting by means of alternating arcs has not been so satisfactory as by means of direct-current arcs, but this difficulty has now been got over by means of the introduction of a new type of lamp, from which the amount of light obtained from a given amount of electrical energy is enormously increased.

25. There is a further objection which must be borne in mind in considering any suggestion of using incandescent gas lamps in the main thoroughfares, even supposing the cost would warrant it, and that is with the present number of tramway poles in the streets the addition of a large number of extra poles in these streets would be a serious matter.

26. The committee are of opinion that the Corporation will not be disposed to reduce the amount of illumination, more especially in the main roads, but, on the other hand, would prefer that the amount should be increased.

27. The committee feel that in aiming at the best lighting of the streets, it is far better that the lamps should be suspended fairly high up so that the light will be properly diffused, and that it should be out of the line of vision of pedestrians and

* We have not reproduced the Westminster figures, as they have from time to time been given in our columns.

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persons in charge of vehicular traffic, the reason being that a light which is not high up will obscure the view of persons, and with the large volume of traffic in the streets, which in this borough is increasing very rapidly, the likelihood of accidents would be considerably increased. This statement can be easily proved by anyone who watches the traffic passing along the streets lighted by high candle-power lamps suspended at a height of, say, 25ft. and along one lighted by lamps where they are of the ordinary height. There is the further advantage of the light rays from the higher placed lamp being in a more vertical direction.

28. With reference to arc lamps, provided they are maintained in reasonable condition, the amount of light will not vary from day to day. In the case of both Nernst and the incandescent gas lighting, there is considerable falling off in candle-power from the time these lamps are first brought into use.

Side-Street Lighting.

29. It will be noticed that the Nernst lighting comes out slightly more advantageous than gas lighting, and, therefore, there is every justification for the Council lighting the side streets by means of their own supply in those streets where the mains are laid.

30. It will be seen from the table that, although the charges made by the South Suburban Gas Company are less than those of the Croydon Company, still the light obtained is not so good, and therefore there is not much actual difference.

Possible Improvement in the Present Street-Lighting.

31. The committee have gone into the question of what improved forms of lighting there are now on the market. The improvement in gas lighting for outdoor open spaces has been by the adoption of high-pressure lamps. These lamps, of course, take a very much larger amount of gas than the ordinary lamp. The number of mantles used is also considerably more if a reasonable efficiency is to be obtained. The cost of the mantles is more and the amount of attention is greater. All these points necessitate a much higher price being charged for such a lamp. There is a further serious disadvantage in connection with the use of these lamps, it being necessary to have a gas-engine or other form of pumping machinery to do the necessary pumping for the same. This also requires attention, and in addition there is the cost of upkeep of the plant.

32. Several kinds of this type of lamp are at the present time being tried in London. The committee would emphasise the point previously mentioned that the gas lamps were fixed rather low, and although the amount of light thereby obtained appears to be greater, the committee consider that it is advisable lamps of larger candle-power should not be fixed low. To get a satisfactory arrangement for street-lighting, the lamps should be of a height that they give a good diffused light, and are well above the line of vision.

33. Making due allowance for the above facts, the committee find that gas lighting has considerably improved by means of high-pressure lamps, but although these advances have been made, so long as the price of the electric arc lamps does not exceed a certain amount, the cost of lighting by means of the ordinary direct-current arc lamps should be more economical than by the high-pressure gas lamps.

34. The committee also find that considerable improvements have been made with electric arc lighting. This has been primarily brought about by the introduction of a new type of arc lamp known as the "flame arc lamp." They have had some of these erected for their inspection, and tests made on the same, the results obtained being very satisfactory. On the table showing the results of the Croydon tests No. 8, reference is made to one of these lamps fixed on the alternating supply. If the candle-power of this new type of lamp is compared with that obtained from the direct-current lamp, which is the most efficient at present in use, it will be seen that in the case of the former approximately treble the light is obtained for the same cost of electrical energy.

35. If one of the gas lamps being installed in the city and described by their makers as 600 c.p. is compared with the sample of the new flame lamp which has been hung in the Brighton-road for the committee's inspection, the candle-power of which on test is actually 1,400, it will be found that with the light from the arc lamp at two and one-third times as much as the light from the gas lamp and the price of the electric arc lamp approximately half as much again as the gas lamp, the price of the former works out at less than half the price of the latter on the basis of light value. The price proposed to be charged for the gas lamp installed in the City is, we understand, £12. 10s., and the price charged per arc lamp in Croydon is £18.

36. The committee would also like to point out for the further information of the Council that the rays given off by this type of lamp are very satisfactory in the penetration of fogs, they being of a reddy yellow tendency. On the other hand, the high-pressure gas lamp's rays are somewhat similar to those of the electric arc lamps, which are not so satisfactory for lighting purposes during a fog.

37. The question of whether more efficient lamps cannot be erected to replace those at present in use, so that the borough should have the most efficient and up-to-date lighting at present known, is a matter which can be dealt with separately, as it does not affect the present question.

38. At the meeting of the Council held on April 17 the following resolution was carried: "That having regard to the heavy expenditure involved in the present mode of lighting the borough, the Lighting and Electricity Committee be requested to carefully consider the matter and make such suggestions to the Council as may tend to considerable reduction in the cost of street-lighting."

39. The committee are of opinion that the result of their investigations had been to show that, taking all things into consideration, the system of lighting which has been adopted is most satisfactory, and they wish further to point out that even if the balance in its favour has been very small indeed, it would yet be in the interests of the Corporation to keep the lighting of the borough as far as possible in its own hands, and so retain any advantage which may accrue through a larger output of the Corporation electricity works. This should carry due weight with any decision that may be arrived at in connection with the matter, as an advantage to any Corporation department means, of necessity, an advantage to the whole of the ratepayers.

40. The examination of each year's working shows that the average cost of supplying electric light has been gradually reduced, and, therefore, the committee feel that the Council should assist them as far as they are reasonably able to do to increase the output of the works, as by so doing it would be conducive to lower cost of production.

41. The amount spent on street-lighting by the electricity department amounts to £13,552, and the annual charge on the amount for interest and sinking fund amounts to £813.

42. The committee have, from time to time, given reductions to all classes of consumers, and they now recommend that arc lighting be reduced by £1 per lamp per annum as from Sept. 29.

July 13, 1905. D. B. Miller, Chairman.

To this report the two gas companies have replied under the date of 15th inst. by a letter which we abstract as follows:

Gentlemen, — The directors of the Croydon and South Suburban Gas Companies have had their attention drawn to a report on street-lighting, dated July 13 last, by your Electrical Committee.

We are instructed to appeal to your sense of justice to allow us to put the case from another point of view, believing that your desire must be to have the streets lighted in the best manner at the lowest cost. We desire to prove by this reply to your committee's report, and by practical experiments to be carried out with your permission in suitable positions in the borough, by each company at its own cost, that incandescent gas lighting is the most efficient and much the cheapest street illuminant. Our directors desire to point out that, to obtain a fair view of the matter, the Council should treat the report as a statement of an electrical department anxious to maintain and extend its business, and should accordingly reserve judgment till the following facts have been considered. It may also be remarked, with reference to the note after Table II. at the end of the report, that it is the practice of the companies to maintain the mantles in good order from day to day—fresh ones being fixed as required. The conditions in which they were seen was, therefore, their normal state.

The report states that "lighting by electricity is considerably on the increase, and several towns have now no gas lighting in the streets." As the towns are not named, nor the particulars given, that statement can only be dealt with generally; but it may be assumed that these are places where the electricity supply is owned by the respective towns and the gas supply is by companies. It by no means follows that to light the streets in the most efficient manner, and at the lowest cost, has been the paramount consideration in these cases. It is most probable that electric lighting has been adopted or extended, on considerations such as those set forth in your committee's report, in order to obtain an increase of business for the electrical department.

If in the towns referred to electricity and gas were both supplied by companies, and the former had been adopted in fair competition, the statement of your committee would have been difficult to answer; but it so happens that in both the important cases mentioned—viz., Paris and London—where both lights are supplied by companies, electric street-lighting, as admitted in the report, is losing ground. Your committee tried to explain that "electric lighting is not making satisfactory progress" in Paris by stating that "the prices charged are very high" (no doubt because the price of electricity is high enough to pay expenses); but they omit to state the fact that the price of gas in Paris is also much higher than in Croydon.

The letter then deals with the city of London experi-

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ments, which have been explained in detail in our columns, and hence deleted, and then goes on as follows:

To return to the report, certain tables are given in which are set out various particulars of the number, distance, candle-power, and the cost of flat-flame and incandescent gas lamps and arc and Nernst incandescent electric lamps. As to the Nernst electric lights, the report says these "are charged at the same rate as the gas lamps." But it does not say that this is a paying rate, there being little doubt that there is a considerable loss. Moreover, these lamps are only 72 yards apart, against 105 yards for the gas lamps. Then it is said "that the Nernst lighting comes out slightly more advantageous than gas," and the Council are advised to light "the side streets by means of their own supply" in this way, which is certainly less efficient and more costly than gas if a paying price is charged.

The first table gives the position in 1894, when batswing flat-flame burners of about 15 c.p. were exclusively used, and the lamps averaged the extreme distance of 118 yards apart, the cost averaging £50. 8s. per mile.

There appears to be a serious and misleading error in the table relating to 1904, which greatly understates the distance apart of the gas, slightly understates that of the Nernst lamps, and overstates that of the electric, as follows:

	Average distances apart.	
	As per table.	Corrected.
Gas lamps	80 yards	105 yards
Nernst lamps	66 ,,	72 ,,
Electric	65 ,,	60 ,,

The gas lamps are 76 per cent. farther apart than the electric arc lamps—that is, there are seven electric against four gas in an equal length of street. Probably one reason for this is to be found in the necessity of placing the arc lamps in so lofty a position, and in the fact that at greater distances the lights would cause very unpleasant alternations of light and shadow. It is a strong testimony in favour of gas that, with lamps so far apart as 105 yards on the average, the borough is as well lighted as it is at present.

In both tables there is a serious omission; in fact, the information given in the seven columns is scarcely intelligible, and is of very little value without the addition of a column giving the cost of lighting per mile of street. This, according to the figures of the second table, average as follows:

Incandescent gas in 1904	£55 8s.	per mile
Nernst electric	78 10	,,
Electric arc	497 5	,,

Moreover, these figures are unfair to gas, inasmuch as they are calculated on the assumption that the hours of lighting are the same for gas as for electricity; the fact being, however, that while each gas lamp is alight throughout the hours of darkness—that is, some 3,980 hours out of the 8,760 in each year—the electric lamps are extinguished at varying hours, many of them at 11 o'clock or midnight.

The cost of lighting has been more than doubled over the entire borough by the adoption of the electric light in about 18 miles of streets out of a total of 145 miles—that is, gas costs less by £438 for 127 miles than electricity for 18 miles.

127 miles of gas cost in 1904			£7,062
3½ ,,	Nernst electric	£288	
14½ ,,	arc electric	7,212	
			7,500
Difference			£538

The cost of electric lighting is given as £7,500 for the year 1904; but in one paragraph the capital cost of the installation is given as £13,582, and it is stated that "the annual charge for interest and sinking fund amounts to £813," which is not included in the £7,500. That figure should, therefore, be increased to £8,313. This makes the cost of lighting 18 miles of streets electrically exceed by £1,251 per annum the cost of lighting 127 miles by gas.

The report says: "The correct basis on which to compare the relative cost of different types of lamps is *the average total cost per candle-power per annum.*" The committee cannot be aware of the difficulty and uncertainty of making photometric tests in the streets, and of the small practical value they have when made, or they would not have penned that sentence. Mr. Morton, the chairman of the City Streets Committee, gave a much better and a really intelligible basis in his speech at the meeting on May 4 of the London Corporation. He said, "In his opinion the best test of good lighting was a man's own test—that was to say, for a person to himself ascertain which illuminant was best to see by." This was practically endorsed by Mr. Williams and by Mr. Cooper in following speeches.

According to Table II. the average candle-power is given, for what it is worth, at 839 candles per mile of street for gas, and 10,537 for electric arcs. Either the one is woefully deficient or the other is scandalously extravagant. What is the use of a comparison of costs based on candle-power per annum when, according to the figures given, to effectively light the streets by one kind of lamp 10,000 candles must be provided per mile, against 800 with the other. Things that differ to such an extent cannot be compared by saying that the extravagant one costs only 11·328d. while the enormously cheaper one costs 15·862d. per candle-power per annum. Note the exactitude of these figures—to three places of decimals of a penny. In fact, the cheaper article in this case is much the dearer, for no man in his senses would think of buying 10,000 articles at 11d. each when 800 of another kind at 15d. would answer his purpose.

"The proof of the pudding is in the eating," and the proof of the lighting is in the seeing. Will the Corporation set apart a certain representative length of street or streets in the districts of the respective companies, and allow them to light them with incandescent gas, high pressure or otherwise, or both, as the Corporation may decide, with or without a limit of price per mile of street, and in a manner which, if adopted by the Council, would represent to the ratepayers an annual saving equal to at least a rate of 1d. in the £, and which it is contended would compare favourably with present electric arc lighting. If so, the companies will be glad at their own expense to supply and fix columns, lanterns, and burners, to effectively light the places selected, and remove the same after a trial of not less than six months, if not approved; but if the Corporation wish the lighting continued, they shall pay to the companies the cost price of the installation—these being the conditions offered to the City Corporation in connection with Southwark Bridge.

In the report it is stated that, "in aiming at the best lighting of the streets, it is far better that the lamps should be suspended fairly high up, so that the light will be properly diffused, and that it should be out of the line of vision of pedestrians." This presumably refers exclusively to electric arc lighting, as only these lights are "suspended." The principle enunciated is contrary to all experience and practice in gas lighting. Gas lights of moderate illuminating power, 10ft. or 12ft. from the ground and fairly near together, give a result in uniform illumination which is most necessary for the efficient lighting of the streets, and which is utterly unattainable by electric arc lamps.

The report recommends an extension of the arc lighting in order to increase the output of the electricity works, though nothing definite is said about the profit of so doing. But making the improbable supposition that some small profit may be made, it cannot be right to call upon the ratepayers to pay another £7,000 a year for electric lighting, less the fraction saved by abolishing gas, in order to increase the output of the electricity works at little or no profit, or possibly at a loss.

If the Corporation contemplate spending £500 a mile per annum for public lighting by electricity when it can be more efficiently done with gas at less than half the cost, the gas companies make the request that the decision be delayed until after the proposed experiment has been made.

(Signed) CHARLES M. OHREN,
Secretary, South Suburban Gas Company.
WILLIAM W. TOPLEY,
Secretary, Croydon Gas Company.

Sept. 15, 1905.

PERSONAL.

The Swindon Town Council have increased the salary of Mr. J. G. Griffin, the electrical engineer, from £300 to £325 per annum.

The Mansfield Town Council have increased the salary of the assistant engineer, Mr. B. Sankey, from £140 to £155 per annum.

Mr. W. A. Toppin has been appointed superintendent of the meter and installation department of the Greenock Corporation at a salary of £130 per annum.

Mr. J. R. Salter is engaged as consulting engineer to the Heywood Town Council in the supervision and completion of the Hopwood section of the tramways.

The Epsom Urban District Council have voted their electrical engineer, Mr. H. F. Foster, £10. 10s. for extra services rendered by him in connection with the waterworks pumping scheme.

Mr. F. Schofield, the traffic manager of the Bradford City tramways, has been presented with an illuminated address, a barometer, and a cheque, on the occasion of his leaving Bradford to take up the managership of the Leyton tramways.

Mr. P. A. Locke, senior chargeman at Plymouth Corporation electricity works, has been appointed chief lecturer in electricity under the education authority of Bolton, Lancs. Mr. Locke has been senior chargeman at Plymouth for five years, and has for some time been lecturer in electricity at the Plymouth technical schools.

The Burnley Corporation Electricity Committee have appointed Mr. James E. Starkie, A.M.I.E.E. (subject to the approval of the Council), to the position of borough electrical engineer in succession to Mr. Birkett, who resigned in May last to take up a similar position at Southend-on-Sea. Mr. Starkie has been engaged at these works about four years, the last three years of which he has been chief assistant engineer.

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LEGAL INTELLIGENCE.

COLLISIONS.

At Wood Green County Court James Chilcott, motor engineer, Hendon, brought an action against the Metropolitan Electric Tramways Co. to recover £91. 10s. for personal injuries sustained and damages in connection with a collison.

PLAINTIFF stated that he had been repairing a motorcar, and on April 6 went out to test it. The owner and another gentleman were in the car. Just as they got upon the tramlines in Edgware-road the engine of the car stopped and he got out to start it. An electric car was approaching and a signal was given for it to stop. It did ease up partially, but forged ahead again and smashed into the back of the motorcar, pitching witness against the wheel of one of Messrs. Carter-Paterson's vans. He was injured so badly that he was confined to his bed for a fortnight; he could not resume work for a month, and he still felt the effects of the accident.

Mr. MANSFIELD, clerk and surveyor to the Kingsbury District Council, stated that he saw the signal given to the tram driver to stop.

Several witnesses for the defence stated that the motor ran about the length of a tram in front of the electric car and stopped. The collision was an accident and unavoidable.

HIS HONOUR considered the accident was brought about by the driver of the tramcar proceeding at a greater rate than he ought to have done and not checking his speed before the collision occurred. The verdict would be for plaintiff, with 40 guineas damages and costs.

At Wood Green Police Court Wm. Charles Wingate, an electric tramcar driver, was summoned at the instance of the police for wantonly driving a car.

P.C. 297 Y stated that he saw defendant driving his car along the Green-lanes near Turnpike-lane, Hornsey. He collided with a cart laden with clay, which had the effect of knocking the horse down and throwing the vehicle upon the footway. The cart in turn collided with a coster's barrow just in front, the occupant of which was thrown out and slightly injured. Defendant did not ring his bell and did not pull up.

THOMAS KEEN stated that he witnessed the affair. The car was travelling 10 miles an hour and the cart was "making its way off the tramlines" when they collided. What surprised him was that the defendant did not pull up.

WM. KITCHENER, driver of the cart, stated that without any warning whatever the tram struck his cart. No bell was rung.

JOHN EDEN, of Park Ridings, Hornsey, owner of the barrow, corroborated.

Mr. HUGHES submitted that the affair was a pure accident. The summons was for "wantonly driving"; that meant wilfully, if anything at all. Therefore, it must be proved that the driver was not guilty of a lack of judgment, but that it was a wilful and wanton act.

DEFENDANT (sworn) stated that he rang the bell four times. Just as he was passing the driver of the cart pulled out to pass the barrow.

JAMES WILLIAMS, of 60, Lordship-lane, Wood Green, said he was in the engineer's department of the Middlesex County Council. He was in the car on the day in question, and he heard the gong sound two or three times. As the tram was passing by the cart turned out; a collision was unavoidable. It was a pure accident. The constable went to the driver three times and told him he was to blame. Witness interfered and told the officer that he was not justified in saying what he did in the presence of persons who might be called as witnesses.

The Magistrates held that "wanton driving" had not been proved, and, therefore, dismissed the case.

ALLEGED LONG-FIRM FRAUDS.

At the Guildhall on Tuesday, before Mr. Alderman Burnett, William Leslie, 40, described as an electrical engineer, and Alice Frances Cheesman, 24, a typist, were charged with conspiring, with others in custody, during the months of May, June, and July, to defraud Messrs. Strode and Co., of St. Paul's-churchyard, and other firms. Particulars of the case have already appeared.

After hearing further evidence Mr. Alderman Burnett remanded the prisoners until to-day.

COMPANIES' MEETINGS AND REPORTS

DICK, KERR, AND CO.

The report for the year ended June 30 last, to be submitted to the meeting on the 28th inst., states that the profits earned during the 12 months amounted to £85,007. Out of this had to be paid debenture and loan interest and trustees' fees, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £14,853, leaving a balance of £70,154, to which must be added the profits brought forward from last year—namely, £39,922—making a total of £110,076 available for appropriation. It is proposed to carry to a special reserve for extensions of manufactories or replacements of machinery, etc., or special depreciation of same (referred to below) £23,389, to pay a dividend of 10 per cent. on the ordinary shares, and to carry forward £42,388. During the past year the Company has been fully employed on important contracts both at home and abroad, and the manufacturing departments have been kept busy. The prospects for the current year are encouraging, although the directors think it right to draw the attention of the shareholders to the severe competition which exists in all branches of the business. The directors called attention last year to the fact that the reserve to be set aside, under Clause 31 of the trust deed, had then reached the limit of £150 000 prescribed by that deed, and they now desire to draw the attention of the shareholders to a new reserve which has been begun. In the previous balance-sheet there was shown a special reserve of £32,611, and the directors propose to transfer £16,611 from this reserve and add to it the sum of £23,389, so as to bring the total amount up to £40,000, this reserve to be set aside for the specific purpose of extensions of manufactories or replacements of machinery, etc., or special depreciation of the same.

MEXICO ELECTRIC TRAMWAYS.

The report of the directors of the Mexico Electric Tramways for the year ended Dec. 31, 1904, states that the result of operations, after charging interest on the debentures of the Compañia de Ferrocarriles del Distrito Federal de Mexico, and after payment of the 3½ per cent. guaranteed on the share capital of that company (under the terms of the lease), shows a net profit of the sum of 453 675dol., which, at the rate of exchange of 22¾d., gives the sum of £43,004 to be carried forward to the credit of the London profit and loss account. The interest received on the debentures of the Compañia de Ferrocarriles del Distrito Federal de Mexico (4,000,000dol. of which is held by this Company) and the dividend declared by the Compañia de Ferrocarriles del Distrito Federal de Mexico on its share capital (all of which is held by this Company) is then added, and, after charging expenses and obligations, etc., against the same, a net balance is shown to the credit of profit and loss account of the sum of £53,896, which, added to the balance brought forward from last year of £5,728, gives the total sum of £59,625. Out of this sum the usual dividend of 6 per cent. has been paid on the preference shares, amounting to £30,000, and a depreciation reserve account has been credited with the sum of £15,000, leaving a balance of £14,625 to be carried forward to next year's account. During last year the La Piedad mule line was reconstructed and opened to electric traction on May 30, and also during that year the reconstruction work to electric traction was commenced both on the Tacuba and Atzcapotzalco line, and also on the Peralvillo New Rastro mule line. To meet the requirements of these new lines and the traffic generally, 28 new passenger cars were added to the Company's equipment. In addition to these, four new express cars, 12 express wagons, and 25 freight cars were also added to the service. As already reported to the shareholders, during the year 1904 the purchase of the Mexican Traction Co.'s interests was concluded. This company was the owner of an important town line, called the Baños, and also possessed many other street concessions in the new quarter of the town, all of which now form a valuable addition to the system.

NEW COMPANIES REGISTERED.

British and Continental Traction Syndicate, Limited (35,791). Capital, £500. Object as indicated by the title. Registered office, 53, New Broad-street, E.C.

Lien Registered.

Beberlein Company, Limited (Makers of Engineering and Electrical Supplies, etc., London).—Issue on Sept. 1 of £200 debentures, part of a series created Feb. 29, 1904, to secure £2,500, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,280.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Florianopolis (Brazil).—The Municipality require tenders for the lighting of the town by Oct. 2.

Spain.—The Arsenal Authorities require tenders for a quantity of copper and lead in sheets and bars. Tenders by Sept. 27.

Martorell (Province of Barcelona, Spain).—The Municipality require tenders for public electric lighting. Tenders by Sept. 23.

Pontypridd.—The Urban District Council invite tenders for (Section B) overhead equipment for tramways; (C) cables for tramways. Tenders by noon on Sept. 30.

Burton-upon-Trent.—The Corporation invite tenders for the supply and laying of feeder cables, conduits, and other works in connection therewith. Tenders by noon on Sept. 25.

Bishop's Stortford.—The Urban District Council invite tendesr for lighting such of the public streets as are at present lighted, for two or three years from Sept. 30. Tenders by 4 p.m. on Sept. 25.

Wemyss (Scotland).—Tenders are invited for the construction of the permanent way of the Wemyss tramways. Tenders to Mr. Stephen Sellon, 36, Victoria-street, Westminster, by 12 noon on Sept. 27.

London, E.C.—Tenders are invited for supply and delivery of electric plant and materials to the East Indian Railway Co. Tenders to Mr. C. W. Young, secretary, Nicholas-lane, London, E.C., by 12 noon on Sept. 27.

Paris.—The Colonial Office, 4 rue Jean Nicot, Paris, require tenders for galvanised iron wire for the Indo-China telegraph service. Tenders by Oct. 10. Specification from Inspection Générale des Travaux publics, room No. 146, at above address.

Manchester.—Tenders are invited for the electrical installation of the new chief fire station and police station, London-road, Fairfield-

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street, and Whitworth-street, Manchester. Tenders to the Chairman of the Watch Committee, Town Clerk's Office, Town Hall, Manchester, by 10 a.m. on Sept. 27.

Langho (near Blackburn).—The Chorlton and Manchester Joint Asylum Committee invite tenders for the supply and fixing of the necessary telephones and electric bells at the new colony for epileptics at Langho, near Blackburn. Tenders to the Clerk, Chorlton Union Offices, All Saints', Manchester, by Oct. 3.

London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of 34 steel single-deck tramcar bodies; maximum traction swing bolster trucks for 34 electric cars; complete electrical equipments for 34 cars; or, alternatively, 34 steel single-deck cars, with trucks and equipments complete. Tenders by 10 a.m. on 29th inst.

London County Council.—The London County Council invites tenders for the manufacture and laying of (*a*) 56 miles low-tension lead-covered, paper-insulated cables, 20 miles dry-core telephone cables, cast-iron feeder pillars, etc.; (*b*) 24 miles extra high-tension three-core, lead-covered, paper-insulated cables, etc. Tenders to Mr. G. L. Gomme clerk, by 10 a.m. on Oct. 3. See advertisement in last issue.

Erdington.—Tenders are required for the construction of Section No. 1 of the Erdington tramways, comprising the laying of the permanent way, including copper bonding, wood block paving, and other works incidental to the laying of about 2½ miles of double-track tramway, for the Tramway Committee. Tenders to the joint engineers, Mr. Robert Green (of Messrs. Pritchard, Green, and Co.), of 37, Waterloo-street, Birmingham, and Mr. Herbert H. Humphries, engineer to the Council, Public Hall, Erdington.

Municipal Board of Mussoorie (India).—The Municipal Board invite tenders for the supply, delivery, and erection at sites, in complete working order, of the following plant: (*a*) steel power pipes; (*b*) water-motors; (*c*) alternators with exciters; (*d*) switchboards with instruments and apparatus; (*e*) transformers; (*f*) induction motors; (*g*) pumps; (*h*) workshop machines. Also for the supply and delivery of the following: (*a*) bare copper wire for overhead mains; (*b*) insulators and lightning arresters; (*c*) arc and incandescent lamps; (*d*) telephone equipment; (*e*) workshop tools; (*f*) general stores. Specifications, form of tender, and general conditions can be obtained on application to Mr. C. H. Shanan, municipal electrical engineer, Municipal Office, Mussoorie, India (telegraphic address, Shanan, Mussoorie), on payment of a deposit of Rs.75 (£5), which amount will be returned on receipt of a bona fide tender. Tenders by Oct. 23.

RESULTS OF TENDERS.

Foreign Contract.—Messrs. Thomas Piggott and Co. have secured an order for 17 of their patent stamped steel tanks for South America.

Croydon.—The Corporation have accepted the tender of T. Harding Churton and Co. for the supply of single-phase induction motors and centrifugal pumps.

Buralem.—The Town Council have decided to order from Dick, Kerr, and Co. a 200-kw. engine and dynamo in place of the set remaining to be delivered by them.

Caerphilly.—The Urban District Council have accepted the tender of Johnson and Phillips, of Old Charlton, London, at £4,247. 16s. 5d., for electric lighting the district.

Hammersmith.—The Borough Council have accepted the tender of the Main Colliery Co. for supply of best through-and-through steam coal up to March, 1906, at 13s. 9d. per ton, delivered at wharf.

Neath.—The Rural District Council have affixed the seal of the Council to a number of documents in connection with the electric lighting undertaking, including contracts with Callender's Cable Construction Co. at £8,449. 17s., and Johnson and Phillips at £9,335. 17s. 9d.

Fulham.—The Guardians have accepted the following tenders for the supply of 5 000 tons of steam coal to the electricity department: Charrington, Sells, Dale, and Co., £1,191. 13s. 4d., 2,000 tons; Orynant Colliery, £716. 13s. 4d., 1,000 tons; Cory Bros. and Co., £704. 3s. 4d., 1,000 tons.

Taunton.—The Town Council have accepted the tender of Babcock and Wilcox, at £1,460, for a new boiler, fitted with superheater and economiser, also high-pressure pipe extensions and sundry ironwork; and that of C. Goodland and Sons for the supply of 2,500 tons Main colliery coal, at 13s. 11½d. per ton, for the electricity works.

Ebbw Vale.—The District Council have accepted the following tenders in connection with the installation of electric street-lighting: W. T. Glover and Co., £3,708, cables; R. Blackwell and Co., £6,159, overhead wires; Electric Glow Lamp Co., £583. 4s. 6d., street lamps; or Nernst lamps, £643. 12s. 6d.; Reason Manufacturing Co. and Messrs. Rumney, meters.

Institution Journal.—The *Journal* of the Institution of Electrical Engineers (part 175), edited by the secretary, Mr. G. C. Lloyd (Messrs. E. and F. N. Spon), contains "The Eddy-Current Brake for Testing Motors," with discussion, by Messrs. D K. Morris and G. A. Lister (Birmingham Local Section); "Alternate-Current Motors in Industrial Service," with discussion, by Mr. P. D. Ionides (Glasgow Local Section); "E.M.F. Wave Forms," by Messrs. E. A. Biedermann and J. B. Sparks (Students' Section); "The Present Electrical Equipment of the London County Council Tramways," by Mr. J. W. Anson (Students' Section); "Application of Electricity to Mines," by Mr. A. C. Anderson (Birmingham Local Section); "Electric Heating: Its History and Development," by Mr. A. E. Jephson (Students' Section); "Equipment of a Generating Station, with special reference to the Chelsea Station of the Underground Electric Railway," by Mr. R. F. Chaffer (Students' Section).

BUSINESS NOTES.

TRACTION.

Nottingham.—An immediate commencement of the Sneinton tramway is promised.

Birmingham.—Good progress is recorded in the reconstruction of the tramways for electric traction.

Leven.—The Town Council have sanctioned the laying of a double line from the starting point to the Royal Bank.

Paisley.—The company has been requested by the Tramways Committee to provide a through service from east to west.

Perth.—All the generating machinery is in readiness, and some trial trips will probably be made on the new cars in a day or two.

Geneva Tramways Co.—The traffic receipts for the month of August were £8,958, being an increase of £106 over the corresponding period of last year.

Leith.—Colonel von Donop last week inspected, on behalf of the Board of Trade, the section from Pilrig to Newhaven, and expressed satisfaction with it.

London United Tramway Co.—A petition having the signatures of 359 residents and ratepayers has been presented against the Richmond-road extension.

Ramsgate.—It is reported that, as the result of the recent accident, expert motormen are being put on the cars to take charge while descending dangerous hills.

Devonport.—Mr. J. W. Endean, who recently resigned his position as manager of the Devonport and District Tramways Co., has been arrested on a charge of embezzlement.

Chatham.—The Town Council have received a letter from the light railway company stating that the extension to Rainham will not be proceeded with until after the winter.

Motor-'Bus Schemes.—It is reported that several new schemes are about to be launched. They provide for linking up coast towns in the South and the East of England and in Wales.

Lowestoft.—The surveyor has been instructed to submit an estimate on the cost of converting St. Peter's-street to double line. The question of laying a double line in the High-street has been deferred.

Anglo-Argentine Tramways Co.—At a Board meeting an interim dividend of 3s. per share, free of income tax, was declared on the ordinary shares of this company on account of the profits for the year 1905.

Greenock.—The Board of Trade, on application by the Corporation, has awarded the sum of £602. 18s. 9d. as share profits due by the tramways company under Article 5 of the Corporation lease for the year ending Dec. 31, 1902.

The Underground.—The process of displacement of the steam trains by the electric locomotives is proceeding apace, and it is stated that the first-mentioned form of traction will entirely disappear from the system within a couple of months.

Thornaby.—The Town Council have decided to press upon the Imperial Tramways Co. the necessity of proceeding with the doubling of the lines between Thornaby and Middlesbrough, as provided for in the recent Act obtained by the company.

Leicester.—The inquest on the body of Mrs. Henton, who was killed by an electric tramcar, resulted in a verdict of accidental death, the coroner remarking that there was no reason to suppose that the driver did not pull up as quickly as possible.

Cardiff.—At the meeting of the Electricity Committee it was reported that the assessment of the tramways had been increased by 200 per cent., representing an additional £2,000 in rates. It was decided to communicate with the town clerk.

Motor 'Buses as Railway Feeders.—At the half-yearly meeting of the Glasgow and South-Western Railway Co. Mr. Patrick Caird (chairman) announced that the directors had placed orders for numerous passenger road motors, which they hoped would act as feeders to the railway.

East Ham.—At the meeting of the Borough Council a resolution was submitted that, instead of the balance of £2,612 on the trams being placed to reserve, a sum equal to a penny rate should be devoted to the general district rate. After some discussion the matter was referred to committee.

Pontypridd.—At the meeting of the Urban District Council a number of tenders were opened for the construction of the permanent way of the tramroad to the junction at Hafod with the proposed Rhondda tramways, and they were referred to Mr. R. P. Wilson, the Council's consulting engineer.

Dundee.—It was inadvertently stated last week that the coal consumption had been brought down to 1·88*l*. per unit. The figure should have been ·188*l*. per unit. The residents along Victoria-road and the neighbourhood have prepared a petition strongly urging an extension of the tramway in their district.

Llandudno Light Railway.—The promoters have obtained an extension of time for constructing their system until Dec. 31 next year. The Board of Trade stipulate that the line shall be open for traffic by that date from Rhos Road to Llandudno, a distance of about four miles. The Board intimate that, failing compliance, the order will be suspended.

Birmingham and Midland Tramways.—The receipts of the Birmingham and Midland and City of Birmingham Tramways show a decrease owing to the omnibus receipts of those companies having hitherto been included. The omnibus business has been sold to the Birmingham and Midland Motor Omnibus Co., which is an associated company of the British Electric Traction Co.

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Piccadilly, etc., Railway.—On Monday last the directors of the Great Northern, Piccadilly, and Brompton Railway inspected the new cars designed for use on this system. Owing to the restricted space available in the tunnels, the roof is rather low-pitched, but the cars are roomy and comfortable. The body of the car is built of steel, and the interior woodwork has been rendered non inflammable.

Hastings.—The sub-station and car-shed which are in course of erection at Bulverhythe are nearing completion, and as the lines are already laid from the end of the wood paving at West Marina to Bexhill, and in Bexhill itself, the company contemplate commencing a service between Bexhill and Bopeep in a day or two, without waiting for the completion of the front line. The company have applied to the Corporation for sanction to Sunday running, and it is probable that a *plébiscite* will be taken.

Tram Tokens.—At a meeting of the Tramways Committee of the Newcastle Corporation a report was presented from the manager respecting the giving of tram tokens to officials connected with the various departments of the Corporation. It was stated that the tokens had been used otherwise than for the Corporation purposes. The committee decided that the tokens should still be given out, but on condition that they were not used on Sundays, and only when the bearers were on Corporation business.

Hythe.—At a meeting of the Town Council a letter from the Traction Corporation was submitted, offering to construct a tramway on the Kingsland system through Hythe, Folkestone, and Sandgate. The company estimate the cost at £110,000, which would have to be raised by the local authorities. It is suggested by the company that the capital cost of a generating station should be avoided by taking energy from the local supply company, provided that it can be obtained at a cost not exceeding 1d. per unit.

Isle of Man.—The electric railway which runs from Laxey, in the Isle of Man, to the summit of Manxland's highest mountain, Snaefell, experienced last week the first accident since its formation. An up car had stopped about a mile out from Laxey owing to something having gone wrong with the connections. Two down cars were pulled up in consequence close to the spot, but the driver of a third car, rounding a curve at 12 miles an hour, did not observe the block in time, and his car crashed into the stationary vehicles, which were rushed along the line for a distance of 50 yards. Some of the passengers sustained slight injuries by jumping from the cars.

Bradford.—The sub-committee of the Tramways Committee appointed some time ago to inquire into the management of the city tramways, consequent upon certain criticisms which were made, will shortly present their report. The findings of the sub-committee are declared to be wholly favourable to the Bradford management. Not content with mere investigation of the system of control, the sub-committee have gone far afield in order that they might obtain data for comparisons, and the result is that Bradford comes out exceedingly well. The report is stated to represent the almost unanimous view of the sub-committee.

Swansea.—A fatal accident occurred last week, when Mr. A. E. Elcock, a visitor, fell against one of the Port Tennant trams, and succumbed to his injuries. The car was proceeding slowly, as it had only pulled up 20 yards before, and just as it was passing the man fell against the side of the front of the car, and was knocked back into the road. The wheels did not pass over him, but it was evident that his injuries were serious, and the ambulance was sent for from St. Thomas police station. On the arrival of the police the injured man was unconscious and bleeding freely from the nose and mouth and a wound on the right temple. He was conveyed to Swansea Hospital, where he expired shortly after.

Burslem.—At the meeting of the Town Council it was reported that the Tramways Sub committee had received a letter from the company requesting permission to lay 30 yards of tramway on Chell road, in the borough of Burslem, being a continuation of the Chell-street tramline from the borough of Hanley. It was recommended (*a*) that the extension be allowed subject to all agreements and conditions at present affecting the tramways, and to the roadway between the car rails and the kerb on the west side being paved with suitable setts on a foundation of cement not less than 6in. thick to the satisfaction of the borough surveyor; (*b*) that the tramway company be requested to consider the question of introducing ½d. stages between certain points. The recommendations were confirmed.

Belfast Street Tramways Co.—The secretary of the Belfast Street Tramways Co. has issued a notice stating that the company is now prepared to make a further return of 15s. per share on the ordinary shares, and shareholders may receive the amount due upon surrender of the share certificate at the company's office on Oct. 11 or 12. The final payment cannot be made until some outstanding matters have been settled, and as some weeks must yet elapse before that can be the case, it is considered best to make a further return of 15s. per share, and against this payment the share certificate will have to be surrendered. A cheque will be sent for the final payment per share, with an account of the liquidation, but the amount thereof cannot, it is stated, now be determined. It will, however, be only a small sum per share.

Rochester.—After some correspondence between the Corporation and the Chatham and District Light Railways Co. the latter have agreed to extend their line to Delce Grange a continuation to Borstal being considered a matter for future consideration. Tenders are to be called for at an early date. The town clerk reported the result of his interview with the solicitors for the company as to the points of difference in the draft lease, and it was resolved that the settlements of the points in difference be agreed to with the exception of Clause 21, as to which the committee are of opinion either that a clause should be inserted that no improvements carrying a royalty should be adopted without the consent of the Corporation being first obtained, or, in the alternative, that it should be made clear that the Corporation are not to be bound to take over any such improvements.

Yarmouth.—It has been decided to contribute £2,000 towards the cost of the improvement proposed to be made at the Haven Bridge. A penny fare is to be established between the Upper Ferry and the Barking Fishery Inn, Gorleston. The returns for five weeks ended Aug. 31 show: Receipts—Yarmouth section, £2,620. 6s. 5d., net increase, £99. 19s. 5d.; Gorleston section, £2,240 7s.—total receipts for month on both sections, £4 860. 13s. 5d. Passengers carried—Yarmouth section, at 1d., 413,992; at 2d., 105,427; parcels, 245; workpeople, 585; scholars, 4. Gorleston section, at 1d., 161,955; at 2d., 186,389; parcels, 1,781; workpeople, 3,097; scholars, 96. Aggregate—Yarmouth section from April 1, receipts, £5,522. 17s. 5d.—increase, £237. 4s. 3d.; passengers, 1,140,230—increase, 68 752. Gorleston section from July 4, receipts, £3,310. 9s. 3i.; passengers, 480,243. On Oct. 1 penny fares will be resumed on the Yarmouth trams.

Aberavon.—At a meeting of the Highways Committee last week a communication from the Board of Trade was read stating that the Crown officers had returned an opinion that the power conferred on the Board of Trade by Section 5 of the Tramways Act, 1870, of dispensing with the consent of a road authority included the case of a tramway over the whole of which a local authority had jurisdiction as such, and as to part as road authority also, the remainder of such tramway being within the jurisdiction of an independent road authority. The law officers, therefore, considered that in dispensing with the consent of the Glamorgan County Council in the case of the Aberavon order the Board of Trade were acting with their powers. The Board of Trade will accordingly in any similar case arising in the future rely upon this opinion of the law officers of the Crown, and not be bound by the decision of the Select Committee. As a result of this it was decided to again support the scheme to be brought forward in the next parliamentary session.

London County Council.—At a meeting a few days ago of the South London Protest Committee on the House of Lords Rejection of Tramways over the Bridges, the hon. secretary, Mr. Councillor W. Westcott, announced that a very large number of new supporters had joined the committee. The Hammersmith Borough Council made representations to the Board of Trade and the County Council in favour of the adoption of hardwood as the material for paving between the tramrails, and of the overhead trolley system being adopted on the portion of the tramway in this borough. The County Council replied that they could only accede to the application regarding paving to the extent of using wood in the vicinity of churches and hospitals. As to the overhead system, they did not think their Act would permit of this. The Board of Trade have upheld the County Council. There is a movement among the inhabitants for a service from Cricklewood to the Marble Arch, and a recent canvass of frontagers showed that 70 per cent. were in favour of the scheme.

Mitcham, etc., Tramways.—A good deal of interest is being manifested locally in the tramways for connecting the neighbourhood with Croydon, for which the British Electric Traction Co. obtained powers. There are four tramways involved, two being connected with a line from Mitcham to Sutton, the remaining two relating to the line from Sutton to Croydon. The former will run *via* the Mitcham-road, under Angel Bridge, to Sutton railway station. The Croydon line will pass through Waddon, Wallington, and Carshalton, to some extent on the route followed now by the 'buses, and will terminate at the Grapes, or corner of Benhill-street. Croydon and Mitcham, again, will be connected by tram, so that the schemes will form a complete circle. The company received the Royal assent to their Bills in 1902 and 1903, and the works are to be completed by July, 1907, and August, 1908. The company propose to lay double track throughout, and the Surrey County Council and Croydon Corporation are agreeable, but some of the other local authorities favour a single line, contending that the road is not wide enough for a double track.

Belfast.—At a meeting of the Tramways Committee the electrical engineer reported on the application of the National Telephone Co. for permission to supply 31 of their services by means of overhead crossings instead of placing them underground. He pointed out that the company proposed to use insulated cables in these services, and that being the case the Board of Trade would not insist on guard wires being provided. A letter was read from the Post Office authorities regarding the alterations necessary to the telegraph wires consequent upon the establishment of electric traction, the cost of the work (£399) falling upon the Corporation, and, in view of the fact that the telegraph undertaking will shortly pass into the hands of the Post Office, and the like ruling would then apply to the telephone wires, it was considered by the committee desirable to have the telephone wires put in their proper places before the advent of the new ownership, so they declined to accede to the application of the Telephone Company, but, at the same time, they indicated that they would be prepared to consider any individual case where there may be exceptional difficulty in giving the service.

Portsmouth.—At the meeting of the Town Council Councillor Kimber moved the adoption of the report of the Tramways Committee, recommending that the surplus of £13 530. 9s 3d. shown in the balance sheet be carried to a reserve fund. As an amendment, Councillor Hemingway proposed that £4 000 out of the tramway profits should be allocated to the rates. This, he pointed out, would be one way of alleviating the distress. Councillor Dittman, seconding, remarked that the time had now arrived when the Corporation would do what it promised when it commenced trading. Up to the present the Corporation had only handed over £1,000 to the rates. With regard to the tramways, enough had been done for future generations. Alderman Foster pointed out that large sums of money would have to be spent on the tramways in the future, and he suggested that £3,500 should be the amount contributed, which would be equivalent

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to a penny rate, while £10,000 might be invested. Councillor Hemingway accepted Alderman Foster's suggestion to make his amendment read that £3,500 should be allocated to the rates. The amendment was put to the meeting and carried by 21 votes to 14.

Bristol.—At the inquest upon Morley Gladstone Monks, aged three, who was killed by an electric tramcar at Kingswood, the evidence showed that the child ran from a shop across the path and into the roadway. A witness stated that the child's left shoulder hit the car underneath the gravel box. Deceased was knocked down and carried along over 40 yards. The driver was seen to apply the brake, but witness did not see him throw any gravel down. It appeared that deceased must have been rolled and pushed about 25 yards by the car, and then disappeared underneath, for when the car eventually stopped he was between the metals near the back wheel. Mr. Sidney E Smith, assistant manager to the Bristol Tramways Company, said that he visited the place of the accident within an hour of the occurrence. He there noticed a quantity of gravel on the track. He afterwards went to the Kingswood depôt, and carefully examined the car. He found the brakes in good working order. Further examination showed that the gate and cow-catcher, etc., were in better condition than any other in the depôt, and why they had failed to act during the accident he was unable to tell. The jury returned a verdict of accidental death. The foreman added that the jury unanimously attached no blame to anyone, but they thought that the company might provide jacks on each car, or at certain distances along the routes, in order to lift up the end of the car in case of an accident such as this one.

New York.—A deplorable accident occurred last week on the Manhattan Elevated Railroad, in which 10 passengers were killed and 40 injured. It was between seven and eight o'clock in the morning that the accident occurred, and the train was crowded with men coming into the city to business along the Ninth-avenue line. At Fifty-third-street there is a switch, which turns the trains, when required, along that street and thence to the Sixth-avenue line. Apparently, the signalman, in error, set the points for the train to turn to the left along Fifty-third-street, instead of proceeding straight ahead down Ninth-avenue, and then, realising that he had made a mistake, suddenly closed the points, turning the second car along Ninth-avenue. There was a moment's strain between the first and second cars, and then the second broke away and turned a somersault over the low parapet into the street below. It fell about 30ft., and landed on its end. The impact was so great that the carriage was smashed and the lower end was driven in, pinioning the occupants in a mass of *débris*. Some of the passengers were killed outright. The third car pulled up with a jerk at the junction, and turned off the line also, but the end caught the corner building across the narrow street, and the car hung balanced between the line and the building. The frightened occupants crawled out of the car, gained the ledge of the railroad, and escaped.

Heywood.—At the meeting of the Town Council last week it was decided that the construction of the Hopwood section of the tramways be proceeded with in conjunction with the tramways from Heap Bridge to the cemetery. An application was received from Messrs. Blackwell and Co. for an extension of time until Nov. 14, 1905, for the completion of the tramways. The reply sent—viz., that an extension until Nov. 14 could only be granted as regards the Hopwood section—was approved. The chairman of the Tramways Committee reported upon the heads of agreement with Rochdale and Bury, which have practically been settled, and which have already been referred to in these columns. Mostly the two agreements were the same, but Rochdale differed from Bury, inasmuch as while the Bury agreement was for three years Rochdale suggested that theirs should be for two years; and Heywood fell into line at once on the understanding that it should be optional for them to conclude the agreement at the end of the two years. One or two details, however, remain to be settled. Heywood contend that the mileage should be taken the nearest way—that is to say, in a direct line from Heywood to Rochdale Town Hall, whereas some of the Rochdale cars ran round by Drake-street. In regard to Clause 8, which reads, "Heywood to pay a proportion of the interest and sinking fund on the capital cost of the two cars," the chairman explained that Heywood would pay interest on the car mileage run in Heywood borough, and sinking fund on two cars, which ultimately should belong to Heywood. If there was any portion of the cost unpaid when their agreement with Rochdale fell through, then Heywood would have to pay that balance, and the cars would become their property on that payment. The agreement continues: "If the agreement is terminated, Heywood to take over the two cars and pay the capital cost less the amount contributed towards the sinking fund." In reply to a question as to when the new cars would run, the Chairman said that the service would probably be in operation by the middle of December, perhaps earlier.

Steel Railway Carriages.—At the invitation of the Brush Electrical Engineering Co. a number of visitors attended at the Metropolitan District Railway car depôt at Mill Hill Park on Monday to inspect the first steel railway carriage constructed in this country. Six steel railway carriages have been running for more than two years on the Central London Railway. These, however, were a product of the United States, but recently the Brush Electrical Engineering Co. undertook to supply an all-steel railway carriage to the Underground Electric Railways of London for trial service on the Great Northern, Piccadilly, and Brompton Railway. The new railway carriage has been built to the designs of Mr. G. C. Cuningham, M.I.C.E., general manager of the Central London Railway, who, it is stated, has been successful in making several important improvements on American practice in the British-made carriage. The new railway carriage is claimed to be superior to the standard wooden car in three respects. The first is its absolute immunity from any danger of fire; the second, a considerable reduction in dead weight; and the third—consequential on the second—consists in the material reduction it will effect in expense of haulage. The Brush Electrical Co. estimate that a saving of about 20 per cent. in the weight of the standard type of wooden railway coach will be effected by the substitution of steel carriages. The steel carriage built by the Brush Electrical Engineering Co. is formed of a steel frame with a body of pressed and riveted steel sheets. The sides have a slight outward curve, and are artistically decorated in red and white. Its length over platforms is 49ft. 9½in., its height from rail to roof 9ft. 5¾in., its interior has a perpendicular of 7ft. 6in., whilst its extreme width is 8ft. 9in. The seating capacity of the car is 54, and its total weight 15 tons 17cwt., against the 21 tons 5cwt. of the Metropolitan District Railway coaches, seating 52 passengers, and the 18 tons 16cwt. of the coaches of the Great Northern and City Railway, seating 58 passengers. The interior sides of the steel coach are faced with non-inflammable wood panelling, but this is likely to be superseded in future deliveries by steel or aluminium sheeting. There is nothing in the appearance of the interior to differentiate it from the ordinary wooden carriage. The Brush Electrical Engineering Co. are now building 18 steel cars from this model for the Great Northern and City Railway Co., whilst the London County Council are inviting tenders for 34 steel cars for the underground tramway from Holborn to the Thames Embankment under Kingsway.

LIGHTING AND GENERAL.

Aldrington.—The electric lighting of the town is now in complete working order.

Blackburn.—The Corporation electricity department have been holding a very successful electrical exhibition.

Govan.—It has been decided that ordinary consumers of electricity be given the alternative of a flat rate of 3½d. instead of 4d.

Hindley.—A sub-committee has been appointed to meet Mr. Hopkinson with regard to the Hindley electric lighting order.

Atlantic Cable Laying.—The cable ship "Colonia" has completed the repairs rendered necessary by her recent grounding off Canso (N.S.).

Anglo-Argentine Tramways Co.—An interim dividend of 3s. per share, tax free, is declared on the ordinary shares, on account of the profits for the year 1905.

Bishop Auckland.—The Urban District Council's electric lighting scheme for the town has been completed. This contract was placed with the old Cleveland Co.

Taunton.—An agreement has been arrived at by the Town Council and the Great Western Railway Co. which necessitates a cable being laid through the latter's property.

Thornaby.—An agreement has been signed transferring the electric lighting order obtained by the Council in 1902 to the Cleveland and Durham County Electric Power Co.

Edinburgh.—The National Electrical Construction Co. have obtained authority to transfer their undertaking to the Musselburgh and District Electric Light and Traction Co.

Direct Spanish Telegraph Co.—The directors have declared an interim dividend at the rate of 4 per cent. per annum, free of tax, for the half-year ended June 30, to be paid on Oct. 2.

Woolwich.—It has been decided to wire several of the Council's houses for the purpose of supplying electricity. The cost will be debited to repairs, and be provided out of the rates.

Electrical and Engineering Science.—Prof. Jamieson, M.I.C.E., etc., of Kelvinside, Glasgow, has resumed his correspondence classes for the winter session. Particulars appear in another column.

Electrical Exhibition.—The Lord Mayor, who will be supported by the sheriffs, has fixed 1 o'clock for the opening ceremony in connection with the electrical exhibition at Olympia on the 25th inst.

Greenock.—The total units of electricity generated at Corporation works during the five weeks of July amounted to 195 921, being an increase of 61,294 units as compared with the corresponding month of last year.

Newton.—The Urban Electric Supply Co. intend to apply for a provisional order for the supply of current to Kingsteignton, and have again asked the District Council's permission, which has again been refused.

Electric Lighting and Heating.—A Parisian journal, *Le Batiment*, 14, rue St. Georges, is opening a competition, to be held between Oct. 15 and Nov. 15, in appliances for the lighting and heating of public and private buildings.

Hampton Court.—The Office of Works are making arrangements for an installation of the electric light not only to the private apartments, but to those parts of the palace to which the public have access. The capital outlay will be about £3,000.

Cradley.—The Empire Electrical Co. propose to apply for an order to supply electricity within the Parish Council's area. The Council at their last meeting agreed to let the matter stand in abeyance until the final settlement between the company and the Halesowen District Council.

Penarth.—The District Council have resolved to convert 80 16-c.p. gas lamps into electric lamps using the Nernst lamp of 32 c.p. which the Penarth Electric Lighting Co. offer to supply and maintain for 3 600 hours per annum at a cost of £2. 14s., as against £2. 14s. 8d. previously paid for gas.

Ossett.—The voting at the last Town Council meeting on the electric lighting scheme, on which it was proposed to spend £8,400, resulted in a tie, and the mayor gave a casting vote in favour of the abandonment of the scheme. It was intimated that if it was possible to upset the vote it would be done.

Stock Exchange.—The committee has ordered the undermentioned securities to be quoted in the official list: Folkestone Electricity

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Supply Co.'s further issue of £25,000 4½ per cent. first debenture stock; Marconi's Wireless Telegraph Co.'s 251,127 shares of £1 each, fully paid, Nos. 1 to 251,127.

Grimsby.—The Town Council have adjourned the consideration of the report of the Lighting Committee, recommending the extension of the electricity station and plant, at an estimated cost of £9,500, and the approval of the engineer's estimate of £8,500 for mains works, etc., required during the next three years.

Eastern Telegraph Co.—A dividend is announced at the rate of 3½ per cent. per annum, less income tax, on the preference stock of the company for the quarter ending Sept. 30 and the usual interim dividend of 1½ per cent. on the ordinary stock, free of income tax, in respect of profits for the quarter ended June 30.

Removal.—The Electrical Trades Engineering Co. have removed their office from York-place, Baker-street W., to their head office and works, the Crown Electrical Works, Maygrove-road, Brondesbury, London, where all communications should be addressed. Telegrams: Eltrenco, London. Telephone, P.O. 958 Hampstead.

Southwark.—The General Purposes and Electric Light Joint Committees have considered offers from private companies to "deal" with the municipal electric light undertaking, and have recommended that "no action be taken." The question was discussed at the last Council meeting, and finally the report was referred back to the joint committee.

Yarmouth.—Twenty-seven applications for 534 lamps in Southtown having been received, which will yield an income of £200, cables are to be laid from Half-Way House to Southtown Station at a cost of £644. The Council propose to expend £500 in placing 10 arc lamps on the front at Gorleston, to be lighted during July, August, and September, at an annual cost of £67.

Rosario Electric Co.—The directors have declared a final dividend of 3s. per share on the 12,000 preference shares of the original issue, making, with the dividend already paid, 6 per cent. for the year ended June 30 last, and of 9·23d. per share on the 8,000 new preference shares, being the equivalent of 6 per cent. per annum from the dates of the respective calls to June 30 last.

Tunbridge Wells.—Strong opposition will be offered at the next Town Council meeting to the resolution advocating the sale of the electricity undertaking, which is to be moved by Mr. Councillor B. M. Woollan, a leading member of the "Ratepayers' League." It appears that a profit of £4,005 has been made and nearly £3,000 has been placed to the relief of the rates.

Dumbarton.—At the last meeting of the Town Council it was proposed that provision be now made for the future lighting of the principal streets of the burgh by electricity to the extent of laying down mains in these streets, and that the matter be remitted to the Public Lamps and Fires and Bills and Electricity Committee with power. After discussion the motion was withdrawn.

Telegraph to Benin.—The telegraph line has been extended to Benin City, Sapeli, and Warri, and offices for the reception of messages have now been opened at the places named. These offices are under control of and worked by the Southern Nigerian Government, and the charge is 2d. per word above the cablegram price to Bonny, the Nigerian Government undertaking the redistribution.

Swindon.—The consideration of the selection of a site for the erection of the weighbridge at the electricity works stands adjourned for three months. The last monthly report of the electrical engineer shows that the number of consumers connected on Aug. 30 was 365, as against 221 a year ago. The number of street lamps converted up to the present date was 187, as compared with 143 a year ago.

Heywood.—The consumption of electricity for the month of July was 3 182 units, as against 2,943 units for the corresponding period of last year, showing an increase of 239 units. The chairman and vice-chairman have been instructed to report as to what allowance should be made to the staff at the electricity works for extra services being rendered in connection with the laying of the new cable for electric tramways.

Pontardawe.—The Council some time ago decided to ask Mr. John Morgan, Cardiff, to report on a scheme for lighting the populous parts in the Pontardawe area. Mr. Morgan estimated the cost at about £32 000. An offer has been received from the Brynamman Electricity Supply Co. stating they were prepared to light the Caegurwen district at £3. 14s. 3d. per lamp of 32 c.p. per annum. The matter is under consideration.

Lighthouses.—The *Revista Maritima Brazileira* for June, 1905, contains an exhaustive article on lighthouses, illustrated by means of coloured plates, in which a different design is used to designate the colour and character of each light used in the various lighthouses on the Brazilian coast. In a table the distances are worked out at which lights up to 10 000,000 c.p. are visible in clear, medium, and foggy weather respectively.

St. Andrews.—The Electric Supply Corporation on Friday inaugurated the electric light and power scheme for the city. Mr. K. A. Scott-Moncrieff London, the general manager, presided, and Mrs. Murray, wife of the provost, switched on the light. The electricity works at Southfield were afterwards visited, where the method of production and working of the plant were explained by Mr. Drummond, the resident engineer, and other officials.

St. Marylebone.—With regard to the change-over at St. Marylebone referred to in another column, it is explained that to lay down new cables would have cost the Council £400,000, while the replacing of the low voltage installations by high-voltage appliances will cost £70,000. Six thousand houses are affected by the change. It is estimated that altogether 100,000 electric lamps will have to be changed, and about 1,500 electrical appliances of 400 doctors will have to be replaced.

Glasgow.—A meeting was held on Tuesday under the auspices of the National Society of Telephone Employés, at which Mr. Wilson presided. It was stated that there were now some 1,500 members of the society in London, Liverpool, and Manchester. A resolution was passed to the effect that the meeting was of opinion that they should join the Society of Telephone Employés to protect and promote the interests of their class.

Durham.—The Consett Iron Co. are about to provide their Chopwell and Gateshead Collieries with an electrical installation. The current will be generated at the Chopwell Colliery at a pressure of 625 volts, three-phase. Part of it will be raised to a pressure of 5,000 volts and transmitted 2½ miles to the Gateshead Colliery, at which point it will be reduced again to the working pressure of 625 volts. This will be one of the first high-tension installations carried out to the new Home Office rules.

Finchley.—Sanction has been received to the borrowing of £23,360 for electric lighting purposes. In arriving at this amount the Board have deducted the sum of £100, representing the difference between the cost of the cooling tower and deep well (£1,600), which were now omitted, and that of the proposed additional boiler and superheater (£1,500) as desired by the Council, and a sum of £40 for the removal of pumps from their present temporary position to a permanent position in the boiler-house. The loan is to be repaid in 16 years.

Bray.—At the last Urban District Council meeting it was proposed that application be made for sanction for a loan of £2,621 for extensions of a capital nature at the electric lighting works, and that the electrical engineer be instructed to prepare the necessary plans, estimates, and specifications showing the probable amounts required, the same to be forwarded to the Local Government Board with as little delay as possible. After discussion, it was decided that a trading account for three years to March 31, 1905, relative to the electric works be prepared.

Farsley.—The District Council have received an offer from the Yorkshire Electrical Distribution Co., who propose to apply for a electrical lighting provisional order for a supply for lighting at 4d. a unit. The company also offered to guarantee to the Council that the cost of electricity for street-lighting would not exceed 2d. a unit. The District Council have now decided to ask the West Riding County Council to consider the advisability of promoting a Bill whereby the public bodies in their area might join forces to meet the electric demands of the West Riding.

Cardiff.—The South Wales Electrical Power Distribution Co. have complained of the action of the Council's committee in supplying power outside their radius in the case of the Ely Paper Mills. The matter has been referred to the electrical engineer and the town clerk to consider. The Cardiff Property Owners' and Ratepayers' Association have written to the Electrical Committee pointing out the advantage of lighting the roads, etc., in Cathays Park with incandescent gas lamps. When the matter came up for discussion, the mayor remarked that an exhibition on a large scale was to take place at an early date at Olympia, London, where the latest improvements in electrical appliances would be shown. They were anxious to be abreast of the times, but they could not commit themselves to the suggestions made until they had seen the latest in electricity.

Fulham.—The Council have decided to support the Poplar Council in the endeavours *re* wiring of consumers' premises mentioned in another note. Permission has been given during the recess to the Postmaster-General to lay two underground telegraph lines in the borough. The arbitration before Mr. Swinburne, the architect under the electric lighting contract for the baths, relative to the question of damages claimed by the Council from the contractors, the National Electric Construction Co., being in the nature of reimbursement for the costs, damages, and expenses incurred by them by reason of the two fatal accidents in December, 1902, has been held. The arbitrator has until Dec. 31 next to make his award. It is expected that he will make the award in the form of a special case, finding certain facts and stating the questions of law for the opinion of the King's Bench Division of the High Court.

Lewesteft.—During August four new consumers were connected to the mains, representing 228 8-c.p. lamps. One motor was connected during the month. There are now connected to the mains 643 consumers, representing 32 410 8-c.p. lamps. The engineer has been directed to dispose of the Old Harbour cables at the best price obtainable. A joint meeting of the Electric Lighting and Tramways Committees recently discussed the subject of an amalgamation of the Electric Lighting and Tramways Committees, with a view to the reorganisation of the office work now undertaken by the committees' and the accountant's office, and came to the conclusion that there was no advantage in an amalgamation of the two committees, but recommended that the Special Finance (Inquiry) Committee should consider whether some economy can be effected by a rearrangement of the work in the offices of the electric lighting and tramways undertakings and the department of the borough accountant.

Harding Churton Motors.—We have received from Messrs. Harding Churton and Co. copies of their recent revised lists of alternating-current motors. We understand that the makers' works are full of orders, and that among the contracts on hand are the following: the Corporation of Croydon, for three single-phase induction motors of the slip-ring type, to be direct coupled to centrifugal pumps, for the Norwood sewage farm; Messrs. McCorquodale and Co., for installation of two-phase motors for driving their extensive printing works; Messrs. Albion, for the entire driving of their clothing factory; Messrs. Whitley Partners (Leeds), a 45-b.h.p. two-phase motor (the fourth motor supplied); Messrs. Bateman's Machine Tool Co., a 25 b.h.p. two-phase motor (the fifth supplied). Messrs. Harding Churton have also recently supplied their alternating-current motors to the Corporations of Leeds, Sheffield, Huddersfield, Burton-on-Trent, Bristol, the Bournemouth and Poole Electric Supply Co., and others.

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Swansea.—Mr. A. Ellis, electrical manager, in his last report states that at the end of August the premises of 1,160 consumers were connected to the mains, with a total equivalent of 140,101 8-c.p. lamps. The total at the corresponding period last year was 113,672, an increase of 23 per cent. in total connections. The estimated revenue from street lighting was £633. 7s. 5d., and from private supply £1,435. 12s. 3d., a total of £2,098. 19s. 8d. The estimated revenue for the corresponding month last year was £1,965, the present being, therefore, 7 per cent. more. The Swansea Council recently applied for power to borrow a further £7,000 for extensions in the municipal telephone system. They have received a similar reply as that mentioned in another column with regard to the Brighton extensions, and have deputed the chairman of the Municipal Telephones Committee to confer with the Postmaster-General on the subject.

Epsom.—The total amount of electricity generated during the last quarter was 32,449 units, as compared with 27,199 in the corresponding period last year. Of this amount 26,517 units were sold for private and public lighting, as compared with 22,191 units of last year. The income from public lighting was £336, as against £299, and from private lighting £324, as against £245. A statement of accounts for works costs and income for the quarter showed the expenditure to have been £440. 9s. 11d., and the income £749. 5s. The estimates of income and expenditure of the electric light undertaking for the ensuing six months were: income, £1,679; expenditure, £1 154, which included provision for improving the lighting power of 50 columns by the substitution of tantalum lamps for the 8-c.p. lamps now in use at an increased cost of 12s. 6d. a column, also £40 for eight additional lamps to be erected.

Pembroke.—The Urban District Council have received sanction to the extension of the electric lighting system in the town, and it is understood that the laying of about eight miles of cable will be begun at an early date. In the main streets existing incandescent, electric, and gas lamps will be replaced by powerful arc lights. The scheme further provides for laying down cables for household supply, and possibly for generating power in Sandymount and Sydney-parade districts, and the Shrewsbury, Aylesbury, Sandford, Burlington, and Anglesea roads and adjoining thoroughfares. A number of applications have been received for private installations. The question of further reducing the charge of 4½d. per unit for lighting purposes is also under consideration. The plant at the station now in use will be amply sufficient to meet the proposed extensions. The whole scheme is to be completed long before the international exhibition in Herbert Park takes place.

Cricket.—On Saturday last members of the cricket section of the General Electric Co. Athletic Club from Witton Works, Birmingham, journeyed from Hammersmith to play the annual cricket match with the Robertson Electric Lampmakers. We are informed that although Birmingham brought with them an extra strong team, they finally suffered defeat by 18 runs. The finish of the match was very exciting, the last six wickets of the Birmingham team falling for seven runs. After the game both teams and their friends were invited to dinner at the Brook Green Hotel, where an excellent spread was provided. The chair was taken by the president of the Robertson Lampmakers' Club, Mr. C. Wilson. After the dinner a smoking concert was held, at which several artists, including members of both teams, appeared. The Birmingham contingent left at 12 40 a.m. on Sunday for Birmingham, after a very pleasant outing, with a very good impression of the cricket abilities of their fellow employés at Hammersmith.

Radcliffe.—The amount of electricity generated during July was as follows: lighting section—generated, 6,230 units; used at station, 2,570 units; used in the Council's departments, 108 units; tramways section, 27,187 units. The following amended charges will come in force on Oct. 1—namely: Lighting purposes—for consumption not exceeding 250 units per annum, 5d. per unit; exceeding 250 units, but not exceeding 500 units per annum, 4¾d.; exceeding 500 units, but not exceeding 1,000 units per annum, 4½d.; exceeding 1,000 units, but not exceeding 1,500 units per annum, 4¼d.; exceeding 1,500 units, but not exceeding 2,000 units per annum, 3¾d.; exceeding 2,000 units per annum, 3½d. Power purposes—for consumption not exceeding 60 units per brake horse-power per quarter, 2d. per unit; exceeding 60 units, but not exceeding 125 units per brake horse-power per quarter, 1¾d.; exceeding 125 units per brake horse-power per quarter, 1½d. Heating—2d. per unit. All to be subject to a discount of 5 per cent. if the account is paid within 21 days from date of demand.

Ashton-under-Lyne.—In consequence of the receipt of a letter from the Ashton under-Lyne and District Property Owners' Association, the Local Government Board have written to the Guardians as follows: "I am directed by the Local Government Board to advert to your letter of the 5th ult., in which you apply for an order authorising the Guardians of the Ashton-under-Lyne Union to borrow a sum not exceeding £5,000 to defray cost of electric lighting works at the workhouse. I am directed in the first instance to state that in ordinary circumstances the Board consider it desirable the Guardians should obtain electric light from a public source, rather than they should themselves construct generating works. I am to inquire, therefore, whether the Guardians consider the question of obtaining a public supply of electricity before deciding to instal the proposed works, and, if so, on what grounds they desire to adopt the latter course. I am also to inquire whether there are any special reasons for lighting the new infirmary and part of the workhouse by electricity, seeing that, as the Board understand, these buildings are already lighted or fitted for lighting by gas. In this connection I am to forward for the observation of the Guardians a copy of a communication which the Board have received from the Ashton-under-Lyne and District Property Owners' Association. I am to add that the Board should be furnished with full details as to the works to be covered by the proposed expenditure.—I am, sir, your obedient servant, Noel Kershaw, assistant secretary." The matter has been referred to the Electricity Committee, the chairman of which has stated with regard to getting the current from the public authority that 2½d. per unit was being charged to the infirmary, but by spending the money they now proposed on a complete plant they could manufacture their own electricity at a cost not exceeding 1d. per unit. In that way, therefore, there would be a great saving.

Manchester.—The following statement of work done recently in preparation for the winter's load on the Corporation electricity plant has been presented to the Electricity Committee: At the Dickinson-street station superheaters have been added to the boilers to decrease the consumption of coal and increase the steam capacity of the station. Two 750 kw. turbines have been added, capable of supplying current for both traction and light purposes. Owing to the fact that it is impossible to increase the boiler capacity at that station for want of space, it is intended to receive there a portion of the high-tension three-phase current from the Stuart-street station, and transform it for supplying the city. For this purpose three 500-kw. motor converter sets have been fixed, with high-tension and low-tension switchgear. Bloom-street station is now working to its full capacity, and is pronounced to be in a highly efficient condition. At Stuart-street, the largest station, two 6,000-h.p. sets, forming the extension of the station, have been practically completed, and for a few days one of them has been running on the town load very satisfactorily. The plant in the original station at Stuart-street has been thoroughly overhauled, and together with the six engine sets in use there has been put in a condition for meeting the winter's load. More plant has been installed at several sub stations in order to deal with the increasing demand. Additional balancing machinery has been fixed at Hunt's Bank and Piccadilly, with a view to improving the general distribution of pressure on the network of mains. By far the most important work carried out this year has been the large extension of the underground mains. Many miles of fibre ducts have been laid, by means of which wires for further extensions can be laid without disturbing the streets and inconveniencing the public. Eight new 1in. pressure fibre ducts have been run in various parts of the city from the Dickinson-street station, so that the Corporation is in a position to deal with any increased demand which is likely to be made for a few years to come. Considerable attention has been devoted to improving the system of mains, and steps have been taken to secure the prompt location of faults should they arise. The electric lighting order for Gorton has been taken over, and the greater portion of the mains have been laid in that district, including those necessary for street lighting in Hyde-road, Wellington street, and Cross-street. The reduction in the price of electricity from 5½d. to 4½d. a unit comes into force on Oct. 1, and a very large increase in the demand for current is anticipated as a consequence. Many orders have, in fact, been already given. Laying the new mains has entailed an expenditure of £13,000, and the contracts entered into and work done have amounted to £25,000.

Hammersmith.—The premises of 44 additional consumers, representing a maximum of 1,674 8-c.p. lamps, have been connected to the mains, and 24 consumers have been disconnected. The present number of consumers taking current from the mains is 1,650. Mains are to be extended to supply new consumers at a cost of £150, £130, and £55 respectively. The London County Council have requested that the Borough Council should lay certain proposed electric light mains at a depth of at least 3ft. 6in. below the surface where such mains pass under the route of the tramways authorised to be constructed by the County Council; also that in future the Borough Council should lay all electric mains under the footways in roads where there are tramways or which are likely to form part of tramway routes, or, where it should be necessary to place the mains in the carriageway, to lay them as near to the kerb line as possible. The electrical engineer has reported that at the present time mains were being laid practically in accordance with the suggestions of the County Council, with the exception of the depth below the surface of tramway routes, to which the committee consider there is no objection, and they have agreed to comply with the requests of the London County Council. It has been decided to support the Poplar Borough Council, who are urging upon the London County Council the desirability of inserting clauses in its next General Powers Bill empowering borough councils to wire and fit consumers' premises for the use of electrical energy and to obtain loans for this purpose. The electrical engineer has presented a report upon the advisability of modifying the present system of discounts with a view of encouraging an increased demand for power from the Council's station, in which he points out that, in considering any reduction in the price to be charged for an article, there are several things to be considered, the chief item being competition; in addition, the cost of production, the value of the article, and the amount of business to be done must also be borne in mind; that the present price of 1½d. per unit with restrictions as to the period of use is too complicated, and does not tend to encourage the use of electricity for power as much as he hoped. The system of discounts (although very liberal and lower than the prices charged by adjoining undertakings at the time they were arranged) is now somewhat high. Other systems of producing power have advanced very rapidly during the past year or so, therefore it is necessary that the prices for electricity should be revised in order to encourage the use of the Council's supply for the large amount of power used in the district. That the charges can be further reduced and still show a profit is proved by last year's accounts, wherein the works cost per unit (including power and lighting) is only ·8d. per unit sold to consumers. The actual cost of the power units being very much less than this, say not more than ½d. per unit, a selling price of 1d. per unit will leave a handsome profit providing that sufficient units are sold, but it must be remembered that the output is the governing factor, as a profit of ·25d. per unit on 1,000,000 units is only just over £1,050; and that after very carefully considering this subject he had come to the conclusion that a uniform rate of charge with discounts will meet the

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circumstances in a more satisfactory manner than any system of maximum demand with restrictions as to the period of use. In consequence, the following resolutions were submitted at a special meeting on Wednesday: "That from and after the reading of the meters at the end of the Michaelmas quarter a uniform rate of 1½d. per unit be charged for electricity supplied for power purposes, subject to the following discounts: on accounts exceeding £10, but not exceeding £25 per annum, 10 per cent.; on accounts exceeding £25 but not exceeding £50 20 per cent.; on accounts exceeding £50, but not exceeding £100, 30 per cent.; on accounts exceeding £100, 33⅓ per cent.; and that in the case of a large consumer whose accounts for power supplies by the Council amount to over £100 per annum special arrangements be made, if so desired by the consumer, to supply current for both power and lighting purposes at the rate of 1½d. per unit less 33⅓ per cent. discount, provided that the amount of current used for lighting does not exceed 20 per cent. of the total consumption per annum, and subject to the consumer entering into an agreement to drive the whole of his machinery by means of the power supplied by the Council for a period of not less than five years."

PROVISIONAL PATENTS, 1905.

SEPT. 11.

13312. Improvements in and connected with telephone exchanges working on the central microphone battery system. Hermann Oppenheimer, 55 Redcross-street, Barbican, London. (Aktiengesellschaft Mix und Genest, Germany.)

SEPT. 12.

13368. Improvements relating to automatic electrical time switches. John Berg and Frank Clemens Wilson, 104, Colmore-row, Birmingham.

13375. Improved means for connecting tubular electrical conduits together and to their fittings. James William Brooks, trading as the Walsall Hardware Manufacturing Company, and Albert Edward Read, 128, Colmore-row, Birmingham.

13380. An improved cut-off attachment for telephones. Edwin Wright, 88, High Holborn, London.

13381. Reversible galvanic battery. Charles Bernard Askew, 55, Chancery-lane, London. (Complete specification.)

13384. An improvement in magnetic motors. Thomas Grainger, Oak Tree, Rogerstone, Monmouthshire. (Complete specification.)

13401. Continuous-current machine with cord winding and reversing poles. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

13403. Improved incandescence bodies of tantalum wire for electrical glow lamps. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 13, 1904, being date of application in Germany.) (Complete specification.)

13419. Telephone improvement and relating to. Joseph Skwirsky, 36, Newman-street, London.

13424. An electric plug adaptor. Oliver Zimmer, 82, Mark-lane, London.

13427. Improvements in and relating to apparatus for purification of water by electrical means. James Franklin Lester, 77, Chancery-lane, London. (Complete specification.)

13432. New or improved electric lighting apparatus for use in connection with cycles and the like. Jacob Lewy, 31, Bedford-street, Strand, London. (Complete specification.)

13447. Improvements in electric motor-starting and controlling switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13448. Improvements in controlling means for automobiles. The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

SEPT. 13.

13459. Improvements in connection with electricity supply systems. George Wilkinson, Tower-chambers, Halifax.

13484. Improvements in electrodes and in methods of making same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13485. Improvements in electric fuses. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

13519. Improvements in and relating to electric control systems. The Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 13, 1904, being date of application in Germany.) (Complete specification.)

SEPT. 14.

13528. Improvements in electric heaters. George Davis, 15, Victoria-street, London.

SEPT. 15.

13620. Improved slow-speed operating mechanism for electric motor starters and like resistance switches. Verity's Limited and Arthur Edgar Gott, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

13634. Improvements in devices for mechanically and electrically connecting tubes or conduits to fittings or other parts. George Whitehead, jun., 33, Chancery-lane, London.

13646. An improved ball joint or socket suitable for supporting electric light fittings and for other purposes. Hugo Hirst and John Hillery Collings, 71, Queen Victoria-street, London.

13673. Bracket for carrying a light on the head and electrical fittings for use therewith. Orazio Mullauro, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13685. An improved electrical alarm for indicating a stoppage or shortage in the cooling water supply of gas-engines. Hans Pastow, 40, Chancery-lane, London. (Complete specification.)

13694. Improvements in and relating to type-printing telegraph transmitters. Frederick Herbert William Higgins, 18, Southampton-buildings, Chancery-lane, London.

13697. Improvements in inspection boxes and fittings for use with steel conduits for electrical purposes. Charles Edward Gunner, "Elmbank," Kemble-road, Waddon, Croydon.

SEPT. 16.

13751. Improvements in and connected with electrical resistances. Michael Chapman and George Luther Stone, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED

To be published Oct. 5.

1904.

6556. Electric arc lamps. Davy.

15453. Electric arc lamps. Oliver.

19475. Electric cranes or the like. Imray. (Siemens-Schuckertwerke G. m. b. H.)

19578. Electric train control systems. British Thomson-Houston Company, Limited. (General Electric Company.)

19651. Electric railways and tramways. Clark.

19749 Apparatus for use in the distribution of alternating electric current. Berry.

19838. Means by which the points of an electrical railway or car line may be operated from an approaching car. Miller.

20285. Fireproofing electric cables. Martin.

20585. Overhead conductor system for electric traction. Brooks and Watson.

22362. Arc lamp hoisting gear and fittings for same. Crompton and Co., Limited, and Abbott.

22364. Electrical switches. Crompton and Co., Limited, and Abbott.

23632. Hangers or ears for electric trolley wires. Allen and Sharples.

23685. Electric projecting lamps chiefly for enlarging and projecting lanterns. Kamm.

24138. Electric cable junction and fuse boxes. Le Feuvre and Greene.

24177. Thermo-electric batteries Johnson. (A. Wolff, jun., and Co.)

24180. Protective devices for electric transmission systems. British Thomson-Houston Company, Limited. (General Electric Company.)

24351. Field magnets or like parts of dynamos and other rotary electric machines. Walker.

24384. Combined mouth gag and electric light. MacCormac and Dental Manufacturing Company, Limited.

24448. Multiple-filament incandescent lamp. Klopfenstein.

24464. Field windings of series-wound dynamo-electric machinery. Hills, Urquhart, and Honey.

24477. Electric arc lamps. Lewis, Case, and Reason Manufacturing Company, Limited.

24632. Electrically-operated switches. Eckstein and Parker.

24698. Electric switches. British Thomson-Houston Company, Limited. (General Electric Company.)

25265. Manufacture of storage battery or accumulator electrodes. Boult. (Accumulatoren und Elektricitäts-Werke Act.-Ges. vorm. W. A. Boese und Co.)

25638. Space telegraphy. Stone. (Date applied for under International Convention, Nov. 24, 1903.)

25644. Space telegraphy. Stone. (Date applied for under International Convention, Nov. 25, 1903.)

25903. Electric secondary batteries. Ekstromer Accumulator Company, Limited, and Oppermann.

25985. Means for automatically winding clocks and the like with the aid of electricity. Hartmann.

1905.

167. Insulation of wires conducting electricity. Longford.

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381. Method of and means for electrically lighting up street and other gas lamps whose burners are beyond reach of hand. Pare.

514. Field windings for single-phase alternating-current electric motors. Zani.

534. Twin or double carbon arc lamps. Verity's Limited and Worsley.

1507. Electrodes for arc lamps. Lake. (Compagnie Générale d'Electricité.)

4957. Printing telegraph systems. Page. (Swift.)

5370. Methods of insulating electric conductors. British Thomson Houston Company, Limited. (General Electric Company.)

6987. Electric warp stop-motion mechanism for looms. Whitney.

6987A. Electric stop-motion mechanism for looms and other textile machinery. Whitney. (Date applied for under Patents Rule 9, April 3, 1905.)

7006A. Earth galvanic cells. Jahr. (Date applied for under Patents Rule 9, April 3, 1905.)

7787. Lifting magnets. Eastwood.

10694. Means for neutralising static electricity. Chapman.

10710. Transmitters for wireless telegraphy. Thompson. (Gesellschaft für drahtlose Telegraphie m. b. H.)

12590. Electrical igniters for explosion motors. Mann. (Date applied for under International Convention, July 11 1904.)

13681. Regulating mechanism for arc lamps. Brockie.

14567. Methods of regulating alternating-current dynamo-electric machines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, July 15, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	5¾-6¼ xd
—— 6 per cent Cum. Pref., 1-100,000	5	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	99-101
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	¾-⅞
—— Non. Cum., 6 per cent. Pref.	2	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100	91-94
—— 4½ per cent. 2nd Debenture Stock	100	78-81
Callender's Cable, Debentures	100	109-111
—— Ordinary	5	10-11
—— 5 per cent. Pref.	5	5 -5¼
Crompton and Co.	3	1¾-1¾
—— 5 per cent. Debentures	100	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	1⅝-1⅞
—— "A" Shares, 01-017,139	5	2-2¼
—— 5 per cent. Debentures	100	89 94
—— 4 per cent. Deb. Stock, Red.	100	85 88
Electric Construction, Nos. 1 to 112,100	2	¾-1⅛
—— 7 per cent. Cumulative Pref.	2	1⅛ 1¼
—— 4 per cent. Perp. 1st Mort Deb.	100	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	97-101
W. T. Henley's Telegraph Works, Ordinary	5	12 13
—— 4½ per cent. Preference	5	5¼-5½
—— 4½ per cent. Debentures	100	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	15½-16¼
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	10-10¼
Telegraph Construction and Maintenance	12	33½-35½
—— 5 per cent. Bonds	100	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10	11¾-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	9⅞-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	11-12
—— 4½ per cent. Debenture Stock, Red	100	106-108
Bromley (Kent) Electric Light and Power Co.	5	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	104-107
Brompton and Kensington, Ordinary	5	9¾-10¼
—— 7 per cent. Preference	5	9⅜-10⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	9¼-9¾
—— Nos. 60,001-80,000	5	9¼-9⅜
Cambridge Electric Supply Company, £10 Ord.	8	12¼-13⅜
Central Electric Supply, 4 per cent. Guar. Deb Stock	100	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	6¾-7¼
—— 4½ per cent Cum. Pref., 80,000	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	4⅜-5
—— ditto (1903) 40,001-80,000	5	4⅜-5⅛
Chelsea Electricity Supply	5	5⅜ 6. xd
—— 4½ per cent Debentures	100	108-110
City of London, Ordinary	10	11-11¼
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104 106
County of London Electric Supply, Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	10	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	111-114
—— 4½ per cent 2nd Debentures Prov. Certs	100	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	5¾-6¼
—— 6 per cent. Cum. Pref.	5	6¼-6⅜
—— 4½ per cent First Mort. Deb.	100	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	2¼-3
—— 5 per cent. Debenture Stock, Red.	100	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	99-102
Havana Electricity, 1-15 000	10	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	7⅞-8¼
Isle of Wight Elec Lt and Pwr., 4 p.c. Db. Stk Red.	100	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	13/16-15/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	12-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10¼
London Electric, Ordinary	3	2-2½
—— 6 per cent Pref.	5	4¼-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	99-.02
Metropolitan Ordinary, 00,001-300,000	5	10⅜ 11¼
—— 4½ per cent. First Mortgage Debenture Stock	100	109 113
—— 4½ per cent. Cum. Pref.	5	5⅜ 5⅝
—— 3½ per cent. Mortgage Debenture, Red	100	99 101
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	100-102 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5	7⅜ 8¼
—— do., 57,0 0-75,000	5	7⅜-8¼
—— 5 per cent. Pref., 1-57,00	5	6¼ 6⅜
—— do., 57,0 0-75,0.0	5	6¼-6⅜
Notting Hill Electric Lighting	10	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	6¼-7
—— 4 per cent. Debenture Stock	100	99 101 xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	101-104
Smithfield Markets Electric Supply, Ord 1-12,000	5	2¼ 2⅜
—— 4 per cent. Debenture Stock	100	76-80
South London, Ordinary	5	3¼-4
South Metropolitan Electric Light and Power, Ord.	1	13/16-15/16
—— 7 per cent. Cum. Pref.	1	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	106-109
—— Ditto, June, 1904	—	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	13¾-14¾
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	£8 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	4¾ 5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5¼-5⅜
Westminster, Ordinary	5	12¼ 13¼
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5	6¼-6⅜
Electric Tramways.—		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5	5⅜-6¼
—— Ord.	5	8¼-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-106
Barcelona Tramways, Ord., 1-20,000	10	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	9 -10
—— 5 per cent. Deb., Red., 1-600	100	98-101
—— 4½ per cent. Red Deb. Stock	100	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75 001-150,606	1	27/32-31/32
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd.	100	96-98
British Columbia Electric Railway Co., Ord. Def.	100	119-122
—— Ord. Pref.	100	104-107
—— 5 per cent. Cum. Perpetual Pref. Stock	100	102-105
—— 4 per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	103-105 p.c
—— 4 per cent. Vancouver Power Deb.	100	98-101
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	9-9¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100	123-125
—— 4½ per cent. 2nd Deb. Stock	100	99-101
Buenos Ayres and Belgrano Trams	5	3 -4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5⅝-5⅞
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5¼
—— 5 per cent. Deb. Stock, Red.	100	106-107
—— Prov. Cert., all paid	100	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	97-99
Calcutta Tramways, 1-102,268	5	9¼-10
—— 4½ per cent. 1st Deb. Stock, Red.	100	107-108
Cape Electric Tramways, Nos. 1-480,000	1	1⅜ 1⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	3¾ 4¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	100 103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	13¼-14¼
—— 6 per cent. Cum Pref.	10	15-16
—— 4 per cent. Debentures	100	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-50,0 0	10	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100	94-97
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4, per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref. Nos. 30,001-60,000	5	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	83-88
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum Pref.	10	9¾ 10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	99 102
Madras Elec. Trams (1904), 5 per cent. Deb. Stk., Rd.	100	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	7/32 9/32
—— 5 per cent. Cum. Pref., 500,001-1,000 000	1	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	105-107
Montreal Street Rail., Sterling 5 per cent (Mort.) Deb., 1908, 1-600	100	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-1¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10	12
—— 5 per cent Cum Pref	10	9¾-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb Sk.	100	104-107
Potteries Electric Traction, Ordinary, 20 001-40,000	10	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	9-9¼
—— 4½ per cent Debenture Stock	100	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,1-2 6 per cent. Preference	1	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	100 p.c.
Electric Railways.—		
Central London, Ordinary	100	90-92
—— 4 per cent. Pref.	100	101-103
—— " " deferred	100	78-81
—— 4 p.c. Deb. Stock (Prov. Script Certs, fully paid)	100	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100 ..	40-42
—— 4 per cent. Debenture Stock	100 ..	107-110
—— 5 per cent. Pref. Stock '91	100 ..	118-121
—— ,, ,, ,, '95	100 ..	117-120
—— ,, ,, ,, '01	100 ..	113-116
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.	— ..	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	99½-100½
Waterloo and City, Ordinary	100 ..	90-92

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100 ..	111½-112½
—— Deferred Stock	100 ..	107½-109½
—— 6 per cent. Cum. First Pref	10 ..	13½-14½
—— 6 per cent. Cum. Second Pref.	10 ..	12-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100 ..	98½-101½
—— 4 per cent. Deb. Stock, Red.	100 ..	104-106
Oriental Telephone and Electric Company	1 ..	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1 ..	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep 16	1,440	1,426	+ 14	- 1,411A	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Aug. 26	424	403	+ 21	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sep. 17	1 0·2	1,077	- 25	- 444	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 16	361	371	- 10	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 13	970	1,034	- 64	+ 656	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 14	1,675	2,037	- 362	+ 582	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 16	1, 50	1,170	- 20	- 864	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 17	2,014	1 956	+ 88	+ 1,733	40	38	March 31	96.766	20,205,186	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 13	1,826	1,294	+ 532	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 16	4,540	4 864	- 324	- 5,577	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 17	1,216	1,165	+ 50	+ 835	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 15	4,960	5,225	- 265	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 16	1,144	1,053	+ 81	—	10 60	10·60	March 3	—	—	—	—	—	—	—
Burton Corporation	,, 17	315	369	- 54	- 965	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 9	2,018	2,011	- 23	+ 363	26†	—	,, 31	112,209	23,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 16	196	228	- 32	- 472	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 16	5,981	6,087	- 106	- 1,552	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway	,, 17	2,310	2,493	- 183	- 513	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	Aug. 1	241	258	- 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	Sep. 14	514	539	+ 15	+ 785	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6 64	—	4·69
Darwen Corporation	,, 1	250	251	- 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Aug. 12	344	317	+ 27	—	4½	4½	,, 3	11,250	2,853,200	281,743	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Sep. 15	137	129	+ 8	+ 464	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 15	3,830	4,034	- 144	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1 23	9 07	5,691	5·55
Dublin S. District, Electric	,, 15	1,019	1,007	+ 12											
Dundee City Tramways	,, 13	1,009	854	+ 145	—	22	22	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 18	861	729	+ 132	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 16	15,724	15 511	+ 213	+11,012b	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 13	1,491	1,531	- 40	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8 56
Huddersfield Corporation	,, 16	1,394	1,337	+ 57	+ 679	35	35	,, 3	69,938	12,838,150	1,666 262	1 24	9·71	1,923	—
Hull Corporation	,, 16	2,165	2,183	- 16	+ 473	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 13	120	142	- 22	- 675	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Aug. 30	225	256	- 31	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Sep 19	6,053	6,078	- 25	+ 3,126	89	89	March 2	288,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 9	10 821	10,655	+ 166	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 17	1,509	1,561	- 52	- 5 1A	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 9	15,079	13,773	+1,251	+56,960	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 14	141	156	- 15	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 16	12 870	12 619	+ 251	+14,673	149	131½	March 31	531,966	126,900,875	14,123,124	1·19	10 73	4,299	6·99
Metropolitan District Railway	,, 17	6,745	6,793	- 90	- 3,289	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 17	17,051	16,885	+ 165	- 111	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 16	135	133	+ 2	+ 207	—	23	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 16	3,762	3,702	+ 60	+ 2,982	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 11	1 511	1 142	+ 369	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 9	2,184	2,324	- 140	+ 1,624	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	336,517	1·24	9·24	1,102	7·92
Rotherham Corporation	Aug. 3	440	645	- 205	—	9½	7½	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	Sep 18	4,356	4,286	+ 70	—	70½	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 17	5,038	4,743	+ 295	+ 5 486	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 13	1,023	1,059	- 31	- 511	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 15	796	562	+ 234	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 17	1,367	1,274	+ 93	+ 891	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	Aug. 30	213	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	Sep. 16	804	793	+ 11	+ 625	11·85	10·5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 14	2,077	1,120	+ 957	—	46	8·62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 13	847	739	+ 107	—	—	7½	,, 31	—	—	—	—			

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. A Half-year's figures.

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NOTES.

University College, London.—The work of the engineering school at University College, London, will begin on Tuesday next. The prospectus of the school shows some important developments in its work since last year. The three years' course for students qualifying for the diploma or for the degree in engineering has now been fully organised. In connection with the department of civil engineering and surveying an important new departure has been taken in the form of enlisting the services of eminent engineers in practice for special courses. For instance, Mr. H. Deane, M.I.C.E., is to give a course in railway engineering, and Mr. A. T. Walmisley, M.I.C.E., in waterways, roads, street paving, and tramways. By this means the teaching of the school will be brought into direct touch with present-day practice.

The Institution.—The issue of the *Journal* dated September contains papers on "The Eddy-Current Brake for Testing Motors," by D. K. Morris and G. A. Lister (Birmingham); "Alternating-Current Motors in Industrial Service," by P. D. Ionides (Glasgow); "E.M.F. Wave Forms," by E. A. Biedermann and J. B. Sparks (Students' Section); "The Present Electrical Equipment of the London County Council Tramways," by J. W. Anson (Students' Section); "Application of Electricity to Mines," by A. C. Anderson (Birmingham); "Electric Heating: its History and Development," by A. E. Jepson (Students' Section); and "Equipment of a Generating Station, with special reference to the Chelsea Station of the Underground Electric Railway." Members are reminded that the volume now consists of two volumes annually.

Wireless Telegraphy.—The Berkshire cavalry camp has become a centre of attraction by reason of an installation of wireless telegraphy. The instruments are carried on the body of a cart, to which another cart containing the dynamo can be attached. The apparatus is in full operation, and is connected with an installation at Aldershot. Other stations are being equipped throughout the manœuvre area, and Sir John French is able to communicate from his headquarters with almost any portion of his command. Another account of the utility of the ethergram comes from New York, where members of the Stock Exchange are having wireless telegraphic receivers installed in the tonneau of their motorcars. By this means and a transmitting apparatus installed at the railway station by the Exchange it is stated that they are enabled to conduct their daily business from the open country, communication with Wall-street having been maintained over a distance of 20 miles, which, the report states, may be increased to 50 miles.

The British Association.—The South African party of the British Association are homeward bound on the "Durham Castle," armed with mementoes of every description, from tomahawks and assegais to ostrich eggs and birds' nests. All the members expressed themselves delighted with the tour, but latterly they have felt the effects of the constant travelling. Scarcely had the visitors embarked at Beira, however, than it devolved upon them to return to shore in order to attend a reception by the Governor. Prof. Darwin, in proposing the health of the Portuguese Sovereign, said it was easy to recall the battlefields on which British and Portuguese arms had fought side by side, but science was now devoted to the pacific arts. Senhor Rapozo, president of the Beira Chamber of Commerce, proposed the health of the association, and Prof. Darwin, in responding, acknowledged the cordial reception which Beira had given them. The party subsequently re-embarked in the "Durham Castle," which left in the afternoon. The tour is voted a great success; numbers of papers were read by eminent scientists, various places of interest were visited, in the course of which the party witnessed the opening of the bridge over the Victoria Falls, and, by all accounts, the visit has imparted a decided impetus to education, and especially scientific education, in South Africa.

Over-Bridge Tramways.—It is something of a novelty to find the London County Council and the City Corporation marching hand in hand, but the favourable reception accorded by the latter authority at their meeting this week to the overtures from Spring-gardens in regard to the Embankment tramway scheme suggests that the House of Lords will find themselves confronted with a still stronger case for sanctioning the County Council's scheme when it again comes before them next session. This is the more likely to be the case seeing that since the summary rejection of the measure by the Upper Chamber in the last session of Parliament the London Traffic Commission has reported favourably upon such a scheme. The Corporation have referred to the Bridge House Estates Committee the Council's suggestion that the City authorities should simultaneously introduce a Bill for the rebuilding or widening of Blackfriars Bridge, with power to obtain expert advice, and as there is likely to be another conference on the whole subject between the Council and the Corporation, it is evident that the former body is more determined than ever to gain its object. It is scarcely necessary to remind our readers that since the rejection of the measure some of the borough councils have also assured the County Council of their support, and with the strong expressions of opinion that have been delivered by a substantial portion of the public the Peers are likely to at any rate give the subject more careful attention than was the case last time.

Municipal Economics.—The fourth year of operation of the East Ham Corporation tramways shows a satisfactory result, and, as sometimes happens in such circumstances, the councillors are not of one accord concerning the allocation of profits. The gross surplus was £11,394, and after providing for interest and sinking fund charges, there remains a net balance of £2,612. Now considering that the capital outlay to date totals £156,253, prudence would suggest placing this sum to the depreciation and reserve fund, which course was, in fact, decided upon. At a recent meeting, however, that resolution was rescinded, and the matter was referred to committee to report upon a proposition that a sum equal to a penny rate should be voted to the relief of the general district charge. The advocates of this step refer to the neighbouring borough of West Ham as a justification for the course proposed. We are not sure that the latter undertaking did well to devote such a large sum as £7,000 to the relief of the rates, but the circumstances were somewhat exceptional, since a profit of over £10,000 was made on the first year's working, and the grant to the rates was made after setting aside over £3,000 for depreciation. The sum shown as placed to depreciation and reserve at East Ham for the preceding year is £342, which is not a great deal in relation to the capital outlay, and the Corporation will be well advised to think well before making the users of the trams pay rates twice over, especially as, even from the ratepayers' point of view, such arrangements may prove to be but robbing Peter to pay Paul.

Wages in Electrical Works.—A strike of considerable magnitude has been threatened in the German capital, and Messrs. Siemens and Halske and the Allgemeine

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Elektricitäts-Gesellschaft, taking time by the forelock, last Friday closed the departments affected, some 8,000 men being placed on the unemployed list. The workmen in these factories contend that, owing to the cost of living having considerably increased, it is necessary to have a minimum wage of 27s. per week. The companies maintain that the ruling prices are too low to permit of an increase in wages of 15 per cent., especially as the working day has been reduced from 10 to 9 hours. They are prepared, however, to grant an increase of 5 per cent., and have intimated their willingness to reinstate the men as far as possible if their representatives withdraw all other demands. At the moment of writing it is not certain whether the offer will be accepted. The situation is of considerable interest to manufacturers in this country, for wages are the determining factor in cost of production, and this has hitherto formed the chief handicap to British manufacturers, the price of materials being pretty much the same in both countries. A few years ago the Kaiser declared Socialism to be "an ephemeral phenomenon,' despite which it is making considerable headway within his realms, with a consequent equalising tendency in the cost of manufacture. The companies in question, however, decided to combat its inroads, for which purpose concerted action was agreed upon. It is difficult to exaggerate the detrimental effect which these conflicts between capital and labour exercise upon a nation's commerce, and the statement in the recent Board of Trade report that, though several disputes of this kind occurred during the past year, they were nearly all settled by conciliatory agencies without cessation of work affords some cause for gratification at home. Later information from Berlin indicates that, instead of coming to an end, the dislocation is likely to extend.

Wolverhampton Tramway Finances.—Alderman C. T. Mander, chairman of the Wolverhampton Corporation Tramway Committee, has indited a somewhat lengthy reply to criticisms upon the form of traction in use in that town and his own predictions as to the profit which would accrue from the introduction of the tramway. He acknowledges that the Lorain surface-contact system consumes ·24 of a unit more energy per car mile than is the case with 39 other undertakings referred to, but points out that even so the total operating costs are ·3d. less. Beyond this it is claimed that the cost of repairing faults is less with the Lorain than the overhead system, and that, apart from æsthetic considerations, the danger to the public is less. The chairman remarks, too, that this additional current consumption is not an unmixed evil, as the Electricity Committee has the benefit of it. This is certainly the case, though it seems a rather doubtful sort of argument when discussing the tramways on their merits. The alderman proceeds to state that the amount spent last year on renewals was something over £3,000, not £4,790, but, as showing the soundness of Wolverhampton tramway finance, he adds that a further sum of £4,790 was charged to renewals account, and that the Tramways Committee have an accumulated reserve of £8,800 in hand to meet renewals of permanent way, etc., which may not need renewal for some years. Mr. Mander also states that according to the standard form of tramway accounts the Corporation made a gross profit for the past year of nearly £16,000 and a net profit of nearly £5,000, while had the system been owned by a company the surplus would have easily permitted of a 5 per cent. dividend after making liberal allowance for depreciation. The alderman's reply is not altogether devoid of an element of self-satisfaction, for which there is some justification, as the Lorain system has not yet proved the dismal failure that some opponents of the surface-contact system predicted, though it renders connection with neighbouring tramways difficult. It was an innovation on the part of the Corporation, which may or may not turn out an expensive one, but it will at least have contributed to a solution of the claims of the various systems; and, meanwhile, Wolverhampton people have the consolation of knowing that they are in a more favourable position than some undertakings using the overhead system.

Mexico.—English manufacturers in quest of new fields have latterly been casting their eyes eastward, but it is not only in the Orient that the merchant may find another outlet for his wares. If he turns to the West he will find the phenomenon of regenerated Mexico scarcely less remarkable than that of awakened Japan, and this journal has joined in the effort to direct attention to that part of the world—a region which, by the way, is already appreciated by our Canadian cousins as well as Brother Jonathan. The great water power of Central America offers great scope for the adoption of electricity, and American capital is taking advantage of the opportunity. One of the latest schemes to be launched from the United States is that of the Mexican-American Power Company, which will erect several electric power plants near the city of Mexico, and build transmission lines for the purpose of providing power for operating industries there and in a number of towns in the vicinity of the power plants. It is one of the largest electrical projects to be undertaken in Mexico, the amount to be invested being estimated at £2,000,000. It is stated that the first instalment of £300,000 in cash has been paid up, and that all preliminary plans are completed for the immediate construction of the power plants. The main plant will be located on the Malinaltenango River, at the foot of the Snow Mountain, near Toluca. Other power plants will be erected on the Meyuce and Tizates Rivers. According to the reports of engineers who have investigated the water supply and fall of these rivers, the three plants will be able to generate not less than 90,000 h.p. The initial plant will have a capacity of 10,000 h.p. The falls in these rivers are so great that it will not be necessary to construct dams or long canals. By digging a short canal the water from the Mallnaltenango River will be dropped into a barranca, or basin, a distance of 820ft., and thus afford the necessary power for the electric generating plant. It is stated that aluminium will be used for the transmission lines. The generating plants will be situated at an altitude of about 10,000ft. In addition to the transmission line to this city, others will be built to Toluca, El Ora, and a number of other towns and mining centres in that part of the country. Until recently outside enterprise has been handicapped by fluctuations in the Mexican currency, but now that a practically settled standard has been adopted this difficulty has been in a large measure overcome, and we hope to see English manufacturers make a larger bid for trade in this quarter.

Rubber.—A recent contribution in one of the dailies supplies some further information anent the rubber-growing industry—an industry whose prospects have been a matter of considerable divergence of opinion lately. It is tolerably clear, however, that it is one of the relatively few branches of commerce in which the supply scarcely equals the demand. This is not entirely because the conditions would not have permitted of greater production—on the contrary, there are large tracts of suitable territory in our equatorial colonies—but rather because the industry has been neglected, or pursued injudiciously. Hitherto the main source of supply has been South America, but latterly Ceylon, the Malay States, and Central America

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have been looked upon as likely fields. The position in regard to the last-named is a matter of some uncertainty, but an undoubted advance has been made both in Ceylon and the Malay States. At present the yield from those regions bears only a small proportion to the world's production of some 56,000 tons per annum, but trade conditions point to their eventually becoming the headquarters of the industry. Three years ago the rubber grown in Ceylon amounted to no more than seven tons, which last year advanced to 35 tons, but there are now planted in that island and the Malay States some 80,000 acres, estimated to yield by 1911 about 16,000,000lb. Even this represents only 12½ per cent. of the world's present output, which, as already mentioned, is hardly adequate to the demand, and the demand, largely owing to the needs of motorcars and 'buses, is steadily increasing; but a great incentive is afforded to Eastern planters to proceed with the industry apace. Largely through unskilful treatment, the supply from South America is becoming less, besides which the more up-to-date methods employed in Ceylon yield a higher grade of rubber. The Eastern product is found to contain 95 per cent. of pure rubber against 75 or 80 per cent. from that raised in the districts surrounding the Amazon. In addition, the article can be cultivated much more cheaply in the East. An impetus has been given to the industry in Ceylon by the discovery that, contrary to previous theories, swampy land is unnecessary, and this has induced tea planters to undertake the cultivation of rubber with a view to augmenting their profits. The rubber trees serve as a shade for the tea plants, though the results are naturally less favourable than with plantations on virgin soil. The other conditions in Ceylon and Malay are quite favourable, as not only is the rainfall suitable, but land can be acquired upon advantageous terms, and the thick Hindoo population is available for labour, so that a reasonable degree of enterprise should result in the development of a substantial industry.

Technical Education.—The Board of Education have issued a circular containing some interesting information in regard to the advantage which accrues from co-operation between employers and managers of technical institutes. As there is considerable variety in the character and amount of such co-operation, the Board have compiled a table of some typical forms of co-operation as showing what has been found actually possible under present conditions. Perhaps the simplest and most common method of co-operation is that in which the employer pays the fees of employés or apprentices taking an approved course suited to the circumstances of the special industry concerned. In many cases students attending approved evening courses are allowed some reduction on the ordinary hours of work without loss of pay. This plan has been extensively adopted, and students have been enabled to attend such classes from about two hours per week to as much as six months in the year in special cases. The care exercised in the selection of the students has, naturally, to be increased as the concession increases. Many large engineering firms employing a number of apprentices make arrangements for their attendance one day per week, or two half days per week, or two or three hours one afternoon or early morning per week, at an approved course of instruction at a technical school. These arrangements are found to work admirably, but still better results are obtained when the total time thus allowed per week approximates to one working day. In certain cases students who have passed successfully through an approved course of study qualify for an increase of pay, and recognition of increased efficiency is also sometimes marked by preference in the matter of promotion. Occasionally employers, or a federation of employers, have selected a few specially qualified students for scholarships, or maintenance fees while attending a two or three years' full-time course specially arranged to bear on their industry. Very carefully thought out schemes for promoting the higher technical education of selected employés have been prepared in particular cases. Certainly not the least valuable form of co-operation is that found in certain districts where committees of employers keep the curricula of the institutes under observation. Where such committees exist it is found advantageous that some of the members should also be members of the institute committee. Such arrangements facilitate another form of co-operation, as where the employers are satisfied of the value of the instruction given at the school, they will often give a preference to the students in dealing with applications for admission to their works. The Board rightly point out that the development of the bond between technical education on the one hand and the practice and commercial aspect of our industries on the other, is a necessary part of further industrial progress. Financial help from employers is of great assistance, but its value is very largely enhanced where the employers take a personal part in supervising the course of instruction, and, by bringing their own experience to bear, ensure that the studies are directed into the proper groove.

Cardiff Trams.—The report of the borough electrical engineer and tramways manager, Mr. Arthur Ellis, for the year ended March 31 is to hand, and reflects the general tale of trade depression during the 12 months. It also voices the handicap under which the department labours of high capital charges and low fares, in regard to the latter of which the Corporation have decided not to make any alteration. Under these circumstances the undertaking might have done worse than come out with a slight balance on the right side. The total working expenses amounted to £74,301, and loan charges represented £33,438, in addition to which the suspense account absorbed £4,448, leaving a net balance of £20. 17s. 6d., without, however, making any allowance for depreciation. In order to counteract the high capital charges and low fares, the management was compelled to resort to economies in operating expenses, with which object a substantial reduction was made in the car mileage, happily without any proportionate loss of revenue. A considerable saving was also effected in the matter of the working staff, and this was facilitated by the adoption of automatic overhead frogs and point irons, enabling the drivers to work the junction points from the car platforms, thus dispensing with a large number of signalmen and point boys. In regard to costs of operation the Cardiff figure of 5·948d. per car mile compares favourably with such large systems as Liverpool, Manchester, Newcastle, Nottingham, Hull, and Bolton, but the income per car mile does not show to advantage in consequence of the low fares. Mr. Ellis takes the opportunity of reiterating that if the system is to show a fair return on the capital outlay, the fares must be adjusted on a fair basis. He estimates that if these were raised so as to produce another 1d. per car mile on the average receipts, the revenue would be increased by £11,000 per annum. In any case he is strongly in favour of a revision on certain sections, notably the Splott route, where passengers are carried some 2½ miles for a penny. We think the Corporation will be well advised in taking heed of the warning given by the president of the Municipal Tramways Association last year against too low fares, at any rate until a sub-

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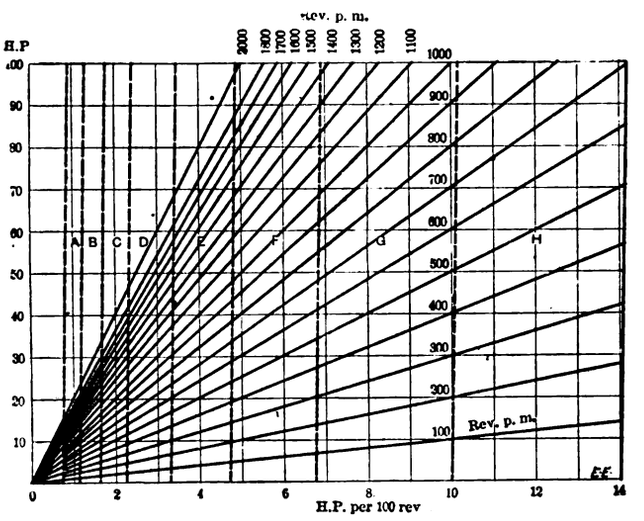
stantial reserve has been accumulated. After investigating the experience of other towns, Mr. Ellis is not inclined to recommend the introduction of a parcels service, especially as Cardiff tradesmen appear to have their own arrangements in this respect. The parcels system is one, we think, possessing considerable possibilities, but it is comparatively young at present, and litigation is pending as to the limits of tramway undertakers' powers in this respect, so that the Cardiff Corporation are perhaps wise in deferring an experiment of this kind. The report contains some interesting remarks in regard to the rolling-stock, the car wheels in some cases having run a total of 78,000 miles, and axle bearings which have been in use for two years are still in good condition. Wear has reduced the diameter of the wheels from 30in. to 26¾in. All these old wheels are being retyred and fitted with deeper tyres, making the diameter 31¾in. In a few cases chilled cast-iron wheels have been tried, but apparently have not given unmixed satisfaction. As the works costs are expected to be further reduced during the current year, an increased balance may be anticipated with some confidence.

Education in South Africa.—The remarks made by the Rev. W. E. C. Clarke to Section L of the British Association, taken in conjunction with the address of Mr. W. Cullen, president of the Chemical, Metallurgical, and Mining Society of South Africa, throw considerable light upon the educational system of Cape Colony and the Transvaal. From the address of Prof. P. D. Hahn to the Education Section of the British Association, referred to in our issue of the 15th inst., it will be noticed that considerable steps have been taken of late years in improving education in the Colony, but the system of primary instruction, which should be the basis of the higher education, appears to still be imperfect. Mr. Clarke gave an interesting *résumé* of the difficulties experienced in the early history of the Colony, when education was pretty much at a discount. A decided advance was made in 1839 by the introduction of the "Herschel system," which gave a stimulus to education, and led to the adoption of the Act of 1865, the basis of the system now in operation. In 1873 a university was established, and a number of high schools have been founded. On the technical side a school of mines was instituted at the South African College in 1896, and the students now complete their course at the Johannesburg Technical Institute. Mr. Clarke considers that the Rhodes scholarships, if made post-graduation scholarships, will not only benefit the holders, but will further higher education. South African education has been gradual of development, and has, perhaps, been a gainer thereby, as it has been the policy of the authorities to benefit by the experience of other countries. One drawback has been the unsatisfactory position of the teacher, and until this has been improved the best results cannot be expected. There are indications that this fact is being recognised. Mr. Cullen had not a very hopeful tale to give in regard to technical education in the Transvaal. He found that, although the inducements offered were very good, the young colonists did not enter the workshops in any numbers, and 90 per cent. of their skilled hands came from oversea. He thought the cause could be traced to the lack of an organised system of apprenticeship, though he was pleased to learn that several private engineering firms had a definite system, which worked excellently. On the mines, however, apprentices were regarded as a nuisance, which is a lamentable state of affairs, and one which, we trust, will be remedied at no distant date. Mr. Cullen quoted the following finding from the report of the commission appointed by the Cape Colony Government: "From the evidence adduced, the commission finds that in almost all professions and trades in respect of which evidence has been given before the commission the more capable and technically trained men have not been trained in this Colony, but have come from other countries; and that a high standard of work in the various trades is hardly attainable by locally-trained artisans owing to the absence of provision for technical education. The absence of any such training debars the Colonial youth from attaining that degree of efficiency which would enable him to compete with the man who has had a technical training elsewhere." It seemed to Mr. Cullen that if this were the state of things in Cape Colony, the Transvaal was in a much worse position. It is consoling, therefore, to learn that the visit of the British Association has imparted a stimulus to education in the Transvaal, and that the establishment of a technical university is probable in the near future. To this Sir Richard Jebb has added his assurance that a keen desire has become manifest in South Africa for a scientific system of education, which, it may reasonably be expected, will have the effect of mitigating the evils complained of by Mr. Cullen.

Motor Rating.—A concise and convenient method of expressing the characteristics of a complete line of motors of one type but of various speeds and outputs is outlined diagrammatically by Mr. C. P. Nachod in the *Electrical World* of New York. In the accompanying illustration the areas A, B, C, etc, correspond to the sizes of frames comprising the line of motors. The radial lines denote speed in revolutions per minute and their ordinates horse-power.



To use the curves, suppose the designer or estimator has an inquiry for a 30-h.p. motor at 1,100 r.p.m. The intersection of the horizontal line passing through 30 h.p. and the line denoting 1,100 r.p.m. falls in the area marked D, whence this is the frame needed. Suppose it is required to find the speed of a motor on an F frame to give 40 h.p. Following the 40-h.p. horizontal until it intersects the line bounding the areas F and G, the intersection is seen to be traversed by the radial line denoting 600 r.p.m., which is, therefore, the lowest speed at which that output could be obtained. Or let it be required to find the horse-power that can be gotten from an E frame with a motor speed of 600. The intersection of the boundary line between E and F with the speed curve for 600 r.p.m. is seen to have an ordinate of 28 h.p, which is the maximum output. It will be seen that in this diagram every motor is represented by a point, whose ordinate is the horse-power, whose position in certain areas is the frame, and whose position on the radial lines is the speed. The boundary lines between the areas are not hard and fast, since one combination of slots and conductors is more

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effective than another; and also since there are only a limited number of combinations available. When a motor rating falls on or very near a boundary line, that rating cannot be positively assumed, but must be checked by a further calculation of the motor. In constructing such a set of curves for a particular line of motors it is only necessary to know the maximum torque, or, what is proportional to it, the maximum horse-power per 100 revolutions for each size of frame. The output of a motor giving 10 h.p. per 100 r.p.m. at 500 r.p.m. is 50 h.p. Therefore, the speed curve for 500 r.p.m. passes through the point whose co-ordinates are 10 h.p. per 100 revolutions and 50 h p. It also passes through zero, and is a straight line; and is thus completely determined. By noting that at the abscissa 10 the speed curves intersecting the vertical are those of 10 times the corresponding ordinate, the curves can be drawn without calculation. The lines marking the frame areas, denoting the maximum horse-power per 100 revolutions, are drawn not quite vertically, but with a slight inclination to the right. This is to allow a higher torque for the higher speeds, due to the improved ventilation, the same heating limit being presupposed for all cases. In all strictness, these may not be straight lines; and the amount of slewing may be difficult to determine. In the line of motors from which these curves were made and used, the motors are so graded that the maximum torques for each frame are approximately in a geometrical series.

Single-Phase Traction. — The first single-phase railway in the southern division of the United States was recently installed between Marietta and Atlanta, at the instance of the Atlanta Northern Railway Company. Energy is generated at a hydro-electric station about 18 miles from the Atlanta terminus at a pressure of 22,000 volts. The trolley line construction is of the general type used in direct-current practice, except that specially heavy insulators suitable for the higher voltage are employed. Within the city limits of Atlanta the trolley voltage is 550, while over all other portions of the railway it is 2,200. A single 4-0 trolley wire forms the entire 2,200-volt distributing system. The trolley wire is suspended from cross spans secured to wooden poles set 90ft. apart on straight track, and about 45ft. apart on curves. The high-voltage trolley line is divided into three sections, each fed from one leg of the three-phase transmission system through oil-insulated self-cooling transformers. There are two transformer stations in each section connected to the same phase, making a total of six stations located approximately 3½ miles apart. The transformer stations are each equipped with one 150-kw. Westinghouse oil-insulated self-cooling transformer, together with the necessary lightning arresters, choke coils, switches, and fuses. The transformer in Atlanta and one in a car-barn near the limit of this city supply the 550-volt section of the trolley, and in order that all transformers may be interchangeable, each is wound so that the secondary voltage of either 2,200 or 550 may be used. As these stations contain no moving machinery, no attendants are required. An occasional inspection of the stations is all that is necessary. The passenger cars are equipped with four Westinghouse 50-h p. motors. The equipment of these cars is notable for its simplicity. The circuit from the trolley passes to an auto-transformer through a double-throw oil switch, which connects it to either one of two taps on the high-tension winding of the transformer according to whether 2,200 or 550 volts is used on the trolley. After leaving the auto-transformer, the circuit passes directly to the ground. The motors may be connected to various taps on the low-tension winding of this transformer, giving five different running points. The connections are made by a drum-type controller, one controller being mounted on each platform. Each controller consists of three drums, one for reversing the relative connections of the field and armature coils of each motor, and the other two, which are directly geared together and operated simultaneously, for varying the voltage impressed upon the motors. The motors are of the conductively compensated type, and are connected permanently two in parallel, the voltage impressed upon each pair of motors being regulated by one of the controller drums mentioned above. The feature of particular interest in connection with the operation of the controller lies in the means employed for preventing sparking in the controller when the connections are changed from one tap to another on the auto-transformer. There are on this transformer six intermediate taps corresponding to voltages 144, 174, 204, 234, 266, and 288 respectively. There are, however, only five running points corresponding to voltages 159, 189, 219, 240, and 277 respectively. It will be noted that these voltages are in each case midway between the ones of the transformer taps. The running voltages are obtained from the neutral point of a so-called "preventive coil"—an inductive coil—which is connected across adjacent taps of the auto-transformer. The segments on the controller drums are so arranged that, in changing the preventive coil from one pair of transformer taps to the next adjacent pair, the circuit is never opened simultaneously at both ends of the coil. In parallel with the preventive coil is connected a "preventive resistance," through one half of which flows the major portion of the current to the motor when the controller is being moved from one running position to another. The preventive resistance is so designed that it takes but little current when subjected to the small voltage between adjacent transformer taps (30 volts), and yet absorbs but little voltage when carrying the full current of the motor. It is evident, therefore, that the motor circuits are never completely opened during operation, and yet there is no direct short-circuit produced between adjacent transformer taps. On the highest running notch of the controller the preventive resistance is cut completely out of circuit, so as to eliminate entirely the loss occasioned by the current due to the voltage between adjacent transformer taps. The freight car is equipped with four motors similar to those used on the four passenger cars with hand control, but in order that this car may be operated on any part of the city system as well as over the company's own tracks, the equipment is arranged for operation on either direct or alternating current. It can be run from a standard 550-volt direct-current trolley, the 550-volt alternating-current trolley in Atlanta, and the 2,200 volt alternating-current trolley between Atlanta and Marietta. To meet these widely different conditions, a combination of rheostatic and voltage control is used instead of pure voltage control as on the passenger cars. The motors are connected permanently, two in series, and the two groups thus formed may be connected to any one of three different taps on the transformer. In starting the car, the motors are connected first to the lowest tap, then to the middle tap through a resistance, next to the middle tap without the resistance, then to the highest tap with the resistance in circuit, and, finally, to the highest tap with the resistance short-circuited. With this equipment three different running points are obtained. When operating on direct current, the motors are connected all four in series and rheostatic control only is used. There are thus four resistance points in addition to the "full-on" position.

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OLYMPIA.

According to programme, as our excellent friends the Japanese would say, the Electrical Exhibition at Olympia was opened on Monday last by the Lord Mayor. Appropriately enough, the Electrical Engineers' Volunteer Corps provided a guard of honour for the occasion under Captain O'Shaughnessy, and a most serviceable body of men they looked drawn up for the reception, after which an inspection of the exhibition was made, lord mayors and mayors from the provinces and the mayors of several London boroughs taking part. That over, or as much of it as time allowed, there was a pause for the formal ceremony of declaring the exhibition open, and then luncheon. The latter was presided over by Mr. E. Cunliffe-Owen. As for the toasts, little can be said here. They were apparently not considered of great importance, as no provision seems to have been made to facilitate reporting them. We were told to sit where we liked, and soon discovered that meant sitting where we could. "Success to the Exhibition" was proposed by the Lord Mayor, and responded to by the chairman; "The Electrical Industry" was proposed by Sheriff Sir G. Vesey Strong, and responded to by Colonel R. E. Crompton on (behalf of the electrical manufacturers), the Mayor of Hammersmith (on behalf of municipal electrical undertakings), and Mr. W. H. Patchell (on behalf of electric supply companies).

Our first impressions of the exhibition as a whole were distinctly favourable. It is something more than a collection of trade exhibits, containing that element which should render it popular among those who seek information as well as diversion. It appeals, then, not only to the trade, but also to the general public, and the advertisement obtained should serve as a stimulant to the electrical industry. Gas has had its say, and now it is Electra's turn. Gas engineers have flattered the electrical industry by imitations, but their devices would seem unable to stand the test of time. It needs no photometric measurements to show the rapid decrease in volume of light emitted by their imitation arc lamps, for example, whereas the yield of the real article could scarcely be improved upon for constancy. The flame arc especially wants a lot of beating, and will doubtless find readier preference over gas lamps when mean efficiency becomes the recognised standard for comparison. Then, again, the ascendancy of electricity for domestic purposes is brought into prominence by the exhibition—its superior adaptability for artistic effects, its convenience, its cleanliness as a cooking agent and for heating purposes generally—not to mention the advantages which these several attributes bring in train. The average consumer knows little and cares less about improvements tending to reduce the cost of producing electricity; the price charged per metered unit is his starting point, and after that, ways and means of economical use should be (but are not always) his care. Inferior lamps and motors have in numerous instances brought electricity into disrepute. Many complaints, too, may be traced to the practice, through ignorance, of using electric incandescent lamps beyond their economical life. It is to the interest of the whole industry that these causes of complaint should be minimised. Hence the educational value of an exhibition such as the one under notice is not an unimportant consideration. At Olympia the consumer is brought into touch with first-class material and the latest means of effecting economy in the use of electricity. Moreover, he can rely upon competent assistance in selecting the best for his particular purpose.

But apart from the purely business point of view, the exhibition is, as we have said, an attractive one. What will appeal, perhaps, as much as anything to the casual visitor is the manufacture of Ediswan and Robertson incandescent electric lamps in progress. This sight alone would well repay a visit. Then there are other popular items, such as electric cooking, which cannot fail to draw crowds—not to mention good music and entertainments of a supplementary character. We have never seen an exhibition more complete on the opening day. Practically there remained nothing to do but clear away a few packing cases and a litter of paper here and there. Complaint was certainly made as to the lack of an adequate supply of current for power purposes, but it was the ear rather than the eye that was conscious of this deficiency. Such unreadiness on the part of the management is to be deplored, but should be capable of speedy remedy—the hum of motors must be added.

The exhibition affords an exceptionally good opportunity of noting the progress made in the various branches of electrical engineering and for reviewing the possible lines of further developments. To draw valuable conclusions in the latter direction, it is necessary to take a general view of the exhibits of a particular class and to see what the most progressive firms are doing. We have arranged for a number of experts to assist us by the preparation of special articles, which will give not only reviews of progress made, but also indicate generally what may be expected from the latest developments. For this purpose many subjects have been selected, and in this week's issue will be found articles on prime movers, direct-current dynamos, electric fittings, and electric illuminants. The experts responsible for these articles have been given a free hand, and their opinions are their own. With these articles as a guide a more comprehensive view of the numerous stands will be possible. We would recommend those of our readers who have not already visited the exhibition to purchase a catalogue of the exhibits before doing so, and to mark on the plan those stands they specially wish to visit. Otherwise the attractions on every hand are so numerous that they may come away without seeing what they desire to do. The catalogue gives a good *résumé* of what is to be seen on each stand. It should also be remembered that lectures have been arranged for several nights each week. This list up to date is as follows, the first lecture commences at 8 p m., and the time for the others will be announced later:

Friday, Sept 29.—"Wireless Telegraphy"; W. DUDDELL, member of Council I.E.E.

Tuesday, Oct. 3.—"Development of the Use of Electric Motors"; Colonel R. E. CROMPTON, C.B., past-president I.E.E., M.I.C.E.

Friday, Oct. 6.—"Domestic Electric Lighting"; J. SWINBURNE, past-president I.E.E., M.I.E.E.

Tuesday, Oct. 10.—"Electricity Meters"; S. Z. de FERRANTI, member of Council I.E.E., M.I.C.E.

Wednesday Oct. 11.—"Electric Heating"; H. J. DOWSING, M.I.E.E.

Friday Oct 13.—"Electric Telegraphs"; A. MARTIN, Postal Telegraphs, Cambridge.

Tuesday Oct 17.—"Electric Arc Lighting"; Mrs. AYRTON, M.I.E.E.

Wednesday, Oct. 18.—"Electric Traction"; W. M. MORDEY, vice-president I.E.E, M.I.C.E.

Friday, Oct. 20.—"Telephones"; F. GILL, member of Council I.E.E.

DIRECT-CURRENT MACHINERY AT OLYMPIA.

BY P. K FRIEDLANDER.

Quite a large proportion of the exhibitors are showing samples of direct-current generators or motors, and although no examples of the largest size are to be seen, there is a fairly representative collection of smaller machines. Great novelty of design or construction is not to be looked for, but sufficient variety still exists to give interest to a survey of the productions of the different firms, and here and there novelties occur which may become the standard practice of the future.

The class of machine which is by far the most commonly met with is the favourite protected type of motor, of which samples are shown by some 30 firms, including Messrs. Siemens Bros., Messrs. Crompton, the Lancashire Dynamo Company, the Phœnix Dynamo Company, the General Electric Company, the Electric and Ordnance Accessories Company, Messrs. Vickers, Sons, and Maxim, the Lahmeyer Electric Company, the Brush Electrical Engineering Company, the Union Electric Company, the Morris-Hawkins Company, etc. These motors have much in common—*e.g.*, the magnets are almost always of the four-pole type with a cast-steel yoke projected so as to form the end protection, laminated pole-pieces, slotted armatures with the "straight out" or barrel type of block winding, field coils taped up and generally without special supporting formers, self-oiling bearings, carbon brushes covering from two to four commutator plates, and a brush gear which, if not absolutely fixed, is at least not intended for adjustment.

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Variations only occur in such comparative details as the shape of the end covers, the methods of supporting the bearings and the brush gear, the details of the brush gear, and also in the over-all dimensions for a given output.

The four-pole construction is retained up to quite large sizes, such as 200-kw. dynamos, by some makers, but the majority pass to six poles at outputs between 100 kw. and 200 kw. at normal speeds. This question of the number of poles has always been more or less a matter of choice, and the correct number for any particular case is greatly dependent on the peripheral current density or number of ampere conductors per inch adopted. The Continental makers, as a whole, are still in the habit of employing more poles than the average English makers, though not necessarily with any consequent improvement in design or price. The introduction of high-speed turbo-dynamos (which, by the way, are unrepresented at the exhibition), of course, tends to reduce the number of poles employed for a given output, in order that the number of magnetic reversals and the core losses may be kept down, and here four poles are found sufficient even for the largest sizes made.

Another cause which will tend to keep the number of poles down is the rapid introduction of reversing or commutating poles, for these more or less remove the limit in the ratio of armature ampere-turns to field ampere-turns previously fixed by sparking considerations. The general

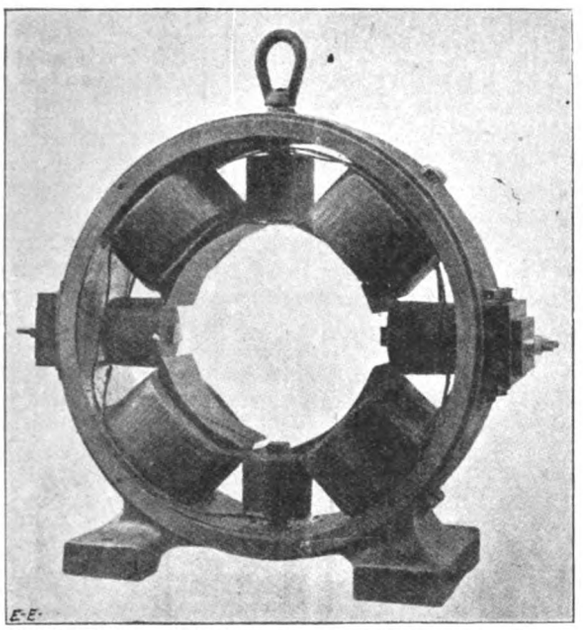

FIG. 1.—Field Frame of a Phœnix Dynamo with Commutating Poles.

action of such poles has been understood for quite 20 years, but it is only during the last two or three years, especially in connection with turbo-dynamos, that they have been at all generally adopted. They offer the very definite advantages of permitting much higher values of the reactance voltage—in other words, fewer commutator plates—to be employed and of compensating for the armature reaction at the commutation point, and so avoiding sparking with fixed brushes over an almost unlimited range of current or speed variation. If the simple reversing poles are replaced by the more elaborate compensating windings of the Dè i or Ryan pattern, as adopted by Messrs. Parsons for their turbo-generators, the further advantage of the prevention of all armature distortion is obtained. The increased expense and clumsiness of the last arrangement, however, more than counterbalances its advantages except in certain extreme cases, and the present tendency for ordinary work seems to be towards the use of small series-wound magnet poles springing from the yoke and acting on the armature at points midway between the main poles. Examples of this type of reversing pole are shown at the exhibition by the Phœnix Dynamo Manufacturing Company (Fig. 1), by the Morris-Hawkins Company (Fig. 5), by the British Electric Plant Company, and by Messrs. Lahmeyer, and several other firms are experimenting in this direction even if they do not employ them in their present standard machines.

The arrangement adopted by the Phœnix Dynamo Company will be seen to consist of a small pole whose face is only a fraction (about one-quarter) of the armature length, and is shaped as shown in Fig. 2. In this way the self-induction of the armature coil during commutation is not increased unduly, as it might be if the pole extended the whole length of the armature At the same time the increased area of the pole behind the neutral line (in a

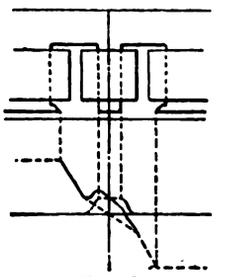

FIG. 2.

dynamo) serves to keep the rate at which the flux is cut (and therefore the reversing voltage induced) constant during the whole time of commutation. The resultant flux curve obtained with a reversing pole equally wide behind and in front of the neutral line is indicated in Fig. 3, whilst the corresponding result with a pole shaped as in Fig. 2 is shown in Fig. 4. A somewhat similar result is sometimes obtained in the machines of the British Electric Plant Company, Alloa, by boring out the reversing pole eccentrically, so as to give a smaller air-gap at one edge than at the other.

The constancy of the reversing field over a fair angular distance is of importance, not only because it permits brush shifting and a consequent adjustment of the compounding effect in dynamos or of the speed in motors, but

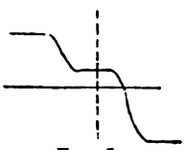

FIG. 3.

also because it is the necessary condition for a straigh commutation curve—*i e*, for a constant rate of change of current in the commutated coil—and this constant rate ensures that no excessive current density will occur at any part of the brush contact area during commutation.

In the Morris-Hawkins machines the cores of the reversing poles are placed near the outer edge of the yoke instead of directly between the main poles, and this avoids any increase in the diameter of the yoke. The main pole-pieces have slanting edges, so that a more extended neutral zone may be produced and the reversing poles (which extend the whole length of the armature) slant correspondingly.

Messrs. Lahmeyer show a variable-voltage direct-current booster fitted with rectangular reversing poles placed midway between the main poles, and extending over the whole length of the armature. Each reversing pole is excited directly by the current of the set of brushes which

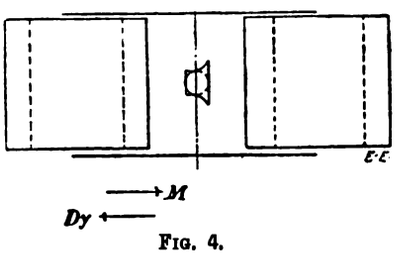

FIG. 4.

it influences. In most cases the peripheral span of the reversing pole is made from 1½ to 3 times the slot-pitch. The use of a very narrow pole-piece, though sufficient for commutation purposes, is not advisable, as experiments carried out by Dr. Breslauer, of the British Electric Plant Company, have shown that such poles are liable to be set in violent vibration by the changes of flux which occur, as slots and teeth alternately pass opposite the pole.

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Although a well-designed generator or motor can be made to comply with most modern requirements without the use of reversing poles—as is evidenced, for instance, by Messrs. Vickers, Sons, and Maxim's planing-machine motor (Stands No. 19-40) which gives a 3 or 4 to 1 speed variation by shunt regulation without any special devices*—yet this is often at the expense of a somewhat lavish use of copper and iron, and it seems highly probable that reversing poles, or some equivalent arrangement, will shortly become the rule rather than the exception, especially for the higher voltages (over 250 volts) and speeds.

The above machines with reversing poles, perhaps, form the nearest approach to novelty in this branch of the exhibits, but there are many other machines of more or less general interest to which reference might be made. Thus, on Stand No. 94, Messrs. Lahmeyer have a collection of large machinery in operation, including a complete haulage plant driven by a three-phase motor, a motor-alternator set, etc. Messrs. Davey, Paxman, and Co. have one of their high-speed Peache engines direct coupled to a 220-volt, 1,300-ampere Parker dynamo, used for the direct-current supply of the exhibition. Messrs. Crompton, besides a large assortment of smaller machinery and apparatus, show a direct-current dynamo driven by a 30-h.p single-phase motor, and supplying the arc lamps on the stand. Electromotors Limited (Stand 101) show drills, buffing machines, a boot-polishing machine, and other small motor-driven machinery, besides a complete line of protected and enclosed motors fitted with their compact new brush gear, of which a full description appeared in last week's *Electrical Engineer*. Messrs. W. G. Walker and Co. exhibit one of their motor testing air brakes (Fig. 7) in operation on Stand No. 199. This apparatus is supplied in the form of a steel support suitable for clamping to any diameter of shaft in place of the pulley, and fitted with two rectangular aluminium blades, whose distance from the centre is readily adjustable. With the three sets of blades provided motors of from $\frac{1}{4}$ h.p. to 26 h.p. at normal speeds can be tested, the horse-power developed being read off the calibration curves supplied with the apparatus.

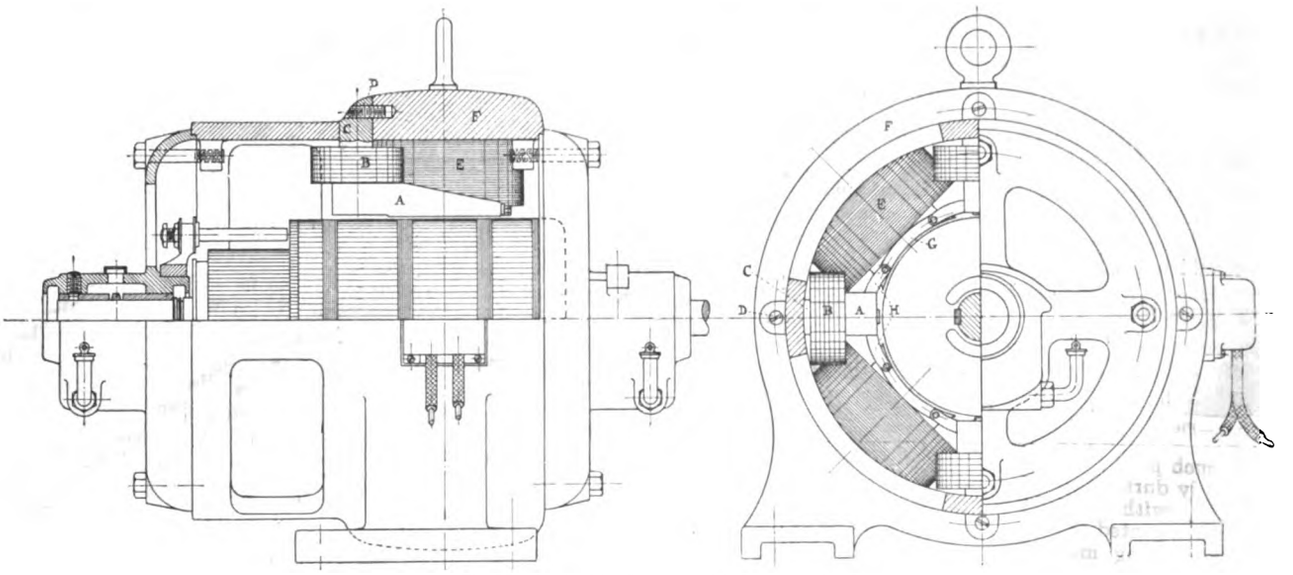

FIG. 5.—The Morris-Hawkins Dynamo with Commutating Poles.

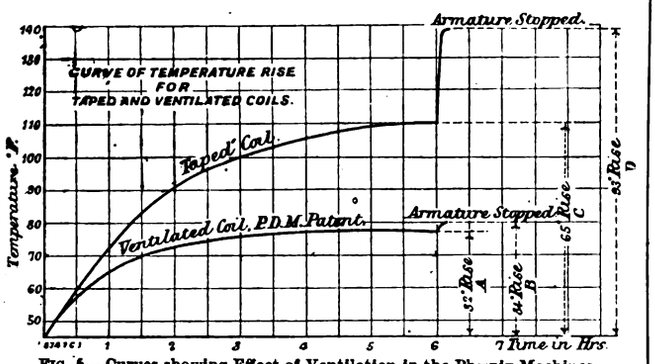

FIG. 6.—Curves showing Effect of Ventilation in the Phœnix Machines.

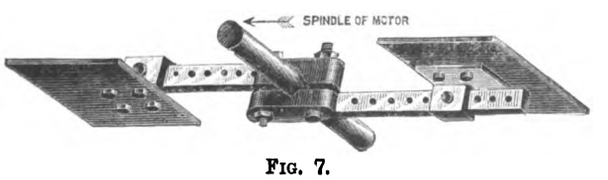

FIG. 7.

On Stand No. 119 the Lancashire Dynamo Company show, amongst an assortment of motors and other apparatus, one of their reversible battery charging and discharging boosters (Turnbull and McLeod patent), a photo of which we reproduce in Fig. 8. This booster has a completely laminated field to allow rapid changes of flux to take place, and is fitted with four field windings: (1) a shunt winding across the booster brushes tending to keep the sum of battery + booster volts equal to the line volts whatever may be the state of the battery; (2) a main winding in series with the battery and the booster armature, compensating for the booster armature reaction; (3) a shunt winding connected across the mains; and (4) a series winding carrying a current proportional to that of the main generators, and acting in opposition to shunt (3). The combined effect of these windings can be arranged either to keep the output of the main generators constant at any desired value, or else to allow the generator current to rise and fall, within certain limits, in proportion to the external load, whilst the battery looks after the whole, or the greater part of, the variations from the normal external load—discharging at times of overload and becoming charged when the external load falls below the normal. The booster shown is capable of giving 120 volts

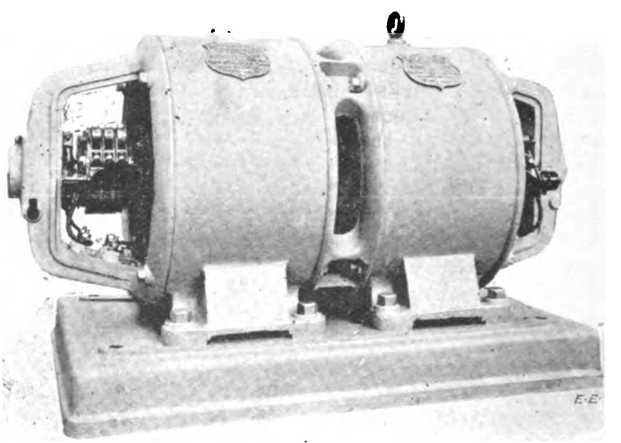

FIG. 8.—A Turnbull and McLeod Booster made by the Lancashire Dynamo and Motor Co.

* See last week's *Electrical Engineer*.

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200 amperes continuously, 300 amperes for one hour, or 60 volts 400 amperes for five minutes, all at 800 r.p.m.

Messrs. Wade and Jones show a number of their self-contained lighting sets consisting of an oil-engine (consuming ordinary commercial petroleum) directly coupled to a direct-current dynamo, and forming a convenient combination for country-house lighting or similar work.

It will be seen that on the whole a satisfactory collection of direct-current machinery has been brought together, but it is to be regretted that more of the small motors are not shown actually at work on the machines of the various trades to which electrical driving has now been so widely applied.

RECENT PROGRESS IN ELECTRIC LIGHTING AS INDICATED BY THE OLYMPIA EXHIBITION.

BY FRANCIS H. DAVIES.

Of the hundred odd years which intervene between Davy's discovery of the arc and the present date, the last thirteen—those which separate the Crystal Palace Electrical Exhibition of 1892 from its successor at Olympia—have been by far the most eventful in the history of electric lighting. At that time there existed simply two practical means of obtaining light from electrical energy: the open arc lamp in its various forms and makes, and the incandescent carbon-filament lamp priced at 3s. 9d. and limited in pressure to 100 volts. These, as far as one could see, represented finality—that is to say, in general principles—and few anticipated and fewer still had any conception of the improved and more efficient methods with which we are now so familiar.

Electrical exhibitions have been much in evidence during the present year, and have served a decidedly useful purpose in bringing before engineers and the general public many of the most recent improvements in electrical methods and apparatus. Their scope, however, has naturally been somewhat restricted, as without exception they have been of a local nature, and intended in the first place more as an advertisement for the electricity supply authority than for the manufacturer. The Olympia Exhibition, on the other hand, is essentially one of broad scope, and it therefore offers a considerably better opportunity for noting the many and varied developments in the commercial application of electricity with which the last few years have been so closely associated. To treat of one department only—that of electric lighting. The visitor cannot fail to be struck with the fact that the keynote of all the progress which has been made is efficiency. Better methods of manufacture have been introduced, with the result that the finished product—arc or incandescent lamp—has been cheapened, and entirely new systems of converting electrical energy into light have been devised, with the sole object of lowering the cost to the consumer by giving him the use of more efficient appliances.

In the field of arc lighting there is much, indeed, to chronicle if a comparison be made between existing methods and those of 13 years ago. But the greatest strides of all have undoubtedly been made in comparatively recent years, and it is naturally these which are most in evidence at Olympia and round which the largest amount of interest centres. In arc lamps improvements have taken place along three lines: (1) perfection of feeding mechanism; (2) lengthening of hours of burning without recarboning and adaptation of the single lamp to circuits up to 230 volts; (3) increase of efficiency by the admixture of certain chemicals with the carbon, or by the use of materials other than carbon for the electrodes. In most of the lamps exhibited the first of these improvements is marked. Not only is arc lamp mechanism now, on the whole, much simpler than it was a few years back, but it is also better designed, less liable to derangement, and capable of withstanding comparatively rough usage. The finish, on the other hand, is not so good, and there are evidences in all modern arc lamps of competition and the cutting of cost of production. That this has in no way deteriorated their action is creditable to the designer, who nowadays only provides for fine finish on the parts where it is of practical value, and reduces those parts to a minimum. The arc lamp of to-day compares unfavourably with those of 10 years back with respect to beauty of workmanship, but it is a better burning and much cheaper lamp, if not quite so lasting, and that is what is wanted.

The long-burning enclosed arc lamp is shown in varied forms by several manufacturers. The chief and most valuable improvement, and one which is embodied in most of the lamps exhibited, lies in the abandonment of the inner and air-tight globe, the large and formerly outer globe being made air-tight instead. From the point of view of efficiency this is a considerable advance, since there is thus less absorption of the light. It would appear that the difficulties which formerly existed in this direction have been finally overcome; in which case the enclosed arc lamp may now be deemed nearly the equal of the open arc in efficiency, being at the same time its superior in other directions owing to its well-known characteristics.

The Reason Manufacturing Company are showing lamps of the "Lewis" single-enclosed type which operate—any number in series—without the use of shunt coils. Such lamps constitute one of the most notable advances in arc lighting, since they combine increased efficiency with a large reduction in the number of working parts. Twin-carbon lamps are much in evidence, and are obviously popular. No less than 180 lamps of this type, made by Messrs. Verity, are used for the illumination of the exhibition, and the Reason Manufacturing Company, the Union Electric Company, the Brockie-Pell Company, and Defries and Sons are all showing twin-carbon lamps. The various types differ chiefly in the arrangement of the feeding mechanism, but it is satisfactory to note that simplicity has been the result aimed at in every case—a certain sign of progress when it is combined with good working results.

The Midget arc is rapidly coming into universal use, and is, perhaps, the electric lamp from which the gas companies have most to fear. Here, again, simplicity of mechanism is the keynote of success, and complication of any sort in such lamps cannot be too strongly deprecated. In this respect, midget arcs of British manufacture are far in advance of similar foreign lamps, which usually are more complicated in mechanism and do not provide sufficient radiating surface to get rid of the heat effectively. The claim of the British-made miniature arc to precedence will be obvious if two representative lamps, British and foreign, be compared side by side. There is a great future before the midget arc both for street and interior illumination, and it is evident that manufacturers recognise this.

The well-known lamp of the "flame" type represents the third great improvement in arc lighting, and at Olympia there is a very fine display of these, particularly by the Union Electrical Company, Messrs. Verity, Oliver, Crompton, Braulik, and Arc Lamps, Limited. The improvement which has been effected in the steady running of such lamps is very marked, and in this and other directions they show a considerable advance, particularly gratifying since it has taken but a comparatively short time to effect. Early lamps of this type were distinguished by very few good features beyond the colour of their light, but it is no exaggeration to say that the reproaches which formerly attached to them have to a great degree been removed, and the flame lamp of to-day is a thoroughly commercial product, and should prove a very serious competitor to other forms of lighting. It is particularly interesting to note the ingenious manner in which long burning is effected by the automatic magazine principle of construction. In the "Oriflame" arc of Messrs. Oliver and Co. there are two magazines, one for positive and the other for negative carbons. These are arranged in the upper part of the lamp, inclining to each other in the form of a letter V, so that the arc takes place horizontally between the lower ends of the two carbons. A solenoid in the lamp body acts upon a movable core, which is mechanically connected to the magazines, and serves for striking and regulating the arc as well as for controlling and feeding downwards each pair of carbons consecutively. The "Oriflame" arc lamp burns from 40 to 50 hours, and the carbon ends are discharged automatically one after the other as they are consumed.

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The efficiency of the flame arc is very high, as may be seen from Fig. 1. This represents the results of a photometric test carried out by the Westminster Electrical Testing Laboratory on three types of arc lamp—a representative enclosed lamp, a representative open lamp, and the "Excello" flame arc of the Union Electrical Company. The mean consumption of these lamps was respectively 485, 476, and 382 watts, and the mean hemispherical candle-power (shown in the diagram by three lines between the candle-power lines) was 338,633 c.p. and 1,325 c.p. respectively.

It has been found impossible so far to enclose flame lamps of any description entirely, owing to the smoke and gases given off by the chemically-treated carbons. This is the direction in which we must look for progress. Magazine methods are both ingenious and effective, but they introduce a certain amount of complication, and cannot be looked upon as a final solution of the long-burning problem. Perhaps no form of electric lamp has progressed so quickly as the flame arc—that is, passed from the stage where it was little better than an experiment and somewhat at a discount, to one where it is almost universally appreciated. The original difficulties which arose out of the formation of slags from the chemically-treated carbons seem to have disappeared, which in conjunction with perfected mechanism is no doubt responsible for the improved performance of the lamps.

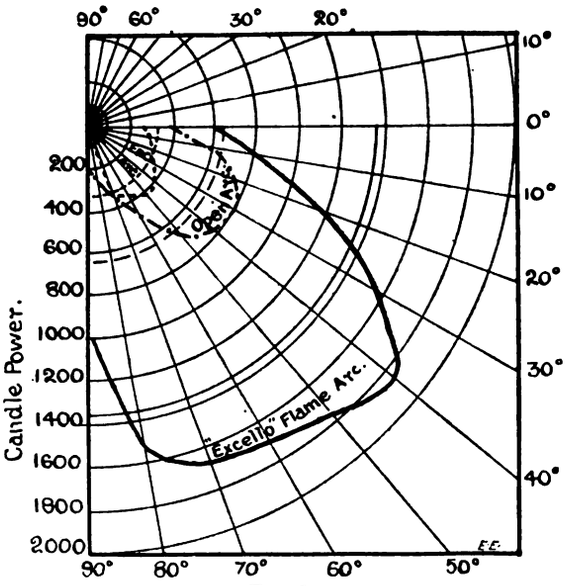

FIG. 1.

The hot-wire type of arc, which is as much in evidence as other recent improvements, dispenses altogether with solenoid control, the expansion and contraction of metal strips with varying lengths of arc, current, and therefore heat, having been substituted as the governing force. Lamps of this description are, of course, suitable for both alternating and direct current circuits, and most satisfactory independent results have been obtained with them. The simplicity of their design and construction is distinctly in their favour, and engineers have not been slow to recognise that such are points of the highest value.

The magnetite arc of Steinmetz is not represented at the exhibition, doubtless due to its present undeveloped state. It is, however, a highly interesting phase of arc lighting, and one of which it is reasonable to expect we shall hear more in the future. The characteristic feature of the magnetite lamp is the use of black oxide of iron mixed with chemicals calculated to increase the life for the negative electrode and copper for the positive. It has been found by experiment that the magnetite pole burns away at the rate of about $\frac{1}{2}$in. per hour, the copper pole being unaffected. The efficiency of the lamp is about twice that of the carbon arc, and lamps have been constructed which by a small sacrifice of efficiency will burn from 500 to 600 hours per one 8in. electrode.

The use of the arc light for blue printing and photographic purposes generally has greatly increased in the last few years. Modern apparatus, compared with the somewhat primitive arrangements that were usual when the arc was first applied to this purpose, show considerable progress, both in the economy of the operations and the quality of the work turned out. Mr. Leonard Shaw is showing a blue-print outfit which possesses some decidedly good points, and, it is claimed, turns out prints of a perfectly even nature with a minimum expenditure of energy in the shortest possible time. The arc lamp, instead of passing slowly from top to bottom of the printing cylinder, and then having to be hoisted and started again, is kept moving quickly up and down, quite automatically, by a small motor. The result is a good diffusion of the light and even prints. Other arrangements provide for the automatic performance of practically all the necessary operations.

The desirability of better diffusion of the light has become recognised in all branches of photographic work to which the electric light is applied. This is specially the case in photo-engraving, where lamps constructed to maintain a very long arc are now often employed. By this means the diffusion is necessarily very much improved and better results attained.

(To be continued.)

PRIME MOVERS AND AUXILIARY PLANT AT OLYMPIA.

BY E. G. BEAUMONT, A.M.I.C.E.

Having regard to the limit imposed by the space available for exhibitors and the variety and number of the purely electrical exhibits, it is not, perhaps, a matter for surprise that those engaged in the construction of engines of all sorts and in the production of important auxiliary plant are not as well represented as could be desired. With few exceptions the engines exhibited are of small powers, but it may be remarked that, on the whole, they are typical of the different classes in general use, and that in one or two instances the internal-combustion engines are of a novel type and design. Apparently, the many prominent firms associated with the construction of steam-turbines are too busily occupied, or have, at all events, for various reasons been unable to provide examples of the type of prime mover now so rapidly coming to the front and claiming so much attention. There is only a notice of the Curtis turbine of the British Thomson-Houston Company, and a reminder in the form of a photograph of the Brush-Parsons type on the stand of the Brush Electrical Engineering Company.

Messrs. W. H. Allen, Son, and Co., Limited, have contributed the largest collection of steam-engines, and the only one in the exhibition representative of the double-acting, enclosed, forced-lubrication, high-speed type. They show one, two, and three crank engines of respectively 30 b.h.p., 130 b.h.p., and 440 b.h.p., the last of these being a three-cylinder compound, and a fine example of an interesting design of engine, of which further particulars will be given later. They are all suitable for steam pressures of 200lb. per square inch, and are of the fixed expansion throttle-governed type with crankshaft governors. A three-throw crankshaft from one of Messrs. Allen's 600-b.h.p. high-speed engines which has been in continuous service for seven years, and has during that time run for 12 hours a day during 300 days per year, exemplifies the remarkable freedom from wear of the running parts of this type of engine when both design and workmanship are excellent. On the journals and crankpins of this shaft there is in some places no measurable wear at all, and the maximum wear on these parts is less than three-thousandths of an inch on a shaft diameter of 6in. The examples of condensing plant shown include a surface condenser, having a thousand square feet of tube surface, designed to deal with 10,000lb. of steam per hour; a three-throw Allen-Edwards air-pump arranged for direct driving by electric motor, and capable of dealing with 25,000lb. of steam per hour, and a vertical steam-driven twin Allen-Edwards air-pump to deal with the quantity of steam condensed by the surface condenser shown. The air-pump barrels of this direct-driven steam set are 10in. diameter, and the compound engine cylinders

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are 5in. and 8in. diameter, the stroke being 7in. As illustrating the small floor space occupied, it may be mentioned that the over-all length and width are only respectively 4ft. 3in. and 3ft. 6in.

The only steam-engine observed running is the 420-b.h.p. Paxman-Peache engine which is supplying light and power for the exhibition. It is of the three-crank, tandem, compound, single-acting type direct coupled to a Parker multipolar continuous-current generator. Except for detail changes and those necessitated by larger dimensions, it is of the same type as the group of Peache engines which for the past eleven seasons have supplied light and power at the Earl's Court exhibitions, and which form striking examples of the reliability of this design of engine.

On the stand of the Lister Electric Manufacturing Company a two-crank two-cylinder engine of Messrs. Sissons's standard type is exhibited coupled to one of Messrs. Lister's 45-kw. 480-volt multipolar generators. This engine is the only example of the high speed type with variable expansion governor controlled gear, and which, requiring the use of only two cylinders, may be expected to show economical results.

Messrs. Verity's show a little single-crank Reavell engine with a cylinder 5in. diameter and a stroke of 4in., coupled to a 12-kw. multipolar generator, the speed of the set being 500 r.p.m.

Messrs. E. S. Hindley's exhibit comprises several small throttle-governed engines of the opened and enclosed high-speed types. The largest of these is a 50-b.h.p. compound vertical engine with cylinders 7in. and 12in. diameter, with a stroke of 7in.

Of other allied exhibits, to some of which detailed reference will be given in our next issue, those of Messrs. E. Green and Son, Limited, who show their familiar type of economiser with certain detail improvements, and Messrs. McPhail and Simpson, who exhibit an interesting collection of superheater and parts, claim attention.

Messrs. Babcock and Wilcox have, as usual, an interesting stand, and, in addition to models of their standard type of water-tube boiler and specimens of wrought-steel pipework, they also show as a working exhibit one of their silent gravity bucket conveyors with an ingenious pawl driving gear with a semi-human motion which is fascinating. Messrs. Babcock and Wilcox are also responsible for the supply of steam to the exhibition, and have one of their marine type boilers at work. It has 2,218 square feet of heating surface, is fitted with a chain-grate stoker, and there is also a feed-water heater.

The Davies Patent Boiler, Limited, call attention to their segmental or tube element boiler, and among other exhibits show the Premier boiler tubes. The latter may be briefly described as a development of the Galloway tube system, and permits of a considerable increase of the heating surface of boilers of the Lancashire and Cornish types, and an improved evaporative efficiency of boilers fitted with these tubes.

With, for the present, passing reference to the exhibits of accessories such as those provided by the makers of lagging materials and protective coverings, among whom may be mentioned Messrs. Hobdell, Way, and Co. and the Cape Asbestos Company, and to those who, like the Price Patent Candle Company, supply interesting information respecting lubrication and the quality and properties of lubricants of many kinds, and Messrs. Avery, who exhibit their automatic coal-weighing machinery, preliminary mention must now be made of those showing internal-combustion or gas, oil, and light oil or petrol engines.

Messrs. Crossley Bros. show three engines, the smallest of which is a 4¼-b.h.p. oil-engine, which, though small, suffices to show the features of this type. It has a constant measured oil feed to the vaporiser, with governing by varying the number of working strokes. Engines of this type using paraffin or the heavier or crude petroleums are made in sizes up to 50 b.h.p. A 27·5-b.h.p. engine direct coupled to a continuous-current generator and a smaller engine of 16 b.h.p. of the same type are shown in operation; the second of these is being run with ordinary town gas. The larger engine is interesting as the only example in the exhibition of an engine running on producer gas and with its suction plant complete. With the producer gas it develops 21·5 b.h.p., as compared with the 27·5 b.h.p. obtained when running with town's gas of higher calorific value. Welsh anthracite is the fuel used in the producer, and with an engine of this size 0·875lb. is used per brake horse-power hour. At a cost of 21s. 4d. per ton this means that the cost of fuel is but 1d. per 10 brake horse-power hours—a remarkable result. I hope to be able to supply some particulars of the results of running of these engines and their producer plants.

The National Gas-Engine Company also show three engines, one of which develops 20 b.h.p. when supplied with producer gas. With this engine a guaranteed consumption of 1lb. of Welsh anthracite per brake horse-power hour is given, and this with fuel costing 22s. per ton is equivalent to practically 10 brake horse-power hours per 1d. The weight of the engine with flywheels suitable for electric lighting or power work is 98cwt. A small 2-b.h.p. National gas-engine is shown direct coupled to a multipolar dynamo. It is totally enclosed, has a cylinder 4in. diameter, and a stroke of 4½in., and runs at 650 r.p.m. with tube ignition. A 6·5-b.h.p. oil-engine is shown, governed by variation of supply of oil to the vaporiser. There is no positive tube or electric ignition, the charge igniting spontaneously on completion of compression. Regularity of ignition is ensured by a peculiar formation of the vaporiser end of the cylinder and of the piston, and by a communicating port.

The Diesel Oil-Engine Company exhibit one of their interesting engines of 20 b.h.p. At the time of my visit it was running quietly and regularly on a very light load. The engine shown is one of those constructed by Messrs. Sulzer, of Winterthur, and the fuel used is crude Texas oil, a heavy petroleum or petroleum residue. The fuel costs with these engines are, like the suction producer-gas supplied engines already referred to, remarkably low. With crude oil costing 2d. per gallon the consumption is only 0·42lb. per brake horse-power hour, equivalent to 10 brake horse-power hours per 1d. The weight of the engine is approximately six tons.

The two-cylinder 12-16-h.p. Wade and Jones oil-engine exhibited by Messrs. A. P. Wright and Co. is one of those earlier referred to as possessing novel features, which will make it necessary to give fuller particulars in following issues. The whole design is very compact, it is as far as possible balanced, and it is run at 700 r.p.m. Among other interesting features of the design is the means provided of starting up without any of the usual preliminary heating required by the majority of oil-engines by utilising petrol as fuel until the vaporiser has been sufficiently heated by the exhaust gases, when, with the engine running on load, the change from petrol to paraffin fuel may be made. Forced lubrication to all bearings at an oil pressure of 30lb. per square inch is adopted. Ignition is on the accumulator and induction-coil system with sparking plugs—that in common use for automobile petrol engines. The floor space occupied with the engine coupled to a continuous-current Parker dynamo is only 6ft. by 3ft.

Messrs. G. Braulik exhibit on their stand the Hillen-brand gas-engine. On a single base-plate and on a floor space of 6ft. by 3ft. a complete 5-b.h.p. gas-engine and suction producer-gas plant is mounted. The heat contained in the exhaust gases is partly utilised to form and warm the air and vapour on its passage to the producer and to dry the steam required in the usual way. By thus utilising some waste heat, and by attention to a particular degree of cooling of the producer gas, an extremely economical engine is obtained, free from difficulties by deposition or separating out of the tar from the gas and fouling of the valves. The consumption of anthracite fuel is claimed to be only 1lb. per brake horse-power-hour in this small engine.

Other small engines to be hereafter referred to include the two-cylinder enclosed Gardner engine shown by Messrs. Crompton and Co. direct coupled to one of their dynamos, and an extremely compact petrol electric combination, consisting of a four-cylinder 18-24 Blake engine and a four-pole Siemens continuous-current dynamo.

(To be continued.)

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SOME NEW DESIGNS IN ELECTRIC LIGHT FITTINGS AT OLYMPIA.

[BY OUR SPECIAL ARTIST].

Of all the goods displayed at Olympia, perhaps those which appeal most directly to the public are the electric

FIG. 1.

light fittings, by reason of their utility and the gracefulness of their lines. The average visitor, when non-technical, sees many mysterious coils of wire, castings, and rotating

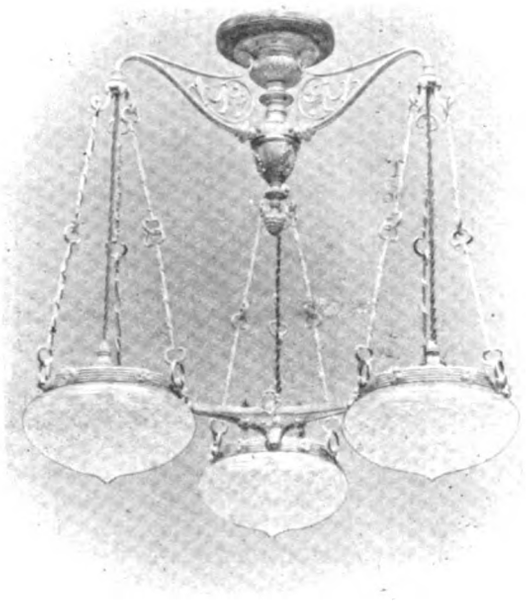

FIG. 2.

masses, but he takes their utility for granted for providing him with the electric light. He does not trouble as to how they do it, but looks on their existence as a means to an end. The electric light fittings are, however, quite different, being the settings for the lamps which give him a healthy and convenient form of light. Perhaps one day every man will be a scientist, and understand the why and wherefore of the generating plant; certain it is that philistinism in art is on the wane, and every man is now (or thinks he is) an artist. The outrageous creations of the Victorian era have been relegated to limbo and the rooms of seaside landladies; the modern man has been educated up to something

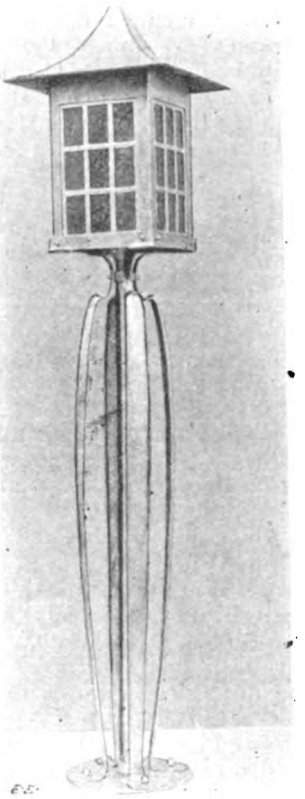

FIG. 3.

higher by his artistic surroundings, that have been evolved out of the brains of a host of designers in furniture, papers, tapestry, and metal work. Having passed through a period of threatened lunacy at the time of the "new art" craze, he now finds himself in a congenial artistic environment, where colours, lines, and ideas are happy and restful.

The designers of electric light fittings in this country

FIG. 4.

never developed those mad things that were to be found on the Continent; the temptation during the reaction from the converted gas fitting was no doubt severe, but it passed, and we have now at Olympia an insight into the revival of

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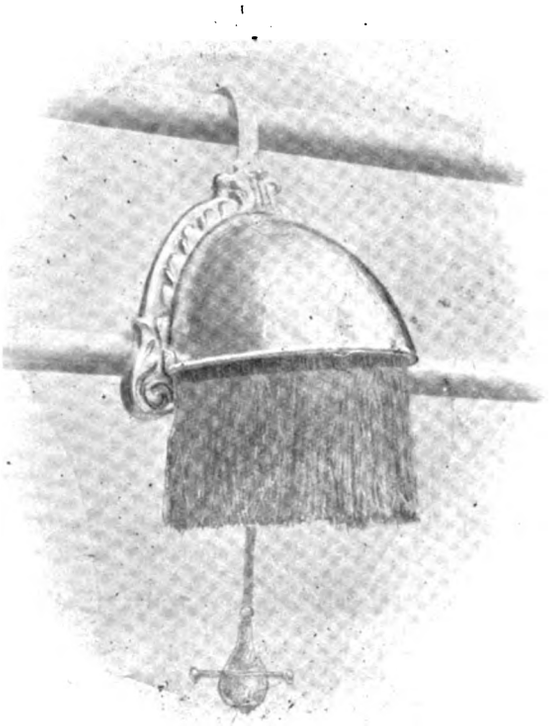
craftmanship that the last few years have evolved. The following illustrations and remarks describe in a few words only some of the many beautiful designs that are to be



IG. 5.

found. The visitor, be he of the public or the "trade," will do well to see the stands for himself, as no illustrations can reproduce the effects of electric lighting.

Messrs. Verity's, Limited, of King-street, Covent Garden, and Birmingham, have some new and pleasing designs on

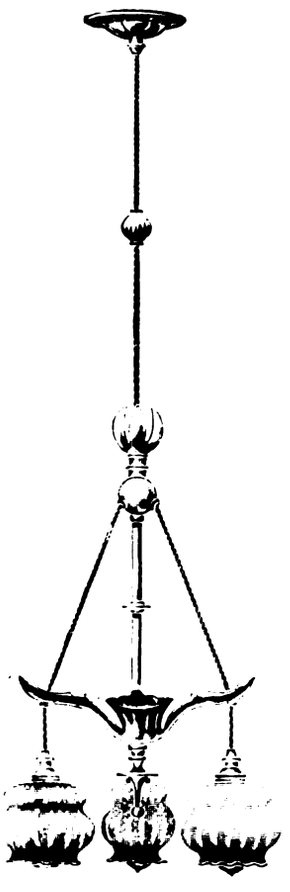


FIG. 8.

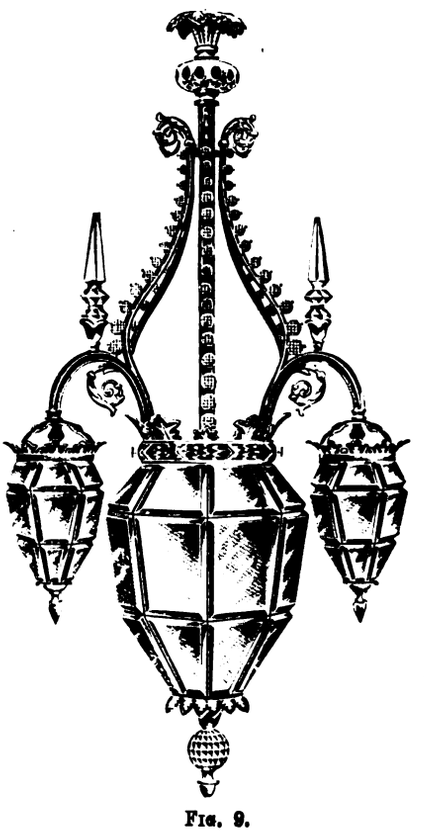


FIG. 9.

view and in their catalogue. For those who treat the electric light as a luxury as well as a necessity, there are fittings which reflect the light on to the ceiling, and thus produce a soft effect unobtainable by other means. Fig. 1 shows such an inverted pendant fitting for one light.

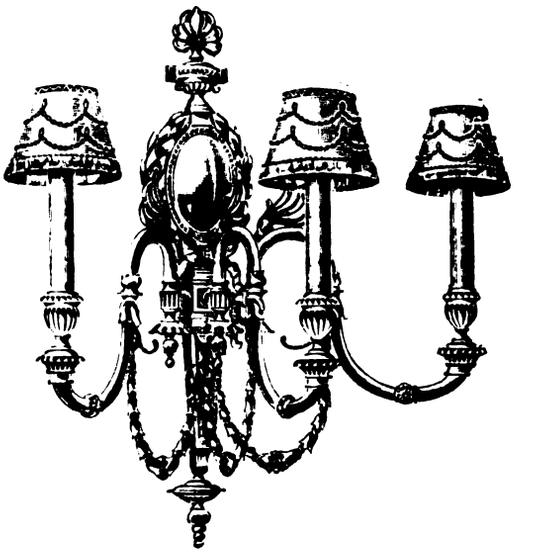


FIG. 6.

Halfway down the cord a metal plate is secured by a grip, and from this depend four chains, which hold a metal bowl of quaint design, with two handles. Fig. 2 shows a more elaborate fitting in the "Adams" style. It is

FIG. 7.

of a very light and graceful design, the three arms that hold the lights being particularly pleasing. The

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dishes for reflecting the light are shown in cut glass, but can be supplied with satin finish if desired. For those who affect the antique in halls, the newel standard shown in Fig. 3 will commend itself. It comprises four hammered strips of metal, surmounted with a leaded glass lantern. The company are selling a novel patent portable table lamp (shown in Fig. 4), being provided with a knuckle joint at the top, whereby the light may be always vertical; it is also suited for hanging on the wall. The hump in the base contains a universal tumbler switch, which is worked into the design of the fitting. A neat and useful little fitting is that shown in Fig. 5. This has been principally designed for hanging on bedrails, for those who practice the habit of reading in bed. A presser switch is attached by a flexible cord. This fitting is also made without a hood for fixing over doorways, steps, etc.

The stand of Messrs. Falk, Stadelman, and Co., Limited, of Farringdon-road, contains, perhaps, a larger display of fittings than any other in the exhibition, and the designs shown herewith give but a small idea of the selection on view. Fig. 6 shows a three light candle bracket in the "Adams" style, for which there is now a considerable demand. It is finished in ormulu, and may also be had for two lights. A handsome fitting suitable for a study or smokeroom is shown in Fig. 7, which is made of repoussé brass with oxidised silver finish; the spread is only 15in. Fig. 8 shows a pretty little three-light pendant for similar situations; in this the spread is 9in., and the metal work is finished in antique brass. A handsome design of hall fitting for those whose taste inclines towards the massive is shown in Fig. 9. This fitting consists of a cut-glass centre lantern and two side pendants to match. The metal work is richly chased brass, finished ormulu.

(To be continued.)

CALCULATION OF ALTERNATE-CURRENT TRANSFORMERS FOR MINIMUM COST.

BY DR. R. POHL AND H. BOHLE, BRADFORD.

The merit of a transformer is judged by the cost of the active material, the efficiency, the drop, and the temperature rise. The latter may be kept within reasonable limits by using suitable methods of cooling, and the drop by dividing primary and secondary windings into a sufficient number of sections. The problem before us consists, consequently, in constructing a transformer at a minimum cost for a given efficiency. This result has hitherto been obtained as follows: We assumed various inductions, current densities, and core diameters, calculated the number of conductors, weight, and price of the active material, and the losses, and altered one or more of the assumed quantities, until, finally, after much labour, we obtained a design which fulfilled our expectations. This method was naturally tedious and wasteful in time; moreover, it did not give us a guaranty that we had actually obtained the most economical transformer.

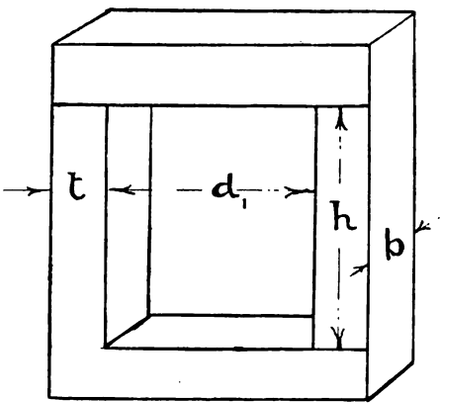

FIG 1.

Undoubtedly, there is only one design for each output which will give the most satisfactory results. The question remains whether a solution of the mathematical problem is possible, and, if so, whether such a method would be sufficiently simple to justify its introduction. The authors believe that in the present article they have described a method which produces the most economical transformer in the first attempt, and which is entirely devoid of mathematical difficulties. For a series of standard designs the greater part of the calculation may be reduced to curves, and one assumption only—that of the efficiency—is sufficient. The latter, which determines also the temperature rise, is easily justified.

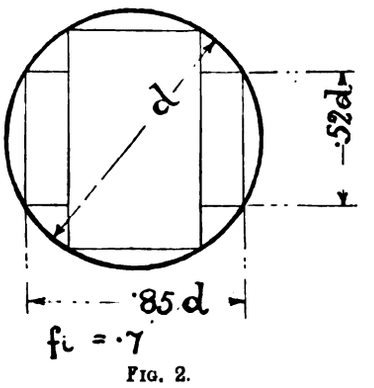

FIG. 2.

If we look through the lists of high-class transformer manufacturers, we find that the efficiency becomes more and more standard, consequently, also, the methods for cooling; because the efficiency is roughly inversely proportional to the losses. For transformers below 50 kilovolt-amperes, natural air cooling is chiefly employed, unless oil is used, principally for insulation purposes. For larger sizes, artificial cooling is almost essential, as otherwise the transformers would become too heavy and costly. The assumption of the efficiency being justified, we may proceed with the mathematical investigations, beginning with the unknown quantities. The same consist of four linear dimensions: t, d_1, h, and b (see Fig. 1), and two specific densities: the current per square millimetre = S, and the number of magnetic lines per square centimetre = B.

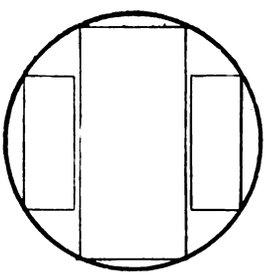

FIG 3.

For a core transformer the relationship between t and b is easily settled. The most suitable shape of the core is evidently a circle, as the ratio of its circumference to area is smallest for such a figure. In practice, however, we cannot make the shape a perfect circle, as we should require sheets of too many different sizes. The latter are limited to two or three from a manufacturer's standpoint, and we employ consequently shapes as shown in Figs. 2, 3, and 4, and which are circumscribed by circles of diameters d centimetres. The effective area of the cross-section of a core may then be expressed by the area of the circle, which

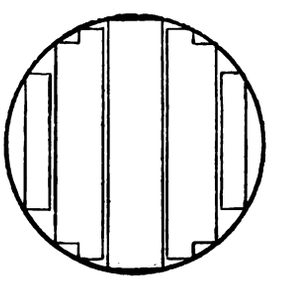

FIG. 4.

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has to be multiplied by a factor, f_i, called the space factor, and which takes into account the insulation of the sheets and the waste of space due to the imperfect circular shape of the core. The factor f_i will be known for every shape of core cross-section and the kind of insulating material we intend to employ. The two unknown quantities, t and b, are thus replaced by a single one—the diameter, d, of the circle circumscribing the core. The space between two such circles is left for the copper windings. The ratio

$$\frac{\text{area taken up by the copper}}{\text{total available area}}$$

is called the space factor, f_c, of the coils. The same depends upon the primary and secondary pressures and the output of the transformer. For a design of about 50 kilovolt-amperes, and transforming in the ratio of 10 to 1, the value of f_c may be taken from Fig. 5. For larger sizes, f_c will be a little larger, for smaller designs smaller.

Next we consider the most favourable distribution of the losses. It is well known that the iron losses become a minimum when the induction is constant—*i.e.*, when $B_{core} = B_{yoke}$. Similarly, the copper losses are least when the current densities in the primary and secondary coils are equal; or, when $S_1 = S_2$. This does not say how we must distribute the total losses.

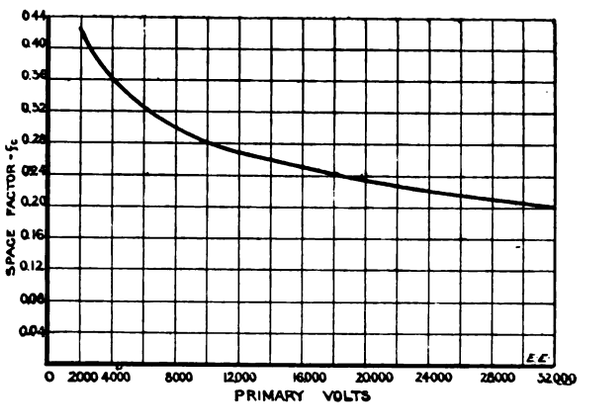

FIG. 5.

Let us assume we are considering a complete transformer. The loss per kilogramme of copper of the primary coil

$$W_{c1} = \frac{I_1^2 r_1}{8{\cdot}9 \times 10^{-5} \times a_1 l_1 w_1},$$

where I_1 = primary current;
r_1 = primary resistance;
a_1 = cross-sectional area of the primary conductor in square millimetres;
l_1 = mean length of a primary turn in centimetres;
w_1 = number of primary turns.

But $$r_1 \frac{\rho \times l_1 \times w_1}{a_1},$$

where ρ is the specific resistance, the value of which at 15deg. C. is about ·0174 ohm per metre length and square millimetre cross-sectional area. Substituting, we find

$$W_{c1} = \frac{I_1^2 \times {\cdot}0174 \times l_1 w_1}{8{\cdot}9 \times 10^{-3} \times a_1^2 l_1 w_1}.$$

Now $$\frac{I_1}{a_1} = S_1 = \text{current density}.$$

Hence $$W_{c1} = \frac{{\cdot}0174\, S_1^2 \times 10^3}{8{\cdot}9} = 1{\cdot}95\, S_1^2.$$

The loss per kilogramme of copper of the secondary winding is found similarly. We have

$$W_c = 1{\cdot}95\, S_2^2.$$

So far we have not taken into account the rise in temperature and the influence of eddy currents in the copper. The effect of the latter is also equivalent to an increase in the ohmic resistance, and which varies between 5 and 25 per cent. It is mainly dependent upon the magnitude of the leakage flux and the size and shape of the conductors. Seeing that S_1 and S_2 should be equal for a minimum copper loss, we may now express the loss per kilogramme of copper by a general equation

$$W_c = K_1 S^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For a temperature rise of 40deg. C. and a mean supplementary loss of 15 per cent., the value of the factor K_1 is 2·6. Multiplying W_c by the weight, G_c, of the copper conductors, we find the total copper losses of the transformer

$$W_c = G_c \times K_1 \times S^2 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The iron losses are due to hysteresis and eddy currents. The former vary proportionally to the 1·6th, the latter to the second power of the induction. The loss per kilogramme may be expressed as follows:

$$W_i = K_2 B^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The factor K_2 is evidently not constant, but decreases with increasing B. For the iron mostly used for transformers, with plates ½mm. thick, K_2 may be taken from

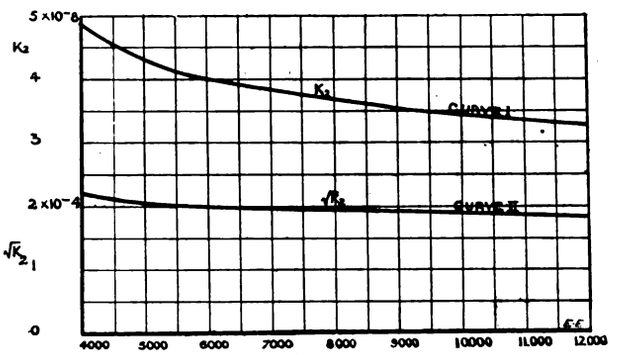

FIG. 6.

Curve I. of Fig. 6. The total iron losses are now given by

$$W_i = G_i \times K_2 \times B^2 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Let, further, p_c and p_i represent the percentage copper and iron losses respectively, thus that $p_c + p_i = 1$. Then

$$W_c = G_c \times K_1 \times S^2 = p_c \times W_v,$$

and $$W_i = G_i \times K_2 B^2 = p_i \times W_v,$$

where W_v is the total loss. Multiplying and extracting the root, we obtain

$$W_v = \sqrt{G_c \times G_i \times K_1 \times K_2 \times \frac{S^2 B^2}{p_c \times p_i}} \quad . \quad . \quad (5)$$

The power of a given transformer may be expressed by the equation:

$$W = K_0 \times S \times B,$$

where K_0 is a constant involving the number of turns, the frequency, and the cross-sections of the iron and copper. Dividing now the loss by the power, we find

$$\frac{W_v}{W} = \sqrt{\frac{G_c \times G_i \times K_1}{K_0^2}} \times \sqrt{\frac{K_2}{p_c \times p_i}} \quad . \quad . \quad (6)$$

This equation informs us that the percentage loss of a given transformer is a minimum when $\sqrt{\frac{K_2}{p_c \times p_i}}$ is a minimum. If $\sqrt{K_2}$ were constant, which is not the case (see Curve II. of Fig. 6), W_v would be a minimum for $p_c = p_i$—*i.e.*, when the copper losses are equal to those of the iron. It will be seen that the latter should be slightly greater than those of the copper.

By making the assumption that $p_c = p_i$, we do not introduce a great error, as $\sqrt{K_2}$ varies only from $2{\cdot}2 \times 10^{-4}$ to $1{\cdot}8 \times 10^{-4}$ for inductions varying from 4,000 to 12,000. Consequently, for all practical purposes, we may say that the total losses are a minimum when those of the iron are equal to those of the copper. This statement must be modified for transformers which are only occasionally fully loaded; for instance, for transformers used for lighting purposes only. For these it is advisable to make the copper and iron losses as nearly equal as possible for the average load, as far as the drop and the temperature rise of the copper at full load will allow. For the design of such transformers the working conditions must be known beforehand. To reduce the annual losses, we must make the constant ones, the iron losses, as small as is compatible with the average load. For any transformer the working con-

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ditions of which are known, the distribution of the losses is thus settled. For power transformers we make $p_c = p_i = \cdot 5$, and for lighting designs we reduce p_i and increase p_c.

Of great importance is also the distribution of the weights—*i.e.*, the ratio

$$\frac{\text{weight of iron}}{\text{weight of copper}} = \frac{G_i}{G_c} = K_g.$$

Let P_c be the price of the copper, P_i that of the iron, and p_c' and p_i' the percentage copper and iron prices, such that $p_c' + p_i' = 1$. Let, further, S_c be the price per kilogramme of insulated copper, S_i that per kilogramme of stamped iron sheets, then

$$P_c = S_c \times G_c = p_c' \times P,$$

and

$$P_i = S_i \times G_i = p_i' \times P.$$

By multiplying and extracting the root, we find

$$P = \sqrt{\frac{G_c \times G_i \times S_c \times S_i}{p_c' \times p_i'}}.$$

Consider, now, a transformer the iron and copper volumes of which may be increased or decreased by adding or taking away sheets, respectively conductors, without altering either the mean length of the magnetic circuit or the mean length of a copper convolution (see Fig. 7). Assuming, further, that the current density and the induction are constant, the power of a transformer may be expressed by

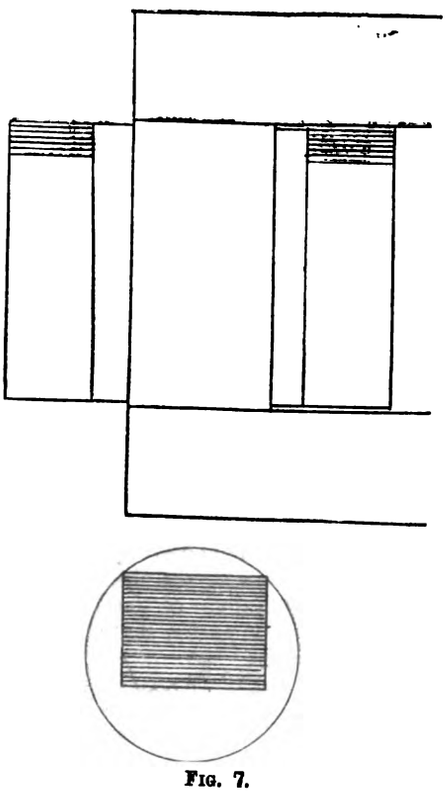

FIG. 7.

$$W = K_a \times G_c \times G_i,$$

whence

$$G_c \times G_i = \frac{W}{K_a}.$$

Substituting this value for $G_c \times G_i$ in the last equation, we obtain

$$P = \sqrt{\frac{W \times S_c \times S_i}{K_a}} \times \sqrt{\frac{1}{p_c' \times p_i'}} \quad . \quad . \quad (7)$$

From equation (7) we find that for a given output the price of a transformer will be a minimum when $p_c' \times p_i'$ is a maximum, or when $p_c' = p_i'$—*i.e.*, when the price of the copper is equal to that of the iron. We may consequently write

$$\frac{G_i}{G_c} = \frac{S_c}{S_i} = K_g{}^{*} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The above proof is not very elegant, but its truth may easily be verified by an actual example. Equation (7) holds for all kinds of transformers of the shell and core types, and its truth is independent of the distribution of the losses.

For lighting transformers it may sometimes be found necessary to make K_g smaller than $\frac{S_c}{S_i}$, as otherwise the temperature rise of the copper may become excessive. The ratio $\frac{G_i}{G_c}$ is then probably accurately stated by

$$\frac{G_i}{G_c} = \frac{S_c}{S_i} \times \frac{p_i}{p_c}.$$

This does not influence the price of the transformer to a great extent, as the curve which shows the relationship between $\frac{G_i}{G_c}$ and the price of the transformer is very flat for such values of $\frac{G_i}{G_c}$, which lie between $\cdot 5 \times \frac{S_c}{S_i}$ and $1 \cdot 5 \frac{S_c}{S_i}$.

After having determined the most favourable relationship between the weights of the copper and the iron, the solution of the problem has become possible. For the five unknown quantities we are able to deduct five equations:

I. $F_1 (d\ d_1\ h\ s\ B) =$ output.
II. $F_2 (d\ d_1\ h\ B) =$ iron loss.
III. $F_3 (d\ d_1\ h\ s) =$ copper loss.
IV. $F_4 (d\ d_1\ h) = \frac{\text{weight of iron}}{\text{weight of copper}} = \frac{\text{price of copper}}{\text{price of iron}}$.
V. $S \times B =$ a maximum.

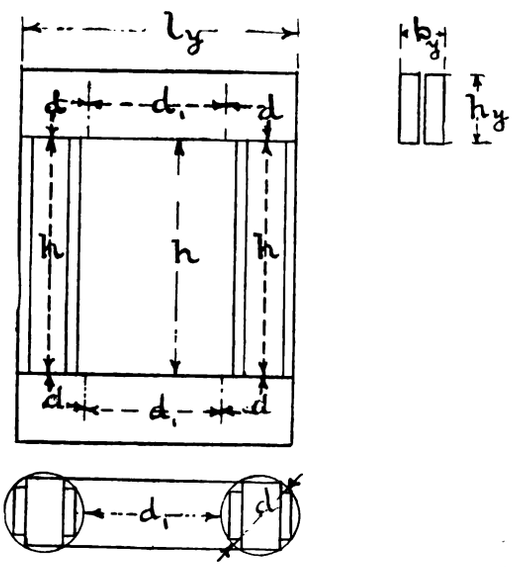

FIG. 8.

The maximum possible, S B, will naturally produce the cheapest transformer. The functions, F, must next be settled. The power of a transformer is given by

$$\text{K.V.A.} = \frac{E_1\ I_1}{1{,}000} = 4 \cdot 44 \times C \times w_1 \times I_1 \times N \times 10^{-11},$$

where E_1 = primary pressure;
C = frequency;
N = flux per core.

But $N = A \times B$, where $A = f_i \frac{d^2 \pi}{4}$ is the effective area of the core, and $I_1 = a_1 \times S$. Hence

$$\text{K.V.A.} = 4 \cdot 44 \times C\ w_1\ a_1\ S\ B\ A \times 10^{-11},$$

or,

$$w_1\ a_1\ S = \frac{\text{K V.A.} \times 10^{-11}}{4 \cdot 44 \times C \times B \times A}.$$

The space between two cores is taken up partly by primary, partly by secondary turns. As the primary and secondary ampere-turns are practically equal, we may write

$$w_1\ a_1\ S + w_2\ a_2\ S = \frac{2\ \text{K.V.A.} \times 10^{-11}}{4 \cdot 44 \times C \times B \times A}.$$

* This law was deducted by R. Pohl in 1900.

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From Fig. 8, it follows that

$$a_1 w_1 + a_2 w_2 = h\, d_1 f_c,$$

where f_c denotes the space factor of the windings. Substituting, we obtain

$$S B h d_1 d^2 = \frac{2 \text{ K V.A.} \times 10^9 \times 4}{\pi \times 4{\cdot}44 \times C \times f_i \times f_c} = \frac{5{\cdot}7 \times 10^8 \times \text{K.V.A}}{C \times f_i \times f_c} = \alpha \quad . \quad (9)$$

h, d_1, and d are here in centimetres; S in amperes per square millimetre.

Next we consider the weights of the iron and copper. We have

$$G_i = f_i \frac{d^2 \pi}{4} \times 7{\cdot}8 \times 10^{-3} (4d + 2d_1 + 2h) =$$

$$\cdot 012 f_i d^2 (2d + d_1 + h)^* \quad . \quad . \quad (10)$$

By a similar equation we may express the weight of the copper—

$$G_c = 2 \times 8{\cdot}9 \times 10^{-3} f_c \left(\frac{d d_1}{2} + \frac{d_1^2}{4}\right) \pi h$$

$$= \cdot 028 f_c \left(d d_1 + \frac{d_1^2}{2}\right) h \quad . \quad . \quad (11)$$

The values of G_c and G_i may also be deducted from equation (5). We find

$$G_c = \frac{W_v}{S B} \times \sqrt{\frac{p_c \times p_i}{K_1 K_2 K_3}} \quad . \quad . \quad . \quad (12)$$

and

$$G_i = \frac{K_3 W_v}{S B} \times \sqrt{\frac{p_c \times p_i}{K_1 K_2 K_3}} \quad . \quad . \quad . \quad (13)$$

By combining equations (11) and (12), respectively (10 and (13), we obtain

$$S B d^2 (2d + d_1 + h) = \frac{K_3 W_v}{\cdot 012 f_i} \times \sqrt{\frac{p_c \times p_i}{K_1 K_2 K_3}} = \beta \quad (14)$$

and

$$S B \left(d d_1 + \frac{d_1^2}{2}\right) = \frac{W_v}{\cdot 028 f_c} \times \sqrt{\frac{p_c \times p_i}{K_1 K_2 K_3}} = \gamma \quad (15)$$

Considering a new design the efficiency and distribution of the losses of which are known, and the space-factors of which have been fixed, the values of the factors α, β, and γ are determined. The equations (9), (14), and (15) may now be used for the solution of the problem—viz, as follows. In all the equations we have the unknown quantities S and B in the product S B. The latter we treat as a single unknown quantity, and we find then from equations (9), (14), and (15):

$$d_1 = 2 d \left(\frac{\gamma}{\alpha} d - 1\right) \quad . \quad . \quad . \quad . \quad (16)$$

$$S B = \frac{\beta - \frac{\alpha}{d_1}}{2 \frac{\gamma}{\alpha} d^4} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

and

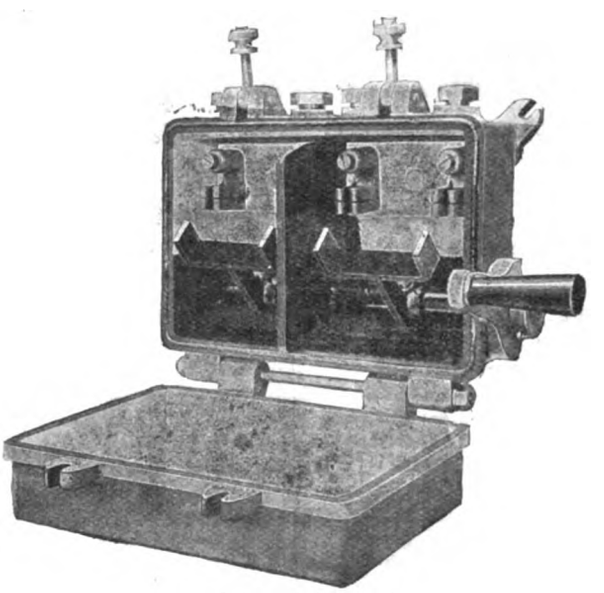
$$h = \frac{\alpha}{S B d_1 d^2} \quad . \quad . \quad . \quad . \quad . \quad (18)$$

(To be continued.)

TRADE NOTICES AND NOVELTIES.

J. and P. Specialities.

The switch shown in the accompanying illustration is of a type manufactured by Messrs. Johnson and Phillips, Limited, Old Charlton, Kent, for mining work, etc. This switch is suitable for circuits up to 600 volts, and is provided with a quick-break movement, durable in every detail. The case is of cast iron, lined with asbestos, and it will be seen that the switch, which is provided with an outside handle, has a long break. It cannot be left in any intermediate position between "on" and "off." Each pole is mounted on a separate porcelain base, a substantial insulating partition being provided between the poles. The spindle passes through a gas and watertight gland into the case. The hinged lid is provided with a rubber ring, so that when closed a perfect joint is made between the lid and box. Suitable rubber glands are provided where the cables enter the box. The holes can be screwed required for gas, simplex, or other threads, to customers' requirements. Details are also to hand of a gas-tight type of direct-current motor starter made by the same firm. This starter is operated through a ratchet and pawl motion, preventing too rapid starting up, arranged so that, although the operator keeps his hand on the starting handle, an overload or absence of voltage breaks the circuit.



Gas and Water-Tight Type Switch.

Catalogues, etc., Received.

Electric Locomotives.—It is well known that Messrs. Mather and Platt, Limited, Salford Ironworks, Manchester, have given considerable attention to the design and construction of electric locomotives, and as these extremely useful adjuncts to mines, collieries, shipyards, and the like are coming more into use, the short illustrated description which the company are issuing of several types supplied by them to fulfil varied conditions of working will, no doubt, prove welcome to many. It is, therefore, with pleasure that we bring it to the notice of our readers.

Armoured Plugs.—An illustrated list which we have received from Mr. A. P. Lundberg, Pioneer Electrical Works, London, N., deals with plugs of various useful types. Among these we notice armoured plugs for use with Lundberg standard "Dot" and "Universal" surface and flush sockets. These plugs are constructed of metal and porcelain only. The brass containing shells are of stout metal, to withstand rough treatment and protect the porcelain parts from injury.

The Electrical Company's Publications.—The Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., have sent us two sheets illustrating the use of lifting magnets for heavy transport work in ironworks, etc. One illustration shows a square lifting magnet fitted with movable poles, for lifting iron or steel having uneven surfaces or elevations exceeding 1in., while a crane fitted with a compact form of lifting magnet for transporting warm blocks of steel is shown in another. From the same firm we have a sheet dealing with commutators for tramway motors and contact fingers for tramway controllers.

Moving-Coil Instruments.—Three new lists of moving-coil instruments are to hand from Messrs. Evershed and Vignoles, Limited, Acton-lane Works, Chiswick, London, W. These lists deal respectively with sector and edgewise pattern instruments, round-pattern instruments, and portable ammeters and voltmeters. In the last-mentioned a useful type of combined portable ammeter and voltmeter is included. We note that this pattern of instrument has been adopted by the Admiralty for use in H.M. ships. It may be added that these lists are excellently arranged and printed.

Switches.—From Messrs. Ernest F. Moy, Limited, we have a new list dealing with switches of their various standard types.

Finsbury Technical College.—The winter evening classes at this college reopen on Monday, Oct. 2. In the advanced course Mr. H. H. Simmons will lecture on Mondays on alternating-current work, and Prof. S. P. Thompson on transformer design, arc lamps, and dynamo design. In the elementary course Prof. Thompson will lecture on Wednesdays on the magnetic properties of iron and steel, and Mr. P. M. Hampshire on the electric circuit and on galvanometers. The building of the new wing is almost complete, and the equipment of the drawing office and heat laboratory is in progress. It is intended to open these to students at the New Year.

* We assume here that the height of the yoke is about equal to the diameter of the core. Even if this is not absolutely correct, the error is very small.

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FACTORIES AND THEIR SITUATION.

We regret the position taken by our contemporary *Engineering* on this question because it knows better, and knows that its leading article of last week consists largely of mere clap-trap played to the gallery. Its policy, however, has led to commendation by the *Evening Standard and St. James's*—a combination possessing all the demerits of two papers and none of their merits. It is, however, with the broad teaching of *Engineering* we wish to deal, and to attempt to show the absurdity of that teaching. Of course, the article is cleverly written, too cleverly, perhaps, in that almost every statement of a definite kind is accompanied with exceptions which render the whole indefinite. The text of our contemporary may be gathered from its opening sentence: "One of the causes contributory to the increase of the unemployed in London and other large cities is the *retention* [the italics are ours] of factories *within crowded areas*, and no opportunity should be lost of directing attention to the fact." There is enough that is misleading in these words to warrant a whole book in explanation. What, in the name of all that is good, is one of the most fruitful causes of crowded areas if it be not the erection of factories? And, again, what in the first place induced the erection of factories in the originally uncrowded areas? The retention or non-retention of a particular factory in a particular place is determined by the special circumstances of that case. The writer of the article, we more particularly refer to, assumes that in the first place a factory is dropped upon a particular site by mere chance, that the men concerned in the work of that factory do not know their business, and that it is as easy to move a factory as to fly a kite. On the other hand, let us assume that the men who build and equip factories do know something of their business. Surely, then, before they commit themselves to expenditure they duly consider *all* the circumstances of the case, and finally act in the manner which after this consideration seems best. The one point they cannot altogether consider is what is going to happen half a century in the future. Assume, further, that the capital is found by a limited liability company, and is successful. The reasons for the building of one factory may similarly cause that of a dozen others, each of which may be successful, and the area become crowded. The charges incurred by the local authority of the area arise very largely because the factories are brought into that area. Are we then to contemplate a continuous migration of factories whenever the contributions levied by the authority reach a certain maximum? As regards the unemployed, will it make any difference to the total number of unemployed wherever the factories are situated, provided the total amount of work or the total population remain the same? Still further, will the migration of factories from the crowded areas lead to an equivalent migration of population, but will it not rather lead to an increase in the unemployed in the area from where the migration occurs? Hundreds of similar questions arise in the discussion of the retention or non-retention of factories. The moral to be deduced from our contemporaries' teaching is something to the effect that no factory should be erected within an area where the density of population is greater than a figure not given. We know that Cadbury and Lever and others advocate ideal conditions and ideal villages or towns, but all these are special cases, and not generally applicable. A factory cannot in general be dumped down anywhere. Babbage long ago proved this, as has the natural trend of business; hence we find aggregation of certain manufactures and certain businesses in certain areas. The development of the electrical

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industry shows how carefully the conditions are considered when opening up a new industry. The various factories are spread over the country, and where placed lead to a greater density of population and a greater local expenditure in the area in which they are placed. The fact of the matter is that *Engineering* in its desire to point out the claims of Kettering—a good, nay, an excellent and laudable object—to the consideration of men about to build factories, has blundered into the farcical view that factories are to be condemned in crowded areas and only supported in sparsely populated areas. The number of the unemployed in crowded areas is a question of quantity of work within that area. The expenditure within given areas is very largely in the hands of those who live within those areas, and if the ratepayers are fools enough to kill the geese that lay the golden eggs they ought to suffer for their short-sightedness. Half of our contemporary's statements we heartily endorse because they are true. Our general condemnation is because text and moral are illogical and untrue.

IMPERIAL NOTES.

Wellington, New Zealand.

Wellington, the capital city of the colony of New Zealand, is situated in the provincial district of Wellington on Port Nicholson, at the southern end of the North Island. It is now the seat of Government, where are the principal parliamentary and Government buildings. On April 1, 1903, its area was extended so as to include the borough of Melrose, which borough consisted of 10 scattered townships or districts adjoining the original city on the south and west The population of the extended city is now about 50,000, its area is 6,174 acres, its unimproved rateable value is £6,611,305, and its capital rateable value £10,840.688.

Public Lighting.—In a previous issue under the above heading we gave an account of the undertaking of the City of Wellington Electric Light and Power Company, Limited, and of the extraordinary success of same. Our special correspondent informs us that the City Council have, with the consent of the ratepayers, recently determined to undertake the lighting of the public street themselves. All lighting wires and cables are now fixed overhead, but it is intended to place the high-pressure wires underground, to place 2,000-c.p. arc lamps on each alternate centre trolley pole, and to light the narrower streets with smaller arc lamps. There are now within the city 33 arc lamps of 2,000 c.p., and over 800 incandescent lamps of 20 c.p. each, but the company also light several suburban districts as far as 3½ miles distant from their station. The incandescent street lamps are charged for at the rate of £3. 10s. each per annum.

Tramways.—The old system of horse tramways was purchased by the Council about four years ago by arbitration at a cost of £20,000. This has been entirely done away with, and a very good system of electric traction has taken its place. There are in all 20 miles of track laid down in double and single lines over about 11 miles of streets, and arrangements are now being made for laying a further length of five miles of single track to the suburbs of Island Bay, Brooklyn, and Kilbirnie in the Melrose district. The overhead trolley system has been adopted, with central poles where the streets are wide enough, with side poles and span wires in part, and elsewhere with single side poles and long bracket arms. It has been necessary to incur considerable expense in raising and altering telegraph, telephone, and electric lighting wires, as these are everywhere in the colony carried overhead, much to the disfigurement of the cities.

Permanent Way —The track is laid to a gauge of 4ft., with standard girder rails weighing 95lb. and 101lb. per yard, on a concrete foundation, and with Chicago copper bond. The pavement of the track in the main streets of the city is of jarrah timber in blocks 5in. deep by 3in. wide, whilst in the outlying districts it is formed with tarred metal surfaced with tar asphalt. The grades are all fairly easy, there being only two or three sharp rises of short length, but which in no case exceed 1 in 12.

Power-House.—The power-house is situated in Jervois Quay, in the centre of the city, and close to the harbour, from which the condensing water is taken. The buildings are substantially erected in brickwork, and cost, with foundations (which were exceptionally heavy and expensive), but exclusive of site, £21,000. The chimney is 134ft. in height, and has an internal diameter of 9ft. 6in. at the base and 10ft. at the top. The plant at present consists of three 300-kw. and one 150-kw. sets. The engines are by Messrs. Belliss-Morcom and the dynamos by the Electric Construction Company. There are three Lancashire boilers, each 30ft. long by 8ft. diameter, with a steam pressure of 160lb. on the square inch, superheated to a total of 500deg. F. Each boiler is of 600 b.h.p., and evaporates 15,000lb. of water per hour. The boilers are fitted with Erith underfeed automatic stokers, and are under forced draught. The coal bunkers will contain 130 tons of coal, which is raised to the stokers by means of an elevator. It is intended to add to this plant at a very early date.

Car-Sheds, etc —The car-sheds, repairing shops, and offices are situated at the Newtown terminus of the system. The shed is built in two bays, each 384ft. long by 52ft. in width, and is of brickwork on concrete foundations, with iron roofs supported centrally on H-iron stanchions. There are eight tracks with inspection pits under, and a traverser at the south end. Adjoining, and at the end of the shed, are the usual workshops, etc., consisting of armature repair shop, fitting shop, painters' shop, blacksmiths' shop, and stores. In the blacksmiths' shop there is provided a wheel press and a small travelling crane, and in the fitting shop the usual gap lathe, grinding lathe, drills, etc. The cost of the car-shed and workshops, exclusive of site, was £19,000, and of the offices which adjoin on the south £3,600.

Cars, etc.—The cars are 34 in number and of various types, some being single-deck enclosed, others, unfortunately, double deckers (which seriously interfere with a quick service), and yet again others of the combination type enclosed at one end and with open cross seats at the other. Fares range between 1d. for a single section and 4d. for the whole distance. Stopping places are defined, and the cars stop only at such places.

Traffic.—The system was only completed in December last, so that the results of a full year's working cannot yet be given; the cars are, however, carrying at the rate of about 12,000,000 passengers per annum, and the revenue per car mile is 11 77d. The number of passengers carried will be found to be very much greater per 1,000 of the population than it is in English towns, but it must be remembered that there are in Wellington practically no poor, the ordinary labourer receiving 8s. per day.

General.—The estimated receipts for the current year from the electric tramways are put down at £68,710, but they will more likely reach about £75,000. The working expenses are placed at £45,145, whilst interest and sinking fund will swallow up £18,000. It will be of interest to note that the working charges in the production of energy amount to only ·7d. per unit, and this notwithstanding the fact that coal costs 17s. 6d. per ton, and the rate of wages is practically double that paid in England. The total expenditure on the tramway system has been as near as possible £300,000.

Christchurch, New Zealand.

The city of Christchurch is situated in the South Island of New Zealand, on the River Avon, about five miles from the sea, and is only 16ft. above sea-level. Recently it has enlarged its area by amalgamating with the adjoining suburban boroughs of Sydenham, Linwood, and St Albans. Its population is now 48 737, its area 4,598 acres, its capital rateable value £6,936,149, and its unimproved rateable value £3,095,928.

Electricity Supply.—The Council, about three years ago, expended a considerable sum in the erection of an up-to-date refuse destructor. This was built by Messrs. Meldrum

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Bros. on the lines of the Beaman and Deas patents. There are two units, or four back-to-back cells fed from the top with combustion chambers, and the heat generated is used for raising steam in a Babcock and Wilcox boiler. Electric generating plant has been provided in connection with this installation, and a considerable portion of the centre of the city is now supplied with light as well as with power. The destructor has been erected at a very short distance from the centre of the city, and though at first there were some complaints of offensive fumes, these appear to have died out. The chimney is 150ft. in height above the level of the ground. The demand for light and power has already increased to such an extent that the Council have been compelled to double their plant, and, as a consequence, it is necessary to burn coal as well as town refuse. Although this plant is still relatively small (two units of 100 kw. each), the revenue is sufficient to pay all working expenses, together with interest and sinking fund and depreciation, and yet to leave a fair profit. The charges made for the supply of electric current for lighting are: under 500 units, 6d. per unit; from 500 to 1,000 units, 4d. per unit; for each unit over 1,000, 3½d. For power and heating 2½d. per unit is charged. It is safe to assume that further extensions will have to be undertaken by the Council at no very distant date. The present arrangement can be but a makeshift at best.

Tramways.—A Tramway Board has been recently created, which, having acquired the old horse and steam tramways, now deals with the whole system within Christchurch and to and within its suburbs. A portion of the new system of electric tramways was opened to traffic on June 5. The work has been carried out by the New Zealand Electrical Construction Company, which commenced operations on Sept. 29, 1904. The amount of their contract was £249,876, but the work is estimated to cost over £300,000, whilst the Board has power to borrow £405,000.

Permanent Way and Equipment.—When completed there will be in all 32 miles and 26 chains of track. The gauge is 4ft. 8½in., and the rails are of the girder type, 92lb. and 95lb. per yard (in 40ft. lengths), while some small quantity for car-sheds and special work are 72lb T-rails. The whole are laid on wooden cross sleepers. The overhead equipment is carried by steel and wooden poles. The trolley wire (63 miles) is of hard-drawn copper with a working strain of 15,000lb. and a breaking strain of 70,000lb. per square inch. The feeder cables—of which there are 22 positive and negative (65 miles in length)—are of insulated copper stranded wire.

Power Station.—The power station has been erected in Falsgrave-street. It is built in brickwork, and has a frontage to that street of 110ft. The value of the site was £2,500, and the contract price for the building was also £2,500. The engine-room and boiler-room are each 46ft. by 40ft., and the coal bunkers occupy a space of 46ft. by 20ft., and will hold a supply of 600 tons. The trucks are hauled from the railway siding by means of an electric winch. Water is supplied from an artesian well 425ft. deep, with a flow of 200 gallons per minute, and runs into a concrete tank capable of containing 8,000 gallons. There are three Babcock and Wilcox water-tube boilers (each capable of evaporating 6,000lb. per hour), with a working pressure of 150lb. per square inch, and these are fitted with Babcock patent automatic chain-grate stokers driven by a small vertical engine. An economiser is also provided, as well as a condenser of the Alberger type, with cooling tower 33ft. high by 22ft. diameter, and with a cooling capacity of 80,000 gallons of water per minute. The fans in connection with this tower are 8ft. diameter, and are electrically driven. The dynamos are driven by Curtis turbo-generators, two of which are installed. One of these is, however, sufficient to meet all ordinary demands, and the other is kept in readiness as a stand-by. These turbines occupy each a floor space of only 8ft. in diameter, and have a normal load capacity of 500 kw., their overload capacity being 750 kw., or 1,000 h.p. each. The shaft has a speed rotation of 30 revolutions per second, and the current is generated at 600 volts. The switchboard is made up of 28 enamelled slate panels, and is 47ft. in length by 7ft. 6in. high. The current for lighting purposes is generated at 220 volts by a 20-kw. dynamo directly coupled to a 30-h.p. high-speed steam-engine. Over the engine-room is a 10-ton travelling crane run on roller bearings.

Car Sheds, etc.—The contract price for this building was £8,882, and the cost of the site was £788. There are three bays, each 106ft. wide by a length of 160ft. The tracks are 10 in number, 140ft long, with inspection pits below. The machine and repair shops adjoin the car-sheds on the western side. The machine shop is 118ft. in length, with overhead travelling crane and jib cranes at each end. There are also provided smiths' shop, armature-room, general store, wagon-room, stable, etc, together with the general offices of the Board.

Rolling-Stock.—There are five different types of cars in use—viz.: (*a*) four-wheel combination, with middle enclosed and two open cross seats at either end (two 25-h.p. motors); (*b*) double-bogie combination, one end enclosed and the other open, with seven cross seats (two 40-h.p. motors); (*c*) four-wheel vestibule cars, entirely enclosed (two 25-h.p. motors); (*d*) double-deck cars (two 40-h.p. motors); (*e*) double-bogie box car, entirely enclosed, with compartment at one end for baggage. The Board has also converted some of the old cars into trailers as an experiment. In addition to the ordinary brakes, the cars are fitted with air-brakes, and at each end are attachments of the cow-catcher type for the prevention of serious accidents. All the cars are fitted with electric heaters, which are placed under the seats.

THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.

BY ALFRED STILL, M.I.E.E., A.M.I.C.E.

(Continued from page 369.)

Capacity of Transmission Lines.—In the case of a concentric or other underground cable conveying alternating currents, the capacity effects may be very great. A large capacity is generally objectionable in practical working, although, as is well known, the effects of capacity tend to balance those of self-induction, and so bring the power factor nearer to unity. If K is the capacity in microfarads of any system of two conductors, n the frequency, and E

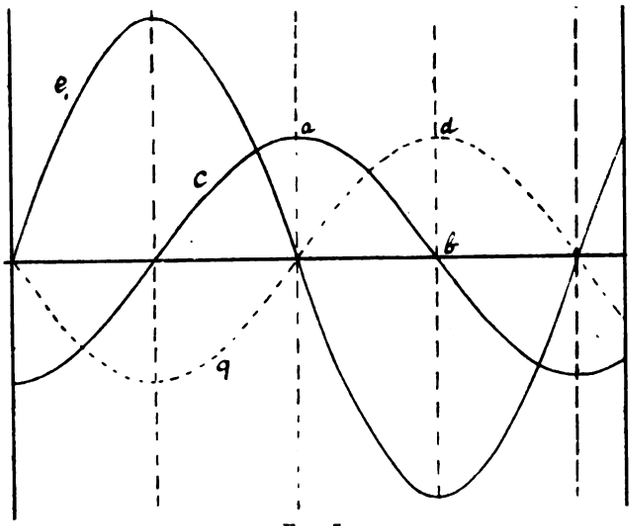

FIG. 5.

the potential difference between the conductors, then the *charging current—i.e.*, the alternating current which will pass between them irrespective of the load at the distant end—will be

$$C = 2\pi n K E \times 10^{-6},$$

on the assumption that the wave form of the E.M.F. is a sine curve. This current is in quadrature with the E.M.F., being 90deg *in advance* of the applied potential difference.

Thus, in Fig. 5, C is the *condenser current*, and the dotted curve *q d* represents the variations in the actual charge of electricity (which must necessarily always reach its maximum value when the current is changing in direction). The *condenser E.M.F.*, or back E.M.F., the direction of which, at every instant, must be such as to tend to *expel* the

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charge, is represented by the curve e_1. The curve of the applied potential difference has not been drawn, but it will evidently coincide in phase with the curve $q\,d$, being exactly *opposite* in phase to the condenser E M F., which it must balance. It will, therefore, lag behind the current wave by a quarter of a period.

The formula given above enables us to calculate the capacity current without any difficulty, on the assumption of the E.M.F. following the simple harmonic law of variation, provided the capacity, K, can be correctly predetermined, or ascertained by actual measurement; but when we come to consider the various wave forms found in actual practice, it is not possible to calculate the capacity current with any degree of accuracy. The sine curve wave will be found to give the smallest condenser current of any possible wave form, and the most intricate mathematical methods will not enable us to accurately predetermine the capacity effects due to alternating currents of irregular or unsymmetrical wave forms.

The two diagrams (Figs. 6 and 7), reproduced by kind permission of Mr. A. Whalley, of the British Insulated and Helsby Cables, Limited, show the extraordinary distortion of the wave forms due to the introduction of capacity in the circuit of an alternator which does not, under all conditions of load, give a difference of potential at the terminals following the simple harmonic law of variation.

In Fig. 6, V is the pressure and A the current when the alternator is supplying 29·5 amperes at 2,040 volts to a transformer on a nearly non-inductive load, whereas Fig. 7 shows the altered pressure curve and the resulting charging current when the same alternator is supplying a current of 6·04 amperes at 1,980 volts between the two conductors of an insulated cable having a capacity of 4·9 microfarads.

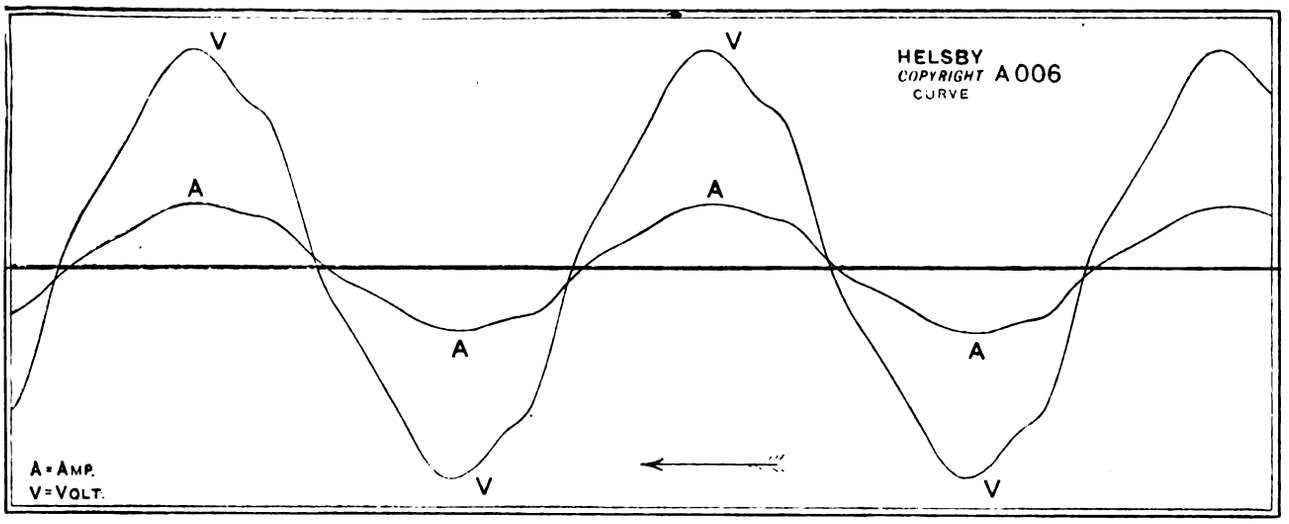

FIG 6.

It is interesting to observe how the smallest ripple in the original curve may become distorted and magnified. The fact that the maximum values of the E.M.F. (and, therefore, of the charge) invariably occur at the instant when the current is changing its direction, should also be noted.

In the case of overhead lines the capacity effects are generally small, and sometimes negligible. The calculation of the capacities between wires, even when symmetrically arranged, appears to offer considerable difficulties to mathematicians, but the formula

$$K = \frac{\cdot 0194}{\log_{10} d/r}$$

applies to the case of a single-phase overhead line.*

Here K = the capacity per mile of circuit in microfarads;
d = the distance between wires;
r = the radius of the wires.

Vector Diagram of Single-Phase Transmission Line taking into account Resistance, Self-Induction, and Capacity.—In Fig. 8 the generator is shown supplying the total current, C, at the initial pressure, E, through the transmission lines to the distant end, where the load is supposed to be partly inductive. The current delivered at the end of the line is C′, and the pressure E′; the coefficient of self-induction of the transmission lines is 2 L, and their resistance 2 r. It will be noticed that the whole of the capacity is shown as being concentrated at the end of the line. This assumption leads to a calculated capacity current somewhat in excess of what would be obtained with the same total capacity distributed along the line, but it simplifies the vector diagram. A closer approximation to actual conditions

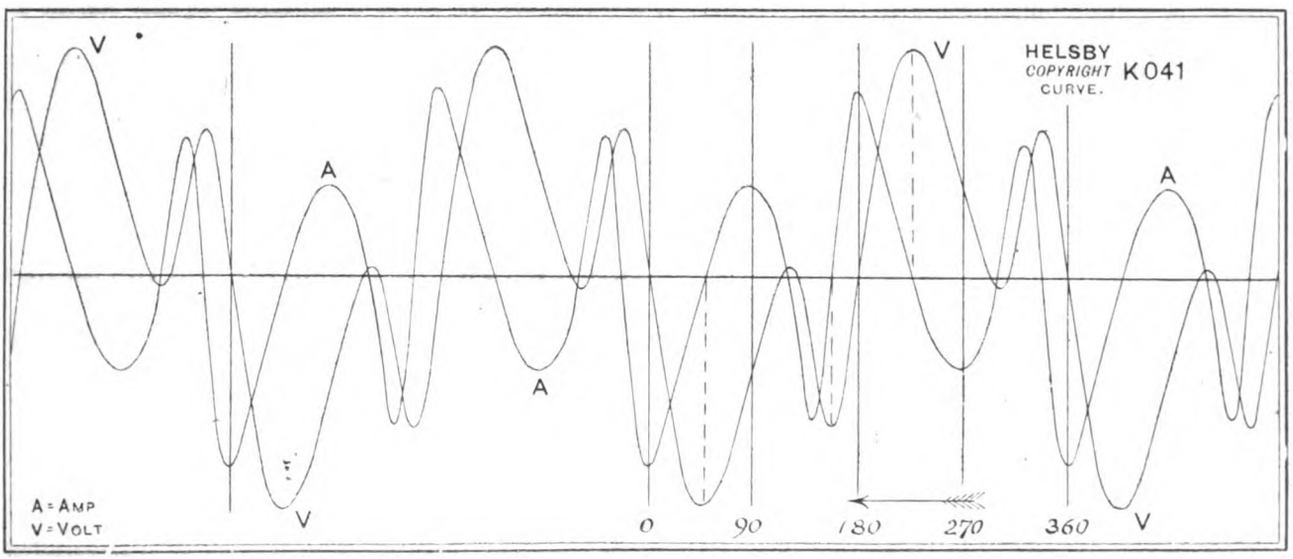

FIG. 7.

* Mr. G. H. Baillie in the *Electrician*, Aug. 8, 1902.

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would be obtained by supposing the capacity to be concentrated at the centre of the line (or, perhaps, rather near the receiving than the transmitting end); or if still greater accuracy be required, no difficulty need be experienced in drawing the diagram on the supposition that the capacity is due to two or more smaller condensers connected between the lines at different points. But it must be remembered that it is not possible to calculate the capacity current on a long transmission line with any great degree of accuracy, because it will depend largely upon the E.M.F., wave form, which, even if known under certain specified conditions, will generally vary considerably with alterations in the load. The capacity of a system of overhead conductors will also depend somewhat upon the state of the atmosphere.

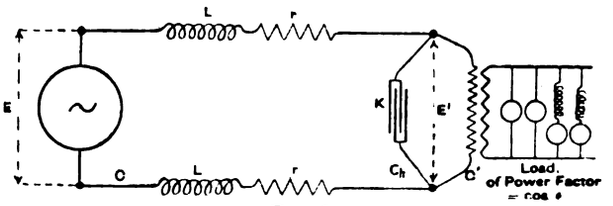

FIG. 8.

Assuming, then, for the sake of greater simplicity of construction that the total capacity, K, of the line is concentrated at the distant end, we may proceed to draw the vector diagram (Fig. 9). Here O E′ and O C′ represent respectively the potential difference and the current at the distant end of the line, the two vectors being drawn with an angle θ between them, such that cos θ is equal to the assumed power factor of the load. Referring to Fig. 8, it will be seen that a condenser of capacity K is supposed to connect the wires at the distant end; the impressed volts at condenser terminals are therefore E′, and the vector for the condenser current (equal to $2\pi n$ K E′, on the assumption of the sine curve wave form) must be drawn 90deg. in advance of O E′. It is represented by O C_k in Fig. 9.

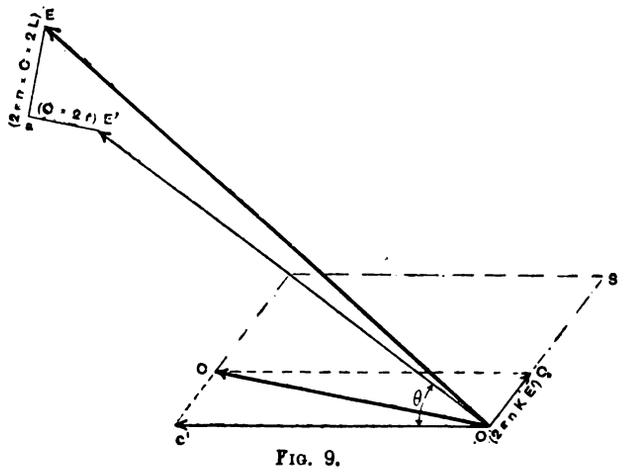

FIG. 9.

The total current supplied to the line at the generator end will be O C, obtained by compounding O C′ and O C_k. With regard to the E.M.F. at generator end, this is the resultant of three components—namely: O E′, the pressure available at receiving end; E′ a (drawn parallel to O C and equal to C × 2 r), to represent the drop due to resistance; and a E (drawn at right angles to O C and equal to $2\pi n$ × C × 2 L), to represent the pressure required to balance the E.M.F. of self-induction. This gives us O E as the necessary pressure at generating end.

The conclusions to be drawn from this diagram (which takes both self-induction and capacity into account) are as follows: (1) On an inductive load the current, C, put into the line at the generating end may be *less* than the current, C′, at receiving end. (2) The total current, C (under the condition of a partly inductive load), comes more and more nearly in phase with the E.M.F. as the capacity current increases up to a certain limit, depending upon the power factor of the load. Thus, if the capacity current were equal to O S instead of O C_k, the total current—as indicated by the chain dotted lines in Fig. 9—would be in phase with E′. This illustrates the effect of capacity supplying the magnetising current of the inductive apparatus constituting the load, and so improving the power factor. (3) The effect of capacity (always on the assumption of a low power factor), by reducing the current in the line, is also to diminish the $C^2 r$ losses or to permit of a smaller section of conductor being used.

It must not be forgotten that these conclusions are derived from a diagram which represents the conditions under full load, or when the total current is large in comparison with the charging current; and, in considering the question of power losses, we must not overlook the fact that, *at light loads*, the charging current may be the cause of *increased* $C^2 r$ losses. In other words, on a low *load factor* (whatever may be the power factor, but more especially when the power factor is high), a large capacity current may not be an unmixed blessing, even when viewed solely from the point of view of its effect on the line losses. As a matter of fact, the charging current on overhead lines is generally small. Let us take as an example the same data as served us to illustrate the effects of self-induction—that is to say:

The pressure E′ = 20,000 volts.
The frequency n = 25.
The length of the line = 50 miles.
The diameter of conductors = ·36in.
Their distance apart = 3ft.

Using the formula given above for the capacity of an overhead line, we have

$$\text{Capacity in microfarads per mile} = \frac{\cdot 0194}{\log 36/\cdot 18} = \cdot 00843,$$

which gives us for the total capacity,

$$K = 50 \times \cdot 00843 = \cdot 4215 \text{ microfarad.}$$

The capacity current will be

$$C_k = 2\pi \times 25 \times \cdot 4215 \times 20{,}000 \times 10^{-6} = 1 \cdot 3 \text{ amperes,}$$

which is a very small percentage of the total current (assumed to be about 50 amperes). At the same time, we have only to suppose an increase in the length of line from 50 to 200 miles, with a correspondingly higher pressure of, say, 50,000 volts, and imagine the frequency to be 50 instead of 25, in order to obtain a calculated capacity current of 26 amperes, which is by no means negligible.

It will be understood that where insulated cables are used (only possible for lower pressures and shorter distances), the capacity current may be from 20 to 30 times as great as in the case of an equivalent overhead transmission, and, moreover, the dielectric losses may become important.

(To be continued.)

ELECTRIC POWER DISTRIBUTION FOR THE RAND.*

BY ROBERT HAMMOND, M.I.C.E.

The idea of laying down central power stations for the purpose of affording a cheap supply of electric energy over extended areas is one that is being adopted in all parts of the world. The earlier works of this description, like those at Niagara Falls, were laid down for the purpose of utilising water power only available at one central spot. Latterly power distribution schemes have been devised in England in places where no water power is available, but where economy in the cost of generation from aggregation of output is relied upon. So markedly is this economy attained that one of the most progressive of our English railway companies, the North-Eastern, has found it actually more economical to draw its supplies of electrical energy for the working of 37 miles of railway from a central power distribution company than to erect its own generating works.

In the present session of the British Parliament powers were sought by a company to carry out a huge power distribution scheme for London in spite of the fact that there are already in existence in the Metropolis 61 electric generating works operating under statutory powers, with a

* Paper read before the Engineering Section of the British Association at Johannesburg, Aug. 30.

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capacity of over 200,000 kw., in which some £16,000,000 have already been invested, and with an annual output of about 160,000,000 units. The argument advanced by the promoters was that by means of entirely new works, equipped with highly efficient generating plants, each of 10,000 kw. capacity, laid down on a site where river water is ample in quantity and available for condensing, and where coal could be delivered alongside, it would be possible to sell electric energy in bulk to the present distributors at a price so low that it would pay them to scrap their existing works. They had, indeed, already entered into provisional contracts to supply at £3 per kilowatt per annum of the consumer's maximum demand plus ·33d. per unit for all electric energy actually used. Presuming an average use of the maximum demand for eight hours per day, excluding Sundays and public holidays, say, 307 working days per annum, we have:

Cost of 1 kw. per Annum

Fixed charge	£3	0	0
307 days and 8 hours = 2,456 units at ·33d. per unit	3	7	6
	£6	7	6

equivalent to an all-round charge of ·62d. per unit. If the average use during the 307 days was 12 hours per day, the payment by the consumer on the above basis would be ·477d. per unit.

During a visit paid by the writer to Johannesburg during the early part of this year he was struck by the fact that in such a dense industrial area as that included in the Witwatersrand, "power distribution" undertakings of magnitude were not in operation. Within a radius of about 25 miles of Johannesburg, calculating only the main shafts in active operation in producing and developing mines, there are some 150 shafts into the gold-bearing banket, and the number increases annually, the workings varying from "surface" to deep level 3,000ft. below the surface. The total number of tons (2,000lb.) mined and hoisted in April of this year was 1,074,464, and after sorting 898,871 tons were milled in 6,532 mills. It is expected that the average for the current year will be rather over than under these figures, startling as they are; and it is certain that in the future operations will be conducted on even a larger scale than at the present time.

The object of this paper is to raise two questions before the Engineering Section of the British Association: firstly, whether the working of the mines could not be cheapened by the greatly-extended application of electric power; and, secondly, whether such electric power could be more economically produced by each mine or group of mines laying down its own plant, or by means of centralisation of generation in works serving a number of mines.

With regard to the general question of the use of electrical energy in mines it may be noted that in the United Kingdom there has been, as usual, great hesitation in adopting new methods and in introducing electricity into mines. Fear of the attendant danger was for a time the great stumbling-block. In 1902, however, a strong committee was appointed by the Home Office with instructions "to inquire into the use of electricity in coal and metalliferous mines and the dangers attending it, etc." That committee, after an exhaustive inquiry, in the course of which evidence was taken from 56 expert witnesses, issued its report on Jan. 9, 1904, and pronounced very strongly in favour of the use of electricity in mines under proper restrictions and precautions. The result has been a great extension of the use of electricity in mines in the United Kingdom. To name one instance, the Powell-Duffryn Steam Colliery Company has eight pits in one valley, and in the present system have installed 5,000 h p. of motors distributed over different collieries. When all the motors are at work some 80 steam-engines, together with boilers for them, will be thrown out of use. At the present time the chief application of electricity is for hauling the trams from the face to the foot of the shaft, and at the same time electricity is being adopted throughout for pumping, ventilating, shunting, screening, lighting, and the working of all colliery machinery, such as workshops, mills, mortar mills, etc. Three electrical winding engines are also being put in of small horse-power for raising and lowering men. Now that the plant has been started, and it has been found that such satisfactory results are obtained, it has already been decided to adopt electrical winding, and the plans for installing an electrical winding engine are almost completed. This work will be put in hand during the next few months.

Turning to the Rand, the question to be first decided is whether a cheapening of the working of the mines would be obtained by a similar extended application of electric power. From the communications of Mr. J. A. Vaughan, chief inspector of machinery to the Government mining engineer, Johannesburg, it appears that there are already in use in the Rand mines electric motors of a total capacity of about 20,000 h p, and the number is being rapidly augmented. Electric energy is at present used for underground and surface pumping, for workshop driving, and in the cyanide works, for pumping the water, the solution, and the slimes. In some mines it is used for crushers, for haulage, for the conveyor belts, and in the mills. From a perusal of the *Proceedings* of the South African Association of Engineers it appears, however, that many of the leading engineers of the Rand are in favour of largely extending its use. Among other important papers read before that association may be specially mentioned: Oct. 29, 1902, Spengel, on "Electric Winding Engines"; Sept. 28, 1904, Pearce, on "Electric Equipment, etc."; Feb. 22, 1905, Wilms, on "Electric Driving of Stamp Batteries."

Electric winding has already been adopted in some of the leading mines in Westphalia and in Belgium, steam hoisting plants formerly in use having been scrapped. The writer recently inspected the St. Nicolas pit of the Esperance et Bonne Fortune Collieries Montegnee, near Liége, where electric winding is in successful operation. Some particulars of this installation may prove of interest to engineers of the Rand. It is designed to draw about 500 tons from a depth of 2,625ft. in eight hours. The loads are four tubs holding 1,100lb. of coal. Each tub weighs 550lb, and the cage weighs 1¾ tons. The diameter of the pulley is 3m. (9ft. 10⅛in.). The haulage speed is about 33ft. per second when the motor makes 64 r.p m. The writer not only advocates the adoption of electric winding, but he fully believes that almost every operation at present performed by steam power could more economically be effected electrically if the power were generated at a central power station supplying the whole of the mines. He has in mind air compressing, haulage and pumping (both underground and on the bank), ventilation, stamp mills, crushing, sorting tables, tailing wheels, and tramways.

It will be noticed that the writer places air compressing at the top of the list. The almost universal practice on the Rand is to work drills by means of compressed air supplied from works on the surface. This method is most uneconomical, as, owing to the inevitable leakage and friction losses, the distribution of compressed air through a long series of pipes results in a serious loss of power, variously estimated at from 50 to 75 per cent. of the power produced on the bank. This should give place to a system by which electrical energy is utilised underground to work compressors placed in ventilated positions within 200ft. or 300ft. from the workings. Under such a system over 75 per cent. of the energy delivered to the electric line would be available at the tool, say: efficiency of distribution line, 95 per cent.; motor efficiency, 95 per cent.; mechanical efficiency of compression, 92 per cent.; volumetric efficiency of compression, 94 per cent.—say, 95 per cent. of 95 per cent., of 92 per cent., of 94 per cent. equals 78·048 per cent. Some have objected to the abolition of the surface compressed-air plant on the ground that the exhaust air is an important element in the ventilation of the mine.

It does not seem to the writer probable that the ventilation of a mine can be dependent to any appreciable degree on the exhaust air from the percussive machines on the face. Surely the whole system of ventilation is one to be dealt with on lines which involve the motion of huge volumes of air at very low pressure, and the percentage effect of the discharged air from the percussive machines would seem to be too trivial to be worth notice. The only case in which the exhaust air from a pneumatic tool may have an appreciable effect upon the ventilation is when men are working on the face on a dead heading. The use of portable compressors would not, however, effect this ventilation in any way, as the compressor naturally cannot be

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placed close up to the face but at a short distance from it in a recess made at the side of one of the main ways. This spot would be fully ventilated by the main ventilating system. It is immaterial to the men working at the face whether the air comes through great lengths of pipes from the surface or through 200ft. or 300ft. of pipe from a compressor in a ventilated position.

With regard to the remaining operations, in one important respect the mines on the Rand work under conditions very favourable to the use of electricity. Pumping operations are generally continuous. For 24 hours per day and seven days per week mining operations are continuous; for 24 hours a day and six days a week milling operations are continuous, in most of the mines (some not milling on Sundays) for 24 hours and seven days a week. Here we have the ideal condition of practically continuous working. Throughout Europe and the United States, in the case of industries so operating, it has proved advantageous to abandon the use of steam in favour of electricity.

Having agreed that the use of electrical energy on the Rand has an enormous field, the question arises as to whether it could be more cheaply obtained from one central station or from separate works supplying one group of mines. Obviously the nearer the generators are to the work to be performed the less the capital outlay on distributing cables, and consequently the less dead interest thereon, the less the cost of upkeep and the less energy lost in distribution. In every "power distribution" scheme the main point to be considered is whether the advantages of centralisation do not outweigh the disadvantages arising from losses in transmission and distribution. To take an extreme case, there would be no engineering difficulties in supplying electrical energy to all the mines on the Rand from a central power-house utilising the Victoria Falls on the Zambesi; but, even disregarding the cost of the enormous works necessary for utilising the water power, the annual charges on the cost of the erection of the electric lines would far outweigh the annual outlay on coal used in works laid down on the Rand.

In order to fully appreciate the problem it is necessary to carefully note how the costs of generation of electrical energy are made up. They divide themselves almost equally into (I.) capital charges; (II.) working expenses.

I. *Capital Charges.*—(1) Interest upon the capital invested; (2) depreciation fund to provide for (*a*) the wearing out of the plant, (*b*) its antiquation.

II. *Working Expenses.*—(1) Coal, gas, oil, or water used as the motive power; (2) (in the case of steam-engines being employed) water (*a*) for boiler feed, (*b*) for condensing; (3) oil, waste, and stores; (4) wages; (5) repairs and maintenance; (6) general expenses, management, etc.

A careful study of each item in turn will lead to the conclusion that aggregation of output tends to economy in every one of them.

I. *Capital Charges.*—By aggregation of output and the resultant diversity factor less plant is required, and, therefore, a lower sum has to be provided annually for interest and for depreciation. By aggregation of output, plants of larger size can be used and the capital expenditure thereon minimised.

II. *Working Expenses.*—Taking each item in turn and confining our attention to steam-driven plants: (1) Coal—Plants of the largest size, which can only be used in works having an enormous output, use less coal per brake horse-power than those of smaller size. Before a recent Parliamentary Committee it was stated that in the case of a particular type of steam generators that the 5,000-kw. sets used 25 per cent. less steam and the 10,000-kw. sets 33 per cent. less steam than the 1,000-kw. sets. (2) Water—(*a*) For the boiler feed. The less steam used in the generators the less will be the water evaporated in the boilers. (*b*) For condensing. The less steam passing through the generators the less water required for the condensing. (3) Oil, waste, and stores—By means of the saving devices possible in plants of large size there would be an economy possible under this head. (4) Wages—There would certainly be an economy here because the same number of men required to operate, say, six plants of 1,000 kw., could as easily work the same number of plants of 10 times the size. (5) Repairs and maintenance—Engineers are aware that the percentage on value disbursed on plants of large size is less than that on plants of smaller size. (6) General expenses, management, etc.—Here, again, it is a truism that large businesses can be managed more economically proportionately than small ones. Possibly, however, there is no need to dwell further on the now almost universally conceded proposition that aggregation of output leads to great economy in production.

In order to apply our general principles to the supply on the Rand, it is necesary, to estimate the total amount of power, electrical and steam, used at the present time. This may be approximated from the amount of coal consumed annually. In the exhaustive report on the working of the Central South African Railways for the year ended Dec. 31, 1904, presented to the chairman and members of the Railway Committee on March 25 last by Mr. T. R. Price, the general manager of the railways, it is stated that "no less than 1,864,926 tons . . . . . consists of coal traffic, chiefly, of course, though not exclusively, for the gold mines." Supposing 1,250,000 tons out of 1,864,926 tons are taken by the gold mines on the Rand, how many horse-power hours does this represent? The coal varies in quality from 12,000 to 8,000 British thermal units per pound. But even so, an average of 6lb. of coal per brake horse-power hour is probably an outside figure, though with the view of keeping the estimate well within bounds the writer adopts it thus:

$$\frac{1{,}250{,}000\ (\text{tons}) \times 2{,}000\ (\text{lb.})}{6\text{lb.}}$$

equals 416,666,666 horse-power hours, or to deal with round figures, say 400,000,000 horse-power hours per annum, equivalent to an average output throughout the year of over 45,000 h.p, working day and night without intermission.

Of course, many of the operations are not continuous, so that the average of over 45,000 h.p. will constantly be exceeded, and at times more than doubled. To arrive at the exact amount of horse-power in use on the Rand is difficult, if not impossible, but a fair approximation may be made by a study of the data kindly supplied by some of the leading mines. In the case of 16 mines, which raised 316,371 tons of ore in the month of April last, 35,894 h.p. was in use. The total quantity used by all the mines during the same period was 1,074,464 tons, and if dealing with 316,371 tons of ore necessitates a maximum of 35,894 h.p., the 1,074,464 tons would, as a mere matter of proportion, require 121,903 h.p. Whatever, however, may be the total capacity of the plant, the broad fact stands out that a conservative estimate places the total requirements of the Rand mines at the enormous figure of 400,000,000 horse-power-hours, or, say, 300,000,000 units (kilowatt-hours) per annum.

In order to arrive at the total capacity of a central power-house to deal with this output, it is necessary to consider the load and diversity factors which would be obtained. The success of a central power station depends entirely upon its ability to afford a supply of energy at very low rates. The extent to which aggregation of output leads to economy in working costs practically turns upon the excellence of the load and diversity factors which would result from the supply to a large number of consumers. Under these conditions the writer hopes that he may be pardoned for going into the question of load and diversity factors in some detail. The term "load factor" is the name given to the ratio of the actual output of any works during a given period to what that output would have been had the works been operating at their maximum rate throughout that period. A moment's consideration will show that this ratio must have an important bearing upon working costs, not only in an electricity works, but in any industrial undertaking. If the load factor of any industrial concern be high, or, in other words, if the output of the works be maintained at a steady rate varying only slightly from the maximum obtained at any one time, it is obvious that the cost of the output will be lower than if the same works with the same output were working night and day at high pressure one week and half time the next.

(*To be continued.*)

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THE DISTRIBUTION OF POWER.*

BY PROF. AYRTON, F.R.S.

(*Concluded from page 413.*)

Now, this is the very opposite of the effect we previously noticed, for in that case it was the alternating pressure that failed to send the current into the transmission system. Surely, then, the one effect is a correction of the other. That is so, and I will give you a practical illustration. I have here two transmission lines, the one with its going and return conductors placed far apart so as to exaggerate the first effect; the other with its going and return conductors near together to exaggerate the second effect; indeed, as I am employing for this experiment only a pressure of 100 volts, there is no risk of brush discharge, and so I have put the wires extremely near together on the second transmission line. The alternating current produced by the dynamo divides itself between the two transmission lines, and the two branch currents are about equal. But, as you may see by means of the oscillograph—an instrument developed in my laboratories by Mr. Duddell, one of my students, for giving us a picture of the current and pressure waves in each of the two circuits—there is a great difference between the waves in the two circuits. In the transmission line with the wires far apart, the reversals of the alternating current occur after the reversals of applied pressure, the crests of the current wave lag behind the crests of the pressure wave, whereas in the case of the transmission line, with the wires very near together, the exact opposite occurs—viz, the crests of the current wave are in advance of the crests of the pressure wave.

Now, in the circuit coming from the dynamo, both current waves exist together, and as the crests of the one wave co-exist with the troughs of the other, there is interference, and the result is practically no current at all. So here we have the rather surprising result of practically no current in a main circuit, and yet a considerable current in each of the branch circuits into which the main circuit divides. This may perhaps be regarded as a beneficial result, and should be added to the score of alternating current. But just as a very small alternating current in the main circuit can be split up into two large currents in the branch circuits, a small alternating pressure can be split up into two large alternating pressures, and in that case the result must be scored against the use of alternating current. In this experiment I use also two circuits, one with the conductors very far apart, and the other with them very near together; but, instead of employing these circuits as two *branch* transmission lines, I put them end on so that they constitute *successive* portions of the same transmission line. An alternating pressure of only 69 volts is provided by the dynamo, and applied to the whole arrangement, and yet you observe that between the going and return conductors in that part of the circuit in which they are far apart, as well as in that part in which they are near together, a pressure exists of 2,400 volts, which is 35 times as great as the entire pressure supplied by the dynamo to the mains. This result with alternating electric pressures is not unlike that obtained with mechanical forces when a small force is resolved into two very large ones, with each of which it makes nearly a right angle. Much damage has been done to electric cables used for the distribution of power by these unexpected high pressures produced by resonance in alternate-current circuits. A cable may have been tested at twice or thrice the working pressure and passed as satisfactory. But if there is a liability of a pressure being applied which, as you see, may in somewhat extreme cases be 20 or 30 times the working pressure, what avails it there being a factor of safety of 2 or 3—disaster must follow.

Now, with direct current for long-distance transmission, there is no question about the electric pressure at the top and bottom of a wave being much greater than the mean pressure, no question about self-induction reducing the current—no objection, therefore, to putting the conductors as far apart as the risk of brush discharge may necessitate—no question about capacity current, no resonance troubles, etc. I wonder whether any of you are thinking, Well, perhaps, there may be something in this heresy after all. No? Oh! then you are thinking, if the arguments were sound, the direct-current system would have been already employed for long-distance transmission. Well, but it has! Power up to 3,000 horse has been transmitted with direct current, at 14,000 volts, from Combe Garot to Le Locle and La Chaud de Fonds, round a circuit 32 miles long, 4 600 h p. has been transmitted with direct current at 23,000 volts, 35 miles from St. Maurice to Lausanne, and a transmission system for 6,000 h.p. at 60,000 volts, over 114 miles from Moutiers to Lyons, is in course of construction.

Another advantage that is possessed by all these examples of direct-current transmission carried out by M. Thury is that it is the current that is kept constant, and the electric pressure that is automatically raised, when the demand for power is increased, whereas with the ordinary alternate-current system it is the pressure at the lamp end that they aim at keeping constant, and the current that varies automatically with the demand for power. Now, it is far more easy to maintain the constancy of the current flowing round a long circuit than to prevent the bobbing up and down of the electric pressure at the distant end of a long transmission line, and that irritating dancing of the lights, which Johannesburg is so familiar with, would be particularly difficult to avoid if the transmission line were long and the electric pressures at its two ends differed by some thousands of volts. Constant current has also its well-known disadvantages, but these would not come into play if the constant current were not taken into houses, mines, etc, but used to drive motor-generators in substations, the dynamo portion of the motor-generator being of any type desired.

The pioneering development that American boldness, enterprise, initiative, and originality have brought about in the electric distribution of power, combined with the extraordinary commercial success that it has won on both sides of the Atlantic, have made people ask, "Is such an industrial revolution in store for South Africa?" At first sight one is inclined to answer, "No!" This country is dotted with coalfields—coalfields blacken the map, and the produce of some of them is reported to be nearly equal to the best Welsh coal in quality. A humorous English paper said that I was going to give this lecture standing on a coal wagon, to indicate how superior, as a carrier of energy, was a coal cart to a current. When, on the one hand, one hears that good coal is brought from Witbank and delivered to the mines on the Rand at 13s. a ton, and that even this price will be lowered on the completion of the new railway from Witbank to Brakpan, one feels that long-distance electric distribution has not much chance; indeed, a proposal to burn slack coal at Vereeniging, only 33 miles from Johannesburg, and electrically distribute the power on the Rand, fell through. On the other hand, when one finds that at the Wankei coalfields themselves large coal costs 15s. a ton *at the pit's mouth*, and that Salisbury pays 36s. 5d, Umtali 43s. 6d., and Kimberley 67s. per ton, one feels that electric distribution in this country possesses possibilities. South Wales has many coal mines—cheap slack coal lies heaped at the pit's mouth. Let me put this question to you: "If an electric supply distributing company were to start in South Wales to obtain their electric energy, *not* from waterfalls, mark you, but from coal brought to their generating stations from coal mines, would you anticipate, I ask, that such a company would obtain customers for their electric energy at coal mines themselves?" "No, emphatically no," you would reply, for that would be taking coals to Newcastle with a vengeance. And yet, what does that map tell us? Why, that within four years since that South Wales company was merely applying to Parliament for an Act to enable them to establish a distribution of power system, 14 of the largest colliery companies and 30 of the mines are taking power at about ½d. a horse for an hour, the demand three months ago having reached 13 000 h p., and rapidly increasing. That the North-Eastern Railway, and such a large number of manufactories along the Tyne, should, as seen from that other diagram, take power from the Tyneside Electric Power Supply Company—which also

* Lecture delivered on Aug. 29 at the meeting of the British Association at Johannesburg.

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has been but four years in existence—was perhaps to be expected, but that coal mines should obtain power by the burning of the product of distant collieries resembles at first sight the method of earning a living attributed to a certain village—viz, by taking in one another's washing.

But this result is but an example of the sub-division of labour. At a coal mine, getting coal, and at a gold mine, getting gold, is the business; and at both, especially in the early days of sinking the mine, it should pay better to buy electric energy from an outside source than to generate the current on the spot. Niagara sends 24,000 h.p. to Buffalo, 30 miles away, and sells at 0·7d. per horse-power hour to an eight-hour user there—a price which is *not* cheaper than the total cost of generating a horse-power hour at Buffalo with a *large* steam-engine. But tapping electric wires to obtain any amount of power that may be needed, and just at the time that it is required, is far more convenient than erecting steam-engines and getting up steam, and certainly cheaper in the early days of sinking a mine. It has been objected that the total steam-power curve of all the gold mines on the Rand show the same sort of falling off during the hours 4 to 7 a.m. and 5 to 8 p.m., and, therefore, that, apart from using larger and more economical engines, and from diminishing the cost of superintendence for the energy sent out, there would be no saving by supplying many mines with electric power from a common generating station. But if there be a railway in the neighbourhood, largely used by workmen, the slack hours on the mines will be the busy hours on the railway. Hence, if that railway be run electrically from the same generating station, the load curve will be flattened and much improved. On the Rand, however, there is an indisposition apparently to utilise distribution of power on a large scale. The labour conditions in this country are certainly peculiar. My friend, Mr. Denny, in his book on "Deep-Level Mines of the Rand and their Future Development," expresses this opinion—and there is no man whose opinions on such matters I value more highly—"It has, however, been fairly conclusively proved that in average conditions hand labour is both speedier and cheaper than machine drilling." But when one watches this hand labour, one thinks of this picture rather than that. Contrary to American and Australian experience, it may be true that in this country white men and machinery may be dearer and slower than black machinery and man rolled into one. But it makes one uncomfortable, even unhappy, to think it possible, for it means that the muscular machine is more valuable than the inventor's brain.

Another objection felt by mine owners here to investing much capital in machinery is the somewhat uncertain character of their business, and a third against a mine depending for a supply of power on an electric current coming from a distance is the climatic conditions. South Africa has various unique big things, but it has not a monopoly of big atmospheric disturbances, and these disturbances do not prevent electrical distribution of power schemes being pushed forward by leaps and bounds in the other three quarters of the world—the list given in Table II. is merely a selection from some of those using the highest working voltages. During my short stay in this country I have been giving this matter much consideration. Without stopping this evening to discuss the subject in detail, I may mention that, after the admirable work of Mr. Wilms, Mr. Spengel, Mr. Heather, and others here on the improvement of lightning arresters for electric transmission lines, I think I also see my way to putting a nail into the coffin of these bugbear lightning troubles.

But, while advocating electric transmission of power, I should not start by constructing a transmission line from the Victoria Falls to Johannesburg. And I say that not because I am of opinion that it could not be made to work, nor that, if direct current were used, it could not be relied on to give as satisfactory results as, or even better results, than some shorter existing ones on the alternate-current system, but because it does not appear to me that along the route there is at present sufficient demand for power to justify as large an expenditure of capital as would be compatible with a transmission line 586 miles long as the crow flies, and which would be no less than 745 miles long if made along a railway through Pietersburg and Gwanda, should that missing stretch of railway between these two places ever be constructed. Those who hold the opposite view will doubtless urge that when the Cataract Construction Company of Niagara acquired in 1890 the right to use 100,000 h.p., and a further right to subsequently use another 100,000 h.p., it required an extraordinary belief in the future of electrical engineering to expect that 200,000 h.p. could ever be distributed at a price that could compete with large local steam-engines, and they will ask, Did not even Mr. George Westinghouse advise Mr. Stetson, the first vice-president of the Cataract Construction Company, in 1890, that it would only be by compressed air that power could be commercially transmitted from Niagara to Buffalo? And now what is the state of things? Power-house No. 1 with 10 5,000-h.p. dynamos has been working for some time, power-house No. 2 with 11 more 5,000-h.p. dynamos was completed last year. Hence 105,000 h.p. can be developed, and of this 75,000 h.p. is regularly distributed. Further, the Canadian Niagara Power Company are constructing an electric station of an ultimate capacity of 110,000 h.p., the Ontario Power Company an electric station a little lower down of 200,000 h.p., and the Toronto Power Company one a little higher up of 100,000 h.p., all these three being on the Canadian side. Also the Electric and Hydraulic Company, who in 1881 started with a station on the American side to supply only 1,500 e.h.p., have in hand a third station which will bring their plant capacity up to 135,500 e.h.p. Consequently the total electrical horse-power that could be sent out from these various Niagara power-houses when completed will approach 700,000 h.p., and represents about 30 per cent. of the water going over the Falls at the time of *minimum* flow. But taking into account the further fact that water is already abstracted to feed the Welland Power Canal and the Chicago Drainage Canal, and that other canals are projected, Mr. A. D. Adams has estimated that about 41 per cent. of the minimum flow of Niagara will cease to pass over the Falls. In fact, *the water that will cease to pass over the Niagara Falls will be nearly five times as large as the total amount passing over the Victoria Falls to day.*

The "Thunder of the Waters," the "Cataract of Fearful Height," in America, which have inspired us and our ancestors with reverential awe, may appeal to our descendants as only a vast electric generating station. Very gratifying to us as engineers—extremely distressful to us as lovers of the beautiful. Now, what has caused this vast development in the distribution of power, what is the secret of this extraordinary success? It is that in the immediate neighbourhood of the Falls there have grown up works which take some 60,000 h.p., works which not only want cheap power, but power in an electric form for electro-chemical processes, and need it an undiminished amount, day and night, week-day and Sunday. The Carborundum Company, which manufactures emery's rival grinding material, furnishes an absolutely steady load of 5,000 e.h.p., the Union Carbide Company 15,000, and so on, loads which, from their magnitude and their absolute steadiness, make the electric light engineer's mouth water.

Now what is the prospect of such a steady load growing up locally within, say, three miles of your falls? Even on the spot it is difficult to obtain trustworthy information; by some it is said that one condition of the contract for the construction of the railway, which is being pushed forward to the copper, lead, and zinc fields at Broken Hill, 400 miles to the north-east, is that 100,000 tons of the ore must be sent to Beira yearly for 10 years. If true, then that ore will not be available for reduction at the falls. There is a convenient spot for a power station near the water at the end of the second gorge—all the Niagara power stations are on the top of the falls with the exception of that of the Ontario Power Company—and it is the latter method of construction that would be the most suitable to follow at a Victoria power station. But jealously guard the beauty of your falls. The protection of the grandeur of their American sister was the underlying idea of Thomas Evershed's hydraulic power scheme of 1886. How little has that object been kept sight of? Niagara *was* glorious nature, to-day it is power; Victoria is poetry.

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EDDY-CURRENT LOSSES IN ARMATURE CONDUCTORS.

Some useful experiments on this subject have recently been carried out by Messrs. B. Loewenherz and A. Van der Hoop, and described in the *Elektrotechnische Zeitschrift*, from which we take the following details. The tests were made on a special iron core shaped like a shell transformer, and shown in Figs. 1, 2, and 3. The dimensions are given in millimetres. The central part of this core represents one complete slot and two half slots of a slotted armature, and into these slots copper bars of various types can be inserted, whilst by passing an alternating current round the magnetising coils, the teeth and slots can be magnetised to any required extent, and corresponding eddy-current losses occur in the copper bars, much as in the case of a rotating slotted armature. The eddy-current losses were measured calorimetrically, the method being based on the fact that the heat developed in a body is partly employed in raising the temperature of the body and partly dissipated to surrounding objects. The first part is given by the product of temperature rise and water equivalent of the body. The second part is less easily arrived at, but preliminary experiments proved that for the case in question, where the copper bar in a slot is quite enclosed from the air and practically surrounded by iron, the total dissipated energy was proportional to the temperature difference between the copper and any given point on the surrounding walls. The writers show that the connection

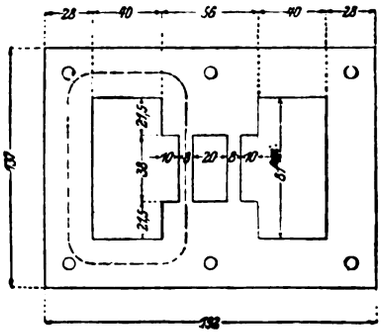

FIG. 1.

between eddy-current losses and temperature may be stated as

$$Q = K \frac{\int_{t_1}^{t_2} \Delta T \, . \, dt}{t_2 - t_1} + Cg. \frac{T_2 - T_1}{t_2 - t_1},$$

or, allowing for change of ohmic resistance with temperature,

$$Q_0 = \left\{ K \, . \, \frac{\int_{t_1}^{t_2} \Delta T \, . \, dt}{t_2 - t_1} + Cg. \frac{T_2 - T_1}{t_2 - t_1} \right\} \times \frac{A + T_0 + \frac{\int_{t_1}^{t_2} (T - T_0) \, dt}{t_2 - t_1}}{A + T_0}$$

where Q = eddy-current loss in unit time;

Q_0 = eddy-current loss in unit time reduced to a normal temperature, T_0;

K = a constant determined from a large number of cooling tests by means of the expression

$$K = Cg. \frac{T_2 - T_1}{\int_{t_1}^{t_2} \Delta T \, . \, dt}$$

t_1 and t_2 = the times at the beginning and end of the reading;

ΔT = temperature difference between the copper conductor and the surrounding iron;

$Cg.$ = the water equivalent (as regards heat absorption) of the copper conductor;

T_1 and T_2 = the temperatures of the copper at times t_1 and t_2 respectively;

A = a temperature coefficient depending only on the material of the conductor.

The temperatures were measured by fine-wire platinum resistance thermometers, and the maximum values of the flux densities both in the teeth and in the slots were obtained by winding exploring coils at the required points and determining the curves of the induced voltages.

A series of 20-minute tests, with five or six sets of temperature measurements in each, was made with seven

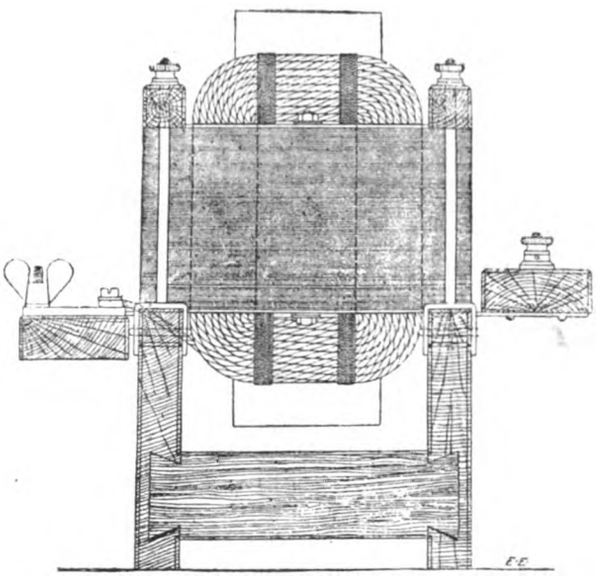

FIG. 2.

different excitations at 50 ~, and from the curves connecting temperature rise of copper and of iron with time, so obtained, together with the corresponding cooling curves, the numerical values of the various constants in the above equations were obtained and the eddy-current losses per one cubic centimetre of copper calculated. This whole series of tests was repeated with the six different types of copper filling shown in Fig. 4.

The results arrived at in this way are given in Figs. 5 and 6. Fig. 5 shows the connection between the watts per cubic centimetre and the ampere-turns per centimetre of tooth (or flux density in slots), and all the curves are exponential

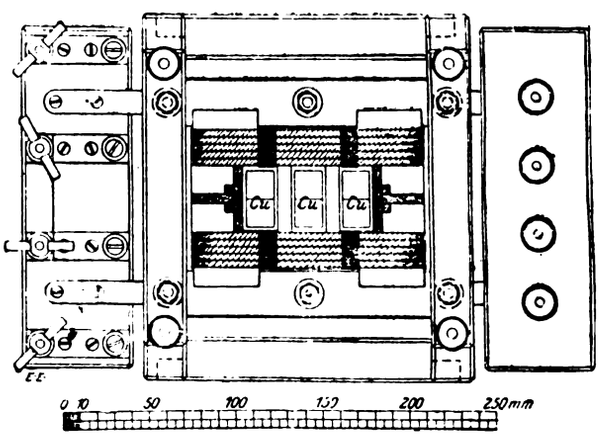

FIG. 3.

functions of the abscissæ, the exponential index working out at approximately 2. It will be noticed that the losses when the copper is subdivided crosswise appear to be slightly greater than when it is solid. This is, however, probably accounted for by the fact that in the former case the platinum thermometer could be inserted in the middle of the bar, whilst in the latter it could only be laid beside the bar, and so did not quite reach the temperature of the bar. The losses with the double bar and the four-fold bar are practically alike, showing that crosswise subdivision has little if any effect. This indicates that the flux passes practically straight down the slot.

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In the case of the cable (VI.) the ends had to be soldered, and it is likely that the losses would have been negligibly small but for this soldering. Fig. 6 shows the connection between watts lost per cubic centimetre and width of

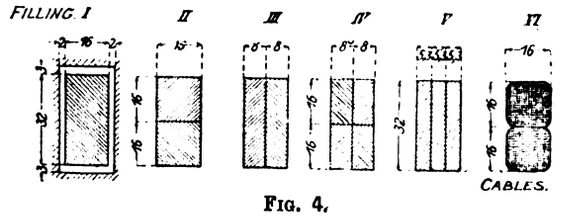

FIG. 4.

copper conductor for the fillings Nos. II, III., and V. at various excitations. The exponential index for these curves averages 1·5. Theoretically, the eddy-current loss per one cubic centimetre is given by the expression $2{\cdot}11 \times \gamma \times \nu^2 \times f^2 \left(\frac{A}{l}\right)^2 \times S^2 \times 10^{-7}$ in watts, whilst from the average of the experimental results the formula is

$$2{\cdot}12 \times \gamma \times \nu^2 \times f^2 \times \left(\frac{A}{l}\right)^2 \times S^{1{\cdot}5} \times 10^{-7},$$

and the exact agreement of the constants is remarkable.

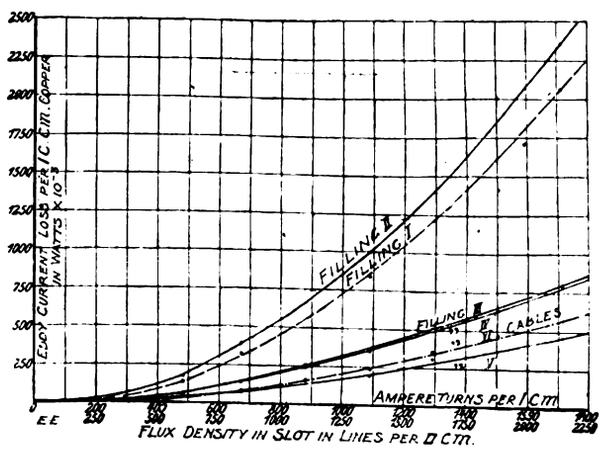

FIG. 5.

γ = specific conductivity in C.G.S. units = $\cdot 58 \times 10^{-3}$ for copper at 15deg. C.;

ν = periodicity (which was 50 in the tests);

f = form factor of the curve of E M F. induced by the slot flux;

$\frac{A}{l}$ = ampere-turns per 1cm. of length of tooth (or slot);

S = width of rectangular conductor in centimetres measured at right angles to the direction of the flux.

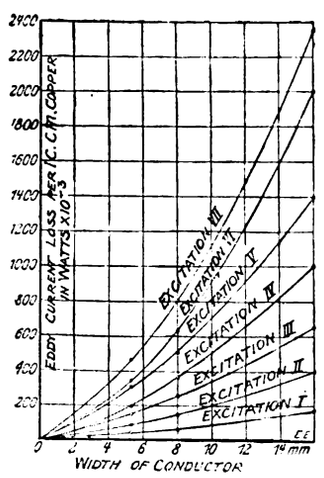

FIG. 6.

As regards the practical application of the above results to actual armatures, it must be remembered that in these tests the flux passed straight down the slot, whilst in an armature, as soon as a slot passes out from under the pole-piece, a cross flux is set up, the effect of which is obviously not related to the thickness of the copper in the same way as that of the straight down flux. Still, the curves given will serve to indicate the approximate eddy-current losses to be expected in any particular case. The ampere-turns per centimetre in place of the flux densities in the teeth have been employed in the formula because it is the former which actually determine the flux density in the slot, and, therefore, the eddy currents in the conductor, whilst the effect of the tooth flux density on the losses is indefinite, and depends on the quality of the iron. The presence of the form factor in the formula enables the effect of various polar flux distributions to be compared, and indicates that flat flux curves are more unfavourable than those produced by bevelled-off pole-tips, not directly because the flux differences within a slot at the pole-tip are reduced, but because the maximum eddy-current voltage is reduced owing to the more uniform rate of change of flux.

BOLTON ELECTRICITY ACCOUNTS.

The accounts of the Bolton electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £256,820. Abstracts of the revenue account, balance-sheet, etc. are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	11,718	8	2
Distribution of electricity	285	7	0
Rents, rates, and taxes	1,412	17	5
Management expenses, salaries, etc.	1,420	16	6
	14,837	9	1
Amount carried to net revenue account	24,138	5	0
	£38,975	14	1

Cr. Income.	£	s.	d.
By sale of current per meter, less allowances	17,967	14	7
Ditto for power	4,715	1	3
Ditto for public lighting	119	13	9
Tramway traction	14,588	6	0
Rental of hired meters	339	17	9
Rental of hired motors	715	19	1
Profit on fittings trade account	529	1	8
	£38,975	14	1

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Preston Savings Bank, less repaid	37,238	10	4
Leeds, etc., Savings Bank, less repaid	12,182	5	10
"Cobra" disaster fund, less repaid	3,200	0	0
Borough of Croydon, less repaid	9,851	14	5
Ordinary mortgages, less repayments	161,150	0	0
Redemption of debt	43,489	9	5
Depreciation and renewals fund account	10,517	3	10
Sundry creditors	4,667	0	8
Reserve fund account	998	11	4
District funds	5,557	0	0
Profit and loss account	577	19	2
	£289,489	15	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	256,820	12	11
Stores on hand	3,522	4	11
Sundry debtors for current supplied	12,994	18	9
Cash at bank and in hand	14,808	0	2
Electric fittings, work in progress	345	6	11
Invested in consols, reserve fund	998	11	4
	£289,489	15	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			6,457,194
Quantity sold: Private lighting	1,265,684		
Public lamps	9,694		
Tramways	3,182,903		
Motors	1,000,348		5,458,629
Quantity used on works			532,944
Total quantity accounted for			5,991,573
Quantity not accounted for			465,621

MEXBOROUGH ELECTRICITY ACCOUNTS.

The accounts of the Mexborough electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £18,572.

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Abstracts of the revenue account, balance sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	844	7	8
Distribution of electricity	29	13	7
Attending and repairs to public lamps	137	9	11
Rents, rates, and taxes	80	15	4
Management expenses, salaries, etc.	226	15	11
	1,319	2	5
Amount carried to net revenue account	1,708	15	3
	£3,027	17	8

Cr. Income.	£	s.	d.
By sale of current per meter, less allowances	1 083	11	11
Ditto by contract	1,041	5	9
Ditto for public lighting	903	0	0
	£3,027	17	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	14,190	9	0
Sundry creditors (including contractors)	1,667	9	5
Interest accrued, wages unpaid, and doubtful debts	172	0	2
Treasurer—loan account, less revenue account	1,981	1	8
Clerk—balance of cash account	0	14	9
General account	465	8	10
Surplus account	1,854	1	0
	£20,331	4	10

Cr. Assets.	£	s	d.
Capital account—amount expended for works	18,572	8	11
Stores on hand	303	8	9
Sundry debtors for current supplied	684	8	6
Cash in engineer's hands	21	5	1
Destructor loan account	18	18	0
Net revenue account—deficit	730	15	7
	£20,331	4	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			292,676
Quantity sold: Public lamps	90,385		
Quantity sold: By contract	117,492		
Quantity sold: Private consumers by meter	67,069		
Quantity sold			274,946
Quantity used on works			4,147
Total quantity accounted for			279 093
Quantity not accounted for			13 583
Total maximum supply demanded (kilowatts)			170

Number of public lamps: 15 arcs, 226 incandescents.

PERSONAL.

The Bradford Tramways Traffic and Fares Sub-Committee recommend the appointment of Mr. T. Stirk, chief assistant in the traffic department, to the post of traffic superintendent.

The recommendation of the Coventry Electricity Committee to increase the salary of Mr. J. A. Jeckell from £400 to £450 per annum, as announced in our issue of Sept. 15, was agreed to by the Town Council at their last meeting.

Mr. Oswald Dewey, who has been for some time on the outside staff of Messrs. Ferranti Limited, Hollinwood, is about to join the Ressin Manufacturing Co. to take charge of their office at 14, New-street, Birmingham, and to represent them in the Midland district.

Mr. William Bruce Dick, of Carrick Grange, Sevenoaks, Kent, largely interested in Messrs. Dick, Kerr, and Co., permanent-way contractors and electrical engineers, of 110, Cannon-street, and Kilmarnock, who died on July 11 last, aged 75, founder of the firm of Dick, Kerr, and Co., left estate valued at £233 349. 2s. 7d. gross in the United Kingdom, of which £157,979. 16s. 11d. is net personalty.

On Friday last at the Ilford electricity works Mr. J. L. Smith, late shift engineer, was presented with a handsome case of drawing instruments, suitably inscribed, by Mr. A. H. Shaw, chief electrical engineer, on behalf of the staff and employés. Mr. Smith has recently been appointed shift engineer to the Stepney Borough Council. Mr. W. H. Taylor succeeds Mr. Smith at Ilford.

Mr. James MacIntosh, B.Sc., A.M.I.C.E., has been appointed lecturer to evening classes in electrical engineering at the Battersea Polytechnic. Mr. MacIntosh studied electrical engineering at Glasgow University, when he took the degree of B.Sc., and was trained in the works of Messrs. Kelvin and White, being for some time in Lord Kelvin's laboratory. He is at present chief assistant to the manager of the Alliance Electrical Co., in charge of the engineering department, and is the inventor of an automatic booster.

Mr. W. H. Jay, district superintendent of the County of Durham Electrical Power Distribution Co., has been the recipient of a handsome suitably-inscribed timepiece, presented to him by the chief assistant, Mr. J. Husband, on behalf of the staff, on the occasion of his leaving Durham to take up the post of district engineer of the Gosforth and Benton area under the Newcastle-on-Tyne Electrical Power Distribution Co. Mr. Jay is succeeded as district superintendent at Durham by Mr. W. S. Verrill, late of the Newcastle-on-Tyne Electrical Supply Co.

LEGAL INTELLIGENCE.

THEFT OF ELECTRICAL FITTINGS.

At the Thames Police Court on Tuesday, Henry Lofthouse, an electrician, was charged with stealing a quantity of electrical fittings, valued at £50, belonging to the proprietors of the Bow Palace of Varieties Theatre.

Prisoner was employed at the theatre as electrician. In the engine-room were fittings in connection with a dynamo and other machines, and these Mr. C. Harley, the manager, saw safe on the 7th inst. On the 11th they were missed, and accused left without giving notice.

Mr. Dickinson sentenced prisoner to four months' hard labour.

COMPANIES' MEETINGS AND REPORTS

YORKSHIRE ELECTRIC POWER.

The fifth half-yearly meeting of this Company was held on Tuesday, Mr. A. G. Lupton presiding.

The CHAIRMAN said the directors hoped that the shareholders would visit the works and see for themselves the progress that had been made in the development of the undertaking. Alluding to the accounts, he said the share capital had been increased by 1,575 shares, which had been issued to Callender's Cable Co. for work done by them. The last call on 19,750 ordinary shares was due in March, and the whole of the calls were paid up with the exception of the call on 52 shares. It had been necessary to organise a considerable staff to superintend the laying of the mains and canvass the district which they were serving. It had caused considerable expenditure, but it was bearing fruit in the rapid development of the undertaking. In February he reported that agreements had been made with customers to the amount of over 900 h.p. These were now connected with the mains, and they had further agreements with consumers and negotiations with others to quite as large an amount. Mr. Woodhouse, their resident engineer, assured them—and the directors thought it was upon good grounds—that the revenue during the year ending June 30, 1906, would meet all the expenditure with the exception of the depreciation sum and interest on capital. They found that those consumers who had experienced a few months of the Company's supply were quite satisfied, and in individual cases they were extending the use of the motive power. That was the best sign they could have. They were supplying three textile factories and several collieries. He believed local authorities were beginning now to realise that the Company could supply electricity on a much cheaper basis than they could possibly hope to generate it themselves, and they were finding an increasing demand from them. At their last meeting he reported that there were two Bills which they should probably have to fight in Parliament. He was glad to say that in both instances clauses were introduced which made it unnecessary for them to do so. There had not been a single share sold by the directors from the beginning, but they had increased their holdings by purchasing shares which had been offered to them.

The report was adopted, and the directors were authorised to borrow sums not exceeding £80,000 by the issue of debenture stock.

SIR W. G. ARMSTRONG, WHITWORTH, AND CO.

The tenth annual report states that for the year ended June 30 last, after deducting depreciation and adding £86,369 from last year, there remains a profit of £530,927 on the year's operations. It is proposed to declare on the ordinary shares a dividend of 3s per share, of which 1s. per share has been already paid as interim dividend, and to carry forward £84,033. The directors state that the establishments of the Company are well supplied with orders. In continuance of the past policy, the sum of £15 000 has been placed to the credit of the account for the renewal of plant. The directors have decided that the comparatively small sum in the books of the Company representing goodwill should be eliminated. They had, therefore, applied the sum of £13,710 to this purpose, and goodwill is now extinguished.

WILLANS AND ROBINSON.

The report of Willans and Robinson for the half-year ended June 30 last, to be submitted at the meeting on the 4th prox., shows a loss of £8,617 at Rugby and £14,285 at Queen's Ferry, or £22,902 in all. As the provision for depreciation at the two places amounts to £17,742 and £5,929 represents the valuing down of certain stocks, the actual reduction in the liquid assets of the Company, as distinct from a book loss, is £1 231. As the debit balance brought forward on profit and loss account was £79,952, there is now a debit balance to carry forward of £102,854. Trade in high-speed engines has continued to be unprofitable, and the new classes of work taken up have not advanced far enough to produce any substantial advantage in the accounts. Of the gas-engine business it can only be said that, while much expense has been incurred, there is not yet sufficient evidence of a commercially profitable result to follow. As regards steam turbines, the directors are satisfied that a successful business is assured. The turbines which have been set to work have done extremely well, and this initial success will, in their opinion, lead to a rapid development of the business. The steelworks at Queen's Ferry were restarted in January, and during the half-year have not only contributed to the general expenses of the business, but have yielded a small profit. The special steels made by the Company are attracting increased attention, and there is a good prospect of satis-

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factory business in the future. The orders for boilers are sufficient to keep the remainder of the works employed upon the moderate scale to which it is at present considered advisable to limit operations. In weighing the real loss at Queen's Ferry it is necessary not only to take into account the amount charged for depreciation and for writing down of old stocks, but the fact that Queen's Ferry is charged to the extent of nearly £3,000, with its due proportion of certain general charges, which, if Queen's Ferry were not at work, would still have to be paid. The directors are satisfied that the best policy is to continue to keep the Queen's Ferry works open and to develop the business as opportunity serves.

MERSEY RAILWAY.

The report for the half-year ended June 30 states that the train mileage run during the half-year was 412,215 miles, as compared with 411,683 during the corresponding six months of 1904. The number of passengers conveyed during the half-year ended June 30 has been 4,862 378, as against 4,499,147 for the corresponding period of 1904, exclusive of season-ticket holders. The total receipts from all sources have been £43 536, as compared with £40,918 for the corresponding period of 1904. The working expenses, exclusive of the charges for pumping, ventilation, and lifts, have been £30 779, equal to 70 70 per cent., as against £29 751, equal to 72 71 per cent. for the corresponding six months. These charges for pumping, ventilation, and hydraulic lifts amounted to £3,949, equal to 9·07 per cent., as compared with £3,839, or at the rate of 9·38 per cent. for the corresponding period of 1904. Since the closing of the accounts the 4½ per cent. redeemable first debenture stock, amounting to £249,276, has been redeemed by the issue of 4 per cent. Mersey Railway new first perpetual debenture stock in terms of the Act of 1900 and the contract with the British Westinghouse Electric and Manufacturing Co. A service of motor omnibuses to and from the stations of the Company in Birkenhead is being arranged for and will shortly be inaugurated.

APPOINTMENTS VACANT.

Canvasser, Batteresa Electricity Department. Applications by Oct. 10. See advertisement.

Electrical Fitter and Repairer, West Africa. Salary, £20 per month. See advertisement in last issue.

Junior Engineers for a company in the Metropolitan district. Apply to B. W., *Electrical Engineer* Office. See advertisement.

Engineering Instructor. the Technical Education Board of Wellington, New Zealand. Salary, £300 and £40 passage allowance.

Assistant for electrical estimating department in large switchworks. Applications to Box H 2, *Electrical Engineer* Office. See advertisement.

Charge Engineer, Willesden Urban District Council. Salary, 35s. per week. Applications by Oct. 4. See advertisement in last issue.

Winders for direct-current and alternating-current work. Apply to Bruce Peebles and Co., East Pilton, Edinburgh. See advertisement in last issue.

Assistant Engineer to act as station superintendent at one of the Edinburgh Corporation's electric generating stations. Commencing salary £180 per annum, rising to a maximum of £270 per annum. Applications by Oct. 2. See advertisement in last issue.

FORTHCOMING EVENTS.

THURSDAY, OCT. 5.

Rugby Engineering Society.—At 8 p.m., general meeting, with lecture by Mr. J. Sugden, entitled "Protection from Electric Shock," to be supplemented by a practical demonstration of the necessary treatment after a shock.

MONDAY, OCT. 9.

Lancashire Electric Power Company.—At 1 p.m., opening of the Radcliffe power station by the Earl of Derby

LIENS REGISTERED AND DISCHARGED.

New General Traction Co., Limited.—A memorandum of satisfaction to the extent of £18,700 of debentures, dated July 8, 1901, securing £200,000, has been filed.

Llandrindod Wells Electric Light and Power Co, Limited, Chester.—Debenture and mortgage, as collateral security registered Sept. 13, for £4,000, pursuant to an order of the High Court of Justice dated Aug. 30, 1905; charged on the undertaking and all the property, present and future.

Electrical Bleaching Co. (1904), Limited, Manchester.—Mortgage registered Sept. 14, for an indefinite amount, the instrument being stamped to cover £10,000 to the Manchester and Liverpool District Banking Co., Limited; charged on messuages, tenements, and other hereditaments, with fixed plant and machinery in Tottington Higher-end, Lancashire, subject to debentures for £14,000.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Paris.—The Post and Telegraphs Department, 13, Rue de Grenelle, require tenders for insulators, cables, etc. Tenders by Oct. 10.

Paris.—The Post and Telegraphs Department, 13, Rue de Grenelle, require tenders for copper and bronze wire and other telegraph material. Tenders by Oct. 9.

Pontypridd.—The Urban District Council invite tenders for (Section B) overhead equipment for tramways; (C) cables for tramways. Tenders by noon on Sept. 30.

Prestwich (Lancs.).—The Urban District Council invite tenders for the installation of electric light in their Council Offices, Prestwich. Tenders by 12 noon on Oct. 9.

Paris.—The Colonial Office, 4 rue Jean Nicot, Paris, require tenders for galvanised iron wire for the Indo-China telegraph service. Tenders by Oct. 10. Specification from Inspection Générale des Travaux publics, room No. 146, at above address.

Langho (near Blackburn).—The Chorlton and Manchester Joint Asylum Committee invite tenders for the supply and fixing of the necessary telephones and electric bells at the new colony for epileptics at Langho, near Blackburn. Tenders to the Clerk, Chorlton Union Offices, All Saints', Manchester, by Oct. 3.

London County Council.—The London County Council invites tenders for the manufacture and laying of (*a*) 56 miles low-tension lead-covered, paper-insulated cables, 20 miles dry-core telephone cables, cast-iron feeder pillars, etc.; (*b*) 24 miles extra high-tension three-core, lead-covered, paper insulated cables, etc. Tenders to Mr. G. L. Gomme clerk, by 10 a.m. on Oct. 3.

Great Western Railway.—The directors of this company invite tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1906. Specification, with forms of tender, may be obtained at the office of the Stores Superintendent at Swindon. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Oct. 16. Full particulars in advertisement columns.

Southgate.—The Light Railways and Tramways Committee of the Middlesex County Council invite tenders for the work and materials required in the construction of the permanent way (for electric traction), bridge work, road widenings, etc., for Contract No. 14; railway No. 2 (order 1900)—a line of double track (with crossovers, contingent works, etc.) to be laid along Bounds Green-road, in the district of Wood Green, and High-road, Southgate, to a length of 1 mile 5 furlongs 1 chain, or thereabouts. Tenders to Sir Richard Nicholson, clerk of the County Council, Middlesex Guildhall, Westminster, S.W., by Oct. 4.

RESULTS OF TENDERS.

Finchley.—The Urban District Council have accepted the tender of the British Accumulator Co., Parliament Mansions, Victoria-street, London, S.W., at £2,761. 10s., for two large storage batteries required at their new sub-station.

Southend.—The Town Council have accepted the tender of the Chloride Electrical Storage Co., at £445, for the dismantling and renewal of the battery (less a sum of £35 to be allowed by them for old material, subject to the Corporation paying carriage to London), and for the maintenance of the battery for a period of 10 years at the rate of £35. 10s. per annum.

Recent Contracts.—Messrs. Dick, Kerr, and Co. report the following recent contracts: J. Kenyon and Son, complete generating plant and motors for driving spinning mills; Cammell, Laird, and Co., 300-kw. D.C. generator; Wallasey Urban District Council, five single-deck cars with top covers, complete with electrical equipments; Ashton, 500-kw. D.C. generator; Star Papermills, complete generating plant and motors for driving the mills; Buenos Ayres Port and City Tramways, 24 double service cars and equipments, 10 combined freight cars and electric locomotives; Cawnpore Tramways, 20 single-deck cars and equipments; London County Council, 16 single-deck steel cars, specially designed for L.C.C. subway.

Ramsgate.—The Corporation have received the following tenders for electric call bells:

J. Bussey, Ramsgate	£137 10 0
Telephone and Electrical Installation Co., London	115 0 0
National Telephone Co., Ramsgate	110 0 0
Electrical Engineering Co., London	109 0 0
Stuart and Moore, London	106 15 6
E. Coveney, Ramsgate	90 0 0
E. J. Philpott, Ramsgate (accepted)	77 16 0
G. Poulson, Ramsgate	58 10 0

Maintenance per annum: Telephone and Electrical Installation Co., £18; National Telephone Co., £7. 10s.; Stuart and Moore, £10; E. Coveney, £9; E. J. Philpott, £4. 10s.; G. Poulson, £2.

Croydon.—The County Council have received the following tenders for the supply of three electric motors and pumps at the farm:

T. Harding, Churton, and Co. (accepted)	£292 0 0
Witting, Eborall, and Co.	296 0 0
Fuller, Wenstrom, and Co.	310 4 0
Gwynnes Limited	345 0 0
Rhodes Electrical Co.	359 0 0
Worthington Pump Co.	353 10 0
J. H. Holmes and Co.	363 0 0
Korting Bros.	376 10 0
Laing, Wharton, and Co.	390 0 0
A. Schove	403 0 0
J. Gordon and Co.	387 0 0
Mather and Platt	405 0 0
Lahmeyer Electrical Co.	406 16 6
W. H. Allen and Son	480 0 0

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BUSINESS NOTES.

TRACTION.

Belfast.—A successful trip was made on Tuesday.

Newcastle.—The lines for the Scotswood extension are being welded by the Goldschmidt thermit process.

Durham.—The Rural District Council have decided to withhold their consent to a further extension of time for completing the Durham and district light railways.

Wellington (New Zealand).—As stated under "Imperial Notes" elsewhere in this issue, the City Council intend to add to the tramways power plant at an early date.

Southend.—The Tramways Committee have resolved to recommend: "That the Council do approve in principle the extension of the tramways system along High-street, Pier-hill, and Marine-parade."

Glasgow.—A large deputation last week waited upon the Tramways Committee, who stated that they would endeavour to bring the question of an extension to Millerston before the Corporation at an early date.

District Railway. — To avoid further accidents, the District Railway Co. are now fitting their electric trains with steel flaps, so that it will be impossible for anyone to get caught between the cars while walking from one to another.

Devonport —At the meeting of the Tramways Committee the scheme for constructing a light railway to Crown-hill came up for discussion, but it was considered unwise to come to any decision until further information is received from the engineer.

Keighley.—From July 1 to Sept. 7 the number of passengers carried on the Corporation trams was 358,921, and the receipts totalled £1 523. 10s., or 7·25d. per car mile. This gives an average of nearly £153 a week, and the committee estimate that at £150 a week the system is self-supporting.

Musselburgh.—The National Electric Traction Co., which laid down the tramways between Joppa and Musselburgh, propose to extend the system eastward from Levenhall to Cockenzie, a distance of about five miles. Mr. E. A. Mitchell, chief engineer to the company, has commenced a survey of the route.

Dunfermline.—Some weeks ago the two companies interested in the laying down of tramways in the Dunfermline district resolved, notwithstanding the County Council strictures, to proceed with their application for a provisional order. On Monday several gentlemen connected with the local company motored over the proposed routes.

Perth.—At the meeting of the Town Council on Monday night, when the fares were fixed, a general consensus of opinion was expressed that a Sunday service of cars should be inaugurated, Lord Provost Love strongly dissenting. A proposal to introduce ½d. stages was defeated, and the fares will remain as at present. The centre of the system is to be the Cross.

Bradford.—A proposal will shortly come before the Bradford Tramways Committee to enter into arrangements with the Mid-Yorkshire Tramways Co. for the issuing of return tickets between Bradford and Dewsbury. Heckmondwike, Batley, and Birstall. It is proposed to charge for the return journey to Dewsbury 1s., to Heckmondwike and Batley 10d., and to Birstall 8d. These charges are much less than the ordinary fares on the railway.

Croydon.—At the meeting of the Town Council it was resolved that a double line from the present terminus to Penge be constructed forthwith. It is proposed that the Thornton Heath line shall be extended. Notice has been served upon the British Electric Traction Co. terminating their lease on May 31 next. The company have made an offer for a renewal of the lease on the basis of 7 per cent. instead of the present 6½ per cent. return on the Corporation's capital expenditure, an increased yearly payment in respect of road repairs, and a quarter of the net profits.

Liverpool Overhead Railway.—A rather curious mishap occurred on the Liverpool Overhead Railway, one of the axles of a train snapping. One account states that in consequence of the axle breaking the body of the carriage became depressed, and a disused rail lying underneath the working track was caught up, carried some distance, and then crashed through the floor of the coach. The carriage was full of working-men travelling to the various docks. Three were injured, but fortunately not seriously. Another version is to the effect that the two ends of the broken axle were driven through the floor.

Torquay.—At the meeting of the Town Council on Monday there was a lengthy discussion on the tramways question. The Dolter Co. asked for the approval of the Council to an alteration in the proposed routes, but the Council decided that they would only agree to this deviation on consideration that the company undertook to relieve them of their obligation to provide electric current for the trams in the event of the Local Government Board refusing to grant the loan of £9,500 which is now being asked for for the extension of the present electricity station, so as to enable the Council to produce the necessary power.

Grimsby.—A deputation has been appointed to wait on the directors of the Provincial Tramways Co. on Oct. 6 in London. They have been instructed to proceed on the following lines: (1) That purchase shall be completed at once. (2) That an agreement be entered into between the tramways company and the Council for the tramways company to pay depreciation from April 3, 1905, until the passing of the proposed Bill to enable the company to take a lease, and the company to pay all working expenses until the proposed lease is executed. (3) That an agreement be entered into for the purchase of the arc lamps and the standards erected by the company; also for the supply of current for public lighting.

Potteries Electric Traction Co.—At Stoke-on-Trent last week a conference of representatives of local authorities whose areas are traversed by the lines of the Potteries Electric Traction Co. was held to consider various alleged nuisances caused by the tramcars of the company. Mr. G. Ralley, mayor of Stoke, presided, and in opening the meeting expressed a hope that the deliberations of the conference would be productive of much good in the way of remedying the nuisances caused by the noise and rattle of the tramcars passing through their respective districts. It was decided to appoint a deputation from the conference to wait upon the manager of the company and lay the whole matter before him, and then, if they could not get satisfaction, they should petition the Board of Trade to hold an inquiry to see if the trams were worked on the most skilful method.

All-Steel Railway Carriages.—In a communication to the *Times* Mr. B. Broadhurst, secretary to the Brush Electrical Engineering Co., states: "We regret to observe from the letter of Mr. Granville C. Cuningham that we were in error in supposing that no steel cars had previously been made in this country. It was, however, practically in response to the demand for certain railways whose managers stated that they were unable to obtain all-steel rolling stock in England that we set out to fill what we honestly believed to be a vacancy. The highest credit is due to Mr. Cuningham, whose enterprising management of the Central London Railway has been of great educational value in electric railway practice; but until we started constructing steel coaches it does not appear that any British manufacturer made any effort whatever to draw attention to their conspicuous advantages, and in the meantime large orders were being placed in America."

Manchester Carriage and Tramway Co.—At a meeting of the shareholders, Mr. Hamilton, solicitor to the company, submitted the statement of affairs, and referred to the appeal pending between the company and the Salford Corporation as to the Swinton and Pendlebury tramways, which have been adopted by the Corporation. The award of the arbitrator, Sir Frederick Bramwell, was in favour of the company, but this was upset by the Court of Appeal, and the company had now gone to the House of Lords on the question. It was expected that the case would be heard early next year, and until it was disposed of no final statement of the company's affairs could be rendered. With the money in hand, however, it was expected that a further payment would be made to the shareholders towards the end of November. A liquidator will be appointed in the place of Sir John Harwood at a future meeting. It is understood that by the time the company is finally wound up the shareholders will have received upwards of £1,000,000 as a result of the liquidation.

Walsall.—The following are the particulars of the working of the tramways during the five weeks ending Sept. 3, 1904, and the corresponding period of this year respectively: passengers, 466,927; receipts, £2 617. 8s. 11d.; car miles run, 59,827·07; receipts per car mile run, 10·49. Passengers, 481,872; receipts, £2,707. 9s.; car miles run, 62,593·27; receipts per car mile run, 10·38. Wages paid (including repair of permanent way): for five weeks ending Sept. 1, 1904, £778. 4s. 2d.; for five weeks ending Aug. 30, 1905, £813. 12s. 10d. In response to a petition, signed by all the drivers and conductors, the Corporation have resolved to allow all the tramway employés, including those engaged in the shed, four days holiday a year with wages after two years' service and five days holiday a year with wages after three years' service, the period of service to count from the time each employé was engaged by the Corporation. The cost of these concessions is about £120 a year. The Corporation are unable to grant the men's application for Sunday work to be considered as time and quarter.

Chester.—At a meeting of the Tramways Committee the city surveyor reported that the gas company had again referred to the question of the company's mains, which will lie under the proposed tramway track. The company had suggested that a portion of the main in Boughton should be removed to a new position, and that additional rider mains should be laid in the Tarvin and Christleton roads. The town clerk reported regarding an interview he and the city surveyor had had with the manager of the company on the subject, when the latter intimated that he was prepared to advise his company to contribute something to the cost of the alteration of the mains. The city surveyor having shown on plans the positions of the gas and water mains—co-extensive with the proposed tramway track—it was, after discussion, resolved that the town clerk and the city surveyor enter into negotiations with the gas and water companies with the view of ascertaining the terms on which it can be arranged for the lines of the existing mains in Boughton, Tarvin-road, and Christleton-road to be so altered as to remove them, as far as possible, from the line of the proposed tramway track, and that they report thereon to the next meeting.

London County Council.—The Poplar Borough Council has decided to consent to the overhead system, and it is not improbable that the Stepney Borough Council will follow suit. The line from the Archway Tavern to Highgate Archway, undertaken by the London and Middlesex County Councils jointly, has been completed, as also have the extensions from Green-lanes to the Alexandra Palace. The Hammersmith Borough Council have decided to give their support to the County Council's Embankment scheme. The Bermondsey Borough Council have assented to the construction of loop lines on the Grange-road section. The Board of Trade, in response to representations from the Camberwell Borough Council, have intimated that they consider a 1in. slot for the conduit system preferable to a ¾in. slot. The County Council are to use silent paving material in Camberwell in front of public buildings, as well as in front of churches and hospitals, and to use granite setts instead of wood for paving the margins of the track where the roads are formed with macadam. A resolution is to be submitted to the Camberwell Borough Council recommending that now that the London, Camberwell, and Dulwich Tramways Co. no longer form an obstacle, the County Council shall obtain powers for continuing their authorised line as far as the Crystal Palace, *via* Lordship-lane.

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Maidstone.—At the monthly meeting of the Urban District Council the following recommendations were adopted: "(*a*) That the Board of Trade be asked to confirm the order of the Light Railway Commissioners so far as that portion of the proposed line is concerned which relates to Upper Stone-street and Loose, and that permission be requested to allow the same to be immediately commenced on the Corporation giving an undertaking to proceed at once with the necessary application to the Light Railway Commissioners for an extension connecting the existing line in High-street with the proposed new line, *via* Mill-street and Knightrider-street. (*b*) That application be made in November next to the Light Railway Commissioners for an order authorising such extension as aforesaid from High-street along Mill-street and Knightrider-street, to the bottom of Upper Stone-street. (*c*) That an application be also made in November next to the Light Railway Commissioners for an order authorising an extension from High-street along Mill-street College-road, King Edward-road, and Old Tovil road to Tovil. (*d*) That the Board of Trade be asked to confirm the order of the Light Railway Commissioners so far as relates to the line from Week-street to Boxley-road, with a clause suspending the work of construction until a suitable connection with the existing system is authorised." There is a net profit on the year's working of £1,531, and the engineer is to be consulted as to the formation of a renewals fund.

Hythe.—In reference to our note last week upon the Traction Corporation's proposal for an electric tramway on the Kingsland surface-contact system for Hythe, Folkestone, and Sandgate, the following are some particulars of the project. The company estimate that a single line could be constructed for £110,000, but consider that double track would be greatly preferable. The costs of construction would be borne by the local authorities, the company offering to negotiate the loan at interest not exceeding 4 per cent. The Traction Corporation offer to form a company on these conditions: "(1) The interest on the loan and redemption fund to be first charges on the profits of the operating company; (2) the operating company then to take 5 per cent. on its share capital; (3) balance of profits to be divided as to one-half to the corporations, and as to the other half to the operating company; (4) the division of profits between the three corporations might be in proportion to the number of car miles in their respective districts, or in proportion to the track mileage, or in any other way to be mutually agreed between the corporations; (5) the capital of the operating company to be fixed by agreement with the corporations." The company estimate a car mileage of 600,000 or more per annum. The receipts are put at 10*d*. per mile and the working expenses at 5½*d*., leaving a profit of £11,250. Loan charges would absorb about £5,500, leaving some £5,700 to be divided between the local authorities and the company. The Traction Corporation recommend that, to save capital expenditure, energy should be taken from the local supply company if it can be had at 1*d*. per unit.

Electric Signalling.—An attempt to cope with the difficulties of railway signalling in foggy weather by electrical means has been essayed by Mr. Elijah Burgoyne, of Nottingham, and the local Press contains the following description of his system: "Electricity plays an important part in the scheme. By an ingenious plan, directly danger is signalled, or the necessity of proceeding cautiously, a gong of different tone sounds on the engine itself, and an immense 'bullseye' on the cab glares with red or green light in the driver's face. Even the densest fog would thus be robbed of its danger, provided there was no failure in the apparatus or supply of the electric current. In theory the idea is effectiveness itself. Beyond the spot where at present the distant signal is situate Mr. Burgoyne proposes that a central rail 100 yards in length should be laid, with a second and much longer central rail near the present home signal. Connected electrically with the signal-box, the pressure of a roller beneath the engine on these central metals would not only ring a bell and cause a lamp (corresponding with the line upon which the train was running) to glow in the signal-box, but bells would ring, and red or green lamps glow on the engine itself, the colour of the lamp depending upon which rail (the right or left) the signalman had converted into a negative. Mr. Burgoyne's model is fitted up in a room at home, and is somewhat crude. Yet the crudeness of a model does not affect the inherent value of an invention, and Mr. Burgoyne states that at least one expert in signalling has pronounced most favourably on his invention, both as regards its simplicity and utility." At present the chief obstacle appears to be expense, besides which the old problem of the "human equation" remains, as the drivers might rely entirely upon the ringing of the gong without taking note of their whereabouts. Still, electricity is coming into favour for signalling purposes, and it will be interesting to watch developments.

Tramway Expansion.—A report by the Board of Trade of their proceedings under the Tramways Act, 1870, during 1905, has just been issued. The number of applications made to the Board of Trade in December, 1904, for provisional orders under the Act was 12—viz.: Aberavon District, Bradford Corporation, Colchester Corporation, Gorton Urban District Council, Keighley Corporation, King's Norton and Northfield Urban District Council, Leeds Corporation, Liverpool Corporation, Luton Corporation, Portobello and Musselburgh, Pudsey Corporation, and Southampton Corporaton. Eleven of the applications included power to construct new or extension tramways, the remaining one—Portobello and Musselburgh order—being to amend a previous order in certain respects. All except two—Aberavon District and Portobello and Musselburgh—were promoted by local authorities. The aggregate length of the proposed tramways was 11 miles 27 chains of double line and 16 miles 52 chains of single line, and the estimated expenditure was £321,226. In the House of Lords the following orders were petitioned against—viz.: (1) Aberavon order, by the Glamorgan County Council and the Great Western Railway Co.; (2) Colchester order, by the National Telephone Co.; (3) Gorton order, by the National Telephone Co.; (4) King's Norton and Northfield order, by the National Telephone Co.; (5) Leeds order, by the Great Northern Railway Co.; (6) Luton order, by the Midland Railway Co.; (7) Portobello and Musselburgh order, by the National Telephone Co.; and (8) Pudsey order, by the Great Northern Railway Co. The Aberavon order was withdrawn, and the opposition of the National Telephone Co. was met by the insertion of special amendments. The amendments desired by the railway companies in the cases of the Leeds, Luton, and Pudsey orders were not accepted by the committee. These amendments consisted mainly of a provision against danger from the falling of railway signalling wires on to the electric tramway wires. The railway companies were dissatisfied with the decision of the committee, and proposed to renew their opposition in the next House. With the assent, however, of both parties, a hearing was held at the Board of Trade, as the result of which a modified form of the clause was settled by the Board of Trade and inserted in the orders mentioned, and also in the Bradford Corporation order. The following orders were petitioned against in the House of Commons—viz.: (1) Bradford order, by the Lancashire and Yorkshire Railway Co.; (2) Leeds order, by the Great Northern Railway Co.; and (3) Pudsey order, by the Great Northern Railway Co. The opposition was, however, withdrawn on the insertion in the orders of the amendments before referred to and of amendments agreed upon between the parties.

LIGHTING AND GENERAL.

Mitchelstown.—Consideration of the electric lighting of the town has been adjourned for one month.

Lancashire Electric Power Co.—The company's power station at Radcliffe will be opened by Lord Derby on Oct. 9.

Babcock and Wilcox.—The directors have declared an interim dividend of 1*s*. 7½*d*. per share on the ordinary shares.

Bridgwater.—The question *re* the installation of the electric light in the chancel of St. Mary's Church has now been settled.

Rawtenstall.—An inquiry has been held into an application for sanction to borrow £12,000 for the purpose of electric lighting.

Bourne.—A scheme for lighting the town with electricity is being discussed by the Urban District Council and the tradesmen's association.

Hammersmith.—The report recommending a reduction in the charge for current, noted in our last issue, has been adopted by the Borough Council.

Swinton.—The agreement between the Swinton and Pendlebury Urban District Council and the Lancashire Electric Power Co. is about to be ratified.

Bridlington.—The Town Council have decided to borrow £4,500 for purposes of the extension of the electricity works. The total number of lights now supplied aggregate 10,211 8 c.p.

Hove Electric Lighting Co.—The directors have declared an interim dividend on the paid-up share capital of the company at the rate of 8 per cent. per annum for the half-year ended June 30.

Agency.—We are informed that Messrs. Andrew Brown and Co., 110, Cannon-street, E.C., are the sole representatives of Messrs. Franz Meguin and Co. for the supply of their perforated metals and embossed plates.

Stock Exchange.—The Stock Exchange Committee have been asked to allow the Bournemouth and Poole Electricity Supply Company's further issue of 3,000 ordinary shares of £10 each, fully paid, Nos. 27,001 to 30,000, to be quoted in the official list.

New Publications.—Dr. Mullineux Walmsley has rewritten and enlarged his well known treatise on "Electricity in the Service of Man" so as to bring it up to date, and Messrs. Cassell and Co. are issuing the work in parts at 6*d*. per number. As before, the subject is treated in a lucid style, and is profusely illustrated. "Building Construction," by Prof. H. Adams, is the title of a volume dealing with materials, processes, principles, and the practice of building construction. This treatise is also being published in parts by Messrs. Cassell and Co. at 3*d*.

Tunbridge Wells.—The proposal to dispose of the municipal electricity undertaking to a private company came before a mass meeting of ratepayers at the town hall on Wednesday. The following resolution was carried: "That in the opinion of this meeting any step taken towards the sale or transfer of the Corporation electricity undertaking to a private company would be detrimental to the best interests of the borough and to the users of electrical energy. This meeting, therefore, urges upon its representatives on the Town Council to oppose any motion in favour of such action."

Blackburn.—Mr. P. P. Wheelwright, A.I.E.E., the borough electrical engineer, recently organised an electrical exhibition, which was held from Sept. 16 to 23, and which was visited by 13,000 people. This exhibition was organised in order to bring before the public the advantages to be gained by the use of electric light and power. The opening ceremony was performed by Alderman William Thompson, chairman of the Electricity Committee. Various entertainments and interesting electrical and scientific demonstrations were given at frequent intervals. There was also a ladies' orchestra, who performed a daily varying programme. Amongst the exhibitors we note, besides the Blackburn Corporation electrical department, the following firms, mostly all belonging to Blackburn and East Lancashire: Messrs. H. Garstang, J. Boyle Limited, H. H. Jackson and Co., W. Thompson, G. Hamilton, the Beaten Metal Co., H. Bailey and Co., the Howe Electrical Engineering Co., G. H. Shaw and Son, C. T. Briscoe, the National Telephone Co., the New Camera Club, Burrows and Garland, J. Eccles, Smoke Preventer Co., Morton and Co., and R. W. Harrison. From what we hear from all sides, the exhibition, which was exceedingly well arranged, proved a great success in every way.

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Llanelly.—Subject to the consent of the Local Government Board being obtained to the borrowing of £6,000, the Council will inform the South Wales Power Co. of their intention to take up option B.

Wellington (New Zealand).—The City Council have decided to undertake the lighting of the public streets themselves. Particulars will be found under "Imperial Notes" elsewhere in this issue.

Ramsgate.—The cable laying for the supply of electric light is proceeding. The station of the District Electric Supply Co., at Whitehall, and their offices at Broad-street, have been brilliantly illuminated.

Keighley.—The Town Council are about to lay 280 yards of cable for the supply of power to the works of Mr. Jonas Wells, Longcroft, at an estimated cost of £210. It is expected that the firm will take 60,000 units per annum.

Wellingborough.—Last week a refuse heap at the destructor works took fire, to the great danger of the adjoining generating station of the electric light company. The fire brigade was quickly on the spot and no damage was done.

Trowbridge.—With regard to the question of the electric lighting, it has been agreed to defer further action until Mr. Pearson (Bristol), the Council's legal adviser in connection with the electric lighting, has been interviewed in the matter.

Hove Electric Lighting Co.—The directors have declared an interim dividend on the paid-up share capital of the company, at the rate of 8 per cent. per annum, for the half-year ended June 30 last. The dividend is payable on Oct. 16 next.

Quarry Bank.—The Midland Electric Supply Co. are now giving their present customers at Quarry Bank, Bilston, Darlaston, Ambleoote, Rowley Regis, and Tettenhall, better terms than were anticipated at the time the various agreements were drawn up.

New Company.—Messrs. J. G. Statter and Co., Cornwall-buildings, Newhall-street, Birmingham, are converting their business into a limited company under the name of the Switchgear Co., Limited. We are informed that the personnel, works staff, foremen, etc., remain unchanged.

Lahore.—The Lahore Municipal Committee have decided on electric lighting for the Mall. Messrs. Jessop and Co., Calcutta, have been selected by the Government to carry out the work. They have undertaken to complete the installation before the Royal visit.—*Indian Engineering.*

Hawick.—An electrical exhibition has been held at the town hall by the Urban Electric Supply Co. The proceeds are to go to the cottage hospital. The company started work at Hawick about five years ago, and the consumption is now stated at 28,000 8 c.p., including 300 h.p. for 80 motors.

Battersea.—The Housing Committee, with a view to encouraging the tenants on the Latchmere and Town Hall estates to use the electric light, are arranging for a new 8 c.p. lamp or 16-c.p. lamp to be presented to the tenants for every 60 Board of Trade units of electrical energy consumed by them.

Cardiff.—The chairman (Councillor Chappell) strongly advocates the purchase of an electric launch, with accommodation for 30 or 40 passengers, for use on Roath Park lake, and the Parks Committee have agreed to seek detailed particulars from towns where electric launches are run on the public lakes.

Wembley.—The Urban District Council have decided not to assent to the applications of the North Metropolitan Electrical Power Distribution Co. and the Mutual Electricity Supply Co., and steps will be at once taken to obtain a provisional order authorising the Council to supply electric light within the district.

Exeter.—The Electric Lighting Committee have instructed the town clerk to at once proceed with the application for a provisional order for Heavitree, and to arrange a conference between the committee and the Heavitree Urban Council in view to a decision being arrived at as to the question of "compulsory area."

Bermondsey.—The Electric Lighting Committee reported at the last Borough Council meeting on a letter signed by a number of residents in the immediate neighbourhood, complaining of smoke arising from the working of the dust destructor, that steps were being taken which would no doubt remedy the cause of the complaint.

London Gazette.—Charles James Singleton, 8, Staple Inn London, W.C., has been released from trusteeship in the estate of Charles Manners Downie, electrical engineer, 4, Bloomsbury-street, London. W. Arthur Turner, 21, Bridge-street, Bradford, has been released from trusteeship in the estate of Cecil Wray, mechanical and electrical engineer, 16, Chevin-view, Eccleshill, Bradford.

Walsall.—The total number of consumers supplied on Aug. 31 last was 429. During August 131,562 units were generated at the station. The total output from the main generators was 117,399 units. The total units from the transformers was 90 030 (estimated). The total units registered on the meters was 85,428. The machinery was run for 702 hours. The wages paid amounted to £131.

Southend.—The electrical engineer's last report shows that one Nernst lamp has been fixed and a new circuit of 10 arc lamps put in circuit for the first time. During the last month 71,167 lighting units were generated, as against 52,810 during the same month last year, an increase of 35 per cent. The number of traction units generated was 56,522, as against 55,782, an increase of 1·3 per cent.

Calcutta Electric Supply Co.—The number of units delivered to consumers during the four weeks ended Aug. 25, 1905, were 453,558, compared with 339,738 in the corresponding four weeks of the preceding year. The directors have declared an interim dividend on the paid-up share capital at the rate of 6½ per cent. per annum for the half-year ended June 30, such dividend to be due and payable on Nov. 15 next.

Stoke Newington.—The London County Council have sanctioned the borrowing of £13,750 (£10,000 for cables and machinery and £3 750 for sub-station). The Borough Council will agree, subject to sanction being given to the borrowing of a sum of not less than £20,750, to provide for all renewals and replacements during the currency of the loan out of a sinking fund to be established for the purpose or from maintenance account, and to take up the loan of £5,000 on account of such sum of £20,750, at £5. 7s. 6d. per cent. per annum, repayable in 30 years.

Basingstoke.—The Local Government Board having refused the application for borrowing £16,450 for electric lighting purposes, a resolution, "That the Council proceed forthwith to obtain the further powers by way of provisional order for giving effect to the provisional agreements dated June 24 and 25, 1905, subject to an arrangement being come to that the National Electric Construction Company bear half of the Council's total costs of obtaining such order, in the event of such order not being granted," was proposed at the last meeting and lost by the mayor's casting vote.

Stirling.—The last report by Mr. A. C. Hanson, electrical engineer, shows that for the four weeks ending Sept. 2 18,796 units were generated at the power station, as compared with 12,950 units for the same period in 1904. The total connections in equivalent 8-c.p. lamps were 16,485, as against 15 675 at the same date last year. The engineer is making a trial of an apparatus by George Sinclair, Albion Boiler Works, Leith, for the purpose of preventing the emission of black smoke from the boiler furnaces, at a cost of £12. 10s. per furnace, which is said to effect a saving in fuel of 5 to 10 per cent.

Bo'ness (N.B.).—With regard to the interest on the money that the Council have at various times lying at deposit until it is payable to the electrical company, the Council have asked the company to pay them the difference of the bank interest and the interest the Council are paying on the loan, as the Council are paying 4 per cent. and are only getting 1 per cent. from the bank. We understand that the company have advised the Council that they are willing to meet them on the point. The other demand of the Council that the company should pay an inspecting engineer for an annual inspection remains as yet unsettled.

French Cable.—A Reuter's telegram of Sept. 20 says the Venezuelan Government, in its reply to the French protest against the closing of the French cable station and the expulsion of M. Brun, the manager, states that it holds documents proving that the cable company accepted the result of the judicial proceedings which it took, and that the Government is only waiting to establish new relations between itself and the company. M. Taigny, the French Chargé d'Affaires, knows this, declares the Government, and therefore his protest can only be regarded as an act of personal hostility. For this reason the Government will abstain from treating with France through M. Taigny.

Leicester.—The committee's report on the electric light undertaking gives the outstanding capital as £220,334. The revenue for the last half-year was: sale of current £14,339, increase £393; rental of stores £676, increase £76; the total revenue being £15,119. Generation of electric light cost £2,917, a decrease of £12; distribution £673, increase £93; management £735, increase £5. The total expenditure was £5 509, leaving a profit of £9 61), an increase of £366 on the corresponding period of last year. Interest on capital claims £3 697; £3 343 has been placed to the sinking fund, which leaves a net profit of £2 623. This fund, added to the profit they already had in hand, now amounts to £15,172. The Council decided six months ago that the new machinery and plant now being placed should be paid for out of the profits. When the new plant is fixed it will absorb £12,000 or £13,000 of those profits, leaving about £2 000 in hand. The department is still progressing, and the committee hope that when the new machinery now being erected is completed they will have plant sufficient to meet all demands for a very long time to come.

Maidstone.—The accounts for the electricity undertaking for the year ended March 31 show, after deducting bank charges, loan interest, and loans instalments, and provision for interest and repayments accrued to date of balance-sheet, aggregating £4,093, a profit of £466 as a net result of the year's working. For the year ended March 31, 1904, the profits before paying these charges were £2 508; last year they amounted to £4,560, a gross increase of £2,052. The gross revenue for 1904 was £6 283, and for 1905 £9,222, an increase of £2,934. The cost of earning the revenue of 1904 was £3,780, and for 1905 £4,662, an increase of £882. The interest and loan charges for 1905 exceeded 1904 by £310. The year 1904 closing with a deficit of £1,275, and the year 1905 with a surplus of £466, it follows that 1905 gained in net earning capacity the sum of £1,741. As regards the capital account, whilst the receipts were only £1,700, expenditure to the amount of £5,901 was made during the year, bringing the over-expended balances up to £5,512, which figures do not include the value of cable and meter purchases taken into stock. The Electricity Committee recommend that the formation of a reserve fund be postponed until the undertaking has been working for five years, and that the charge for energy in future for shops and dwelling-houses combined be 4½d. per unit, with a rebate of 10 per cent if over 10,000 units be consumed in the year.

Lincoln.—The electricity works revenue account for the last year shows gross profit, £3,928, carried to net revenue account. There has been paid for generation of electricity, £1,714, including coal and cartage, wages, oil, waste, repairs, and maintenance, management expenses, etc. The income from the sale of the current is: private lighting, £5,770; power, £299. 10s.; public lighting, £789. The net revenue account shows a debit balance from the last account of £906; payment to redemption of debt, £1.225; payment towards dividends on 3 per cent. redeemable stock, £1,384, and the balance at credit on March 31, 1905, was £254. The balance-sheet of the fund gives the total liabilities at £47,296, and the principal assets—land, buildings, and plant—amount to £51,332. The assets aggregate £53,979,

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the balance of assets over liabilities amounting to £6,683. The accounts include particulars of the tramway accounts from the time the undertaking was taken over in July, 1904, to the end of the financial year, and there is much interesting information in the volume regarding the general district fund, the city fund, the police pension fund, and the redeemable stock and consolidated loans fund, and the education fund accounts. The aggregate balance-sheet gives the assets at £1,035 317, and the liabilities at £639,279 there being a balance of aggregate assets of £397,037, made up of the following balances: city fund, £145,998; education fund, £1 304; electricity works fund, £6 683; gasworks fund, £82,252; general district fund, £108 097; tramways fund, £3 447; waterworks fund, £49 253. The appendix contains the city accountant's report on the various Corporation undertakings. Commenting on the electricity works accounts the report states that the accounts show that the year's working has resulted in a gross profit of £3 928 (equal to 7 65 per cent. on the capital employed). From that sum has been met the sinking fund and interest charges, amounting to £2,767, leaving a net profit for the year of £1,161, an increase of £403 on last year's net profit. Nothing has as yet been set aside for depreciation, and having regard to the possible risks arising from obsolete machinery, it is very desirable, now that the funds of the undertaking permit of its being done, to begin to build up a reserve fund to meet exceptional renewals of machinery. He recommends that the amount now standing to the credit of net revenue account (£254. 6s. 1d.) be transferred to a reserve (depreciation) account.

PROVISIONAL PATENTS, 1905

SEPT. 18.

18790. Improvements in method and apparatus for producing electricity. Henry Ernest Fry, 24, John-street, Bedford-row, London.

18793. Improvements in or relating to systems of electrical distribution for lighting and other purposes. Charles Norman Staniland and Oliver Prescott Macfarlane 139, Queen Victoria-street, London.

18813. Improvements in or relating to electrolytic electricity meters. The Bastian Meter Company, Limited, and Charles Orme Bastian, Birkbeck Bank-chambers, Chancery-lane, London.

18814. Electric incandescence lamp with filament of metallic tungsten. William Phillips Thompson, 322, High Holborn, London. (Deutsche Gasglühlicht Akt.-Ges. [Auer Ges.] Germany.) (Complete specification.)

18832. Improvements in and relating to electromagnetic apparatus for producing reciprocating motion. Ferdinand Fanta, 1, Queen Victoria-street, London.

18846. Improvements in the control of electric motors. The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

18847. Improvements in prepayment electric time switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

18848. Improvements in prepayment meters. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (The General Electric Company, United States.)

18852. A combined automatic adjusting apparatus and lubricating axle for use on trolley heads of electric cars and the like. Henry Niblett, Russell House, Albion-avenue, Bispham, Blackpool, Lancs. (Complete specification.)

SEPT. 19.

18875. An improvement in the construction of pendant, bracket, and standard fittings for gas, oil, and electric lighting. Thomas Ford and Frank Ford, Victoria Works, Emily-street, Highgate, Birmingham.

18886. Improvements in electric percussive tools. Frederick Dwight Johnson and Henry Samuel Potter, Palace-chambers, Westminster, London.

18904. Improvement connected with electric switches. George Smith, 173, Fleet-street, London.

18909. Improved method of electric welding. Adolph Frederick Rietzel, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Feb. 24 1905, being date of application in United States.) (Complete specification.)

18924. Improvements in or relating to telephonic apparatus. William Mudd Stell and Andrew George Adamson, 46, Lincoln's-inn-fields, London.

18927. Improvements relating to safety devices for use with overhead electrical conductors. Auguste Victor Millet, 7, Southampton-buildings, Chancery-lane, London.

SEPT. 20.

18943. An improved automatic device for controlling electric circuits, lamps, and the like for electric signs and the like. Charles Adams and William Chancellor, 8, Crescent-gardens, Bath.

18972. An improved electric lamp. August Bourdos and Max Lorenz, 83, Charlotte-street, London.

19007. Improvements in electrical resistances. Andrew Hilliard Atteridge and the British Submarine Boat Company, Limited, Norfolk House, Norfolk-street, London.

19015. Improvements in or relating to apparatus suitable for use in the distribution of electric current. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

19034. Improvements in wireless telegraphic apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19035. Improvements in insulating material. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

19036. Improvements in systems of electric metering. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

SEPT. 21.

19059. Improvements in or in connection with the trolley poles of electric tramcars and like vehicles. Alfred Adams, 3, Brown-street, Market-street, Manchester.

19093. Improvements in reciprocating electric engines. Bruno Otto Wagner, Fife House, Kingston-on-Thames, London. (Date applied for under Patents Act, 1901, Sept. 22, 1904, being date of application in United States.) (Complete specification.)

19099. Improvements in and relating to automatic transmitters for electric telegraphy. Walter Judd, Angus Fraser, and Alexander Robertson Hardie, 323, High Holborn, London.

19111. Improved method of and ingredients for the manufacture of a substance suitable for electrical insulation. Charles Hess, 173, Fleet-street, London.

19116. A new or improved machine for electrically soldering metal wires, cables, hoop irons, and the like. Louis Stanislas Rolland, 31, Bedford-street, Strand, London. (Complete specification.)

19138. Improvements in and relating to dynamo-electric machines. The Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Sept. 23, 1904, being date of application in Germany.) (Complete specification.)

SEPT. 22.

19153. Improvements in starting switches for electric motors. Thomas Edgar Weaver, 134, Claremont-road, Manchester.

19201. Constant current distributing system for utilisation of variable sources of power. Otto Bohm, 322, High Holborn, London. (Complete specification.)

19210. Improvements in protective devices for electric distribution systems. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

19211. Improvements in electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

SEPT. 23.

19230. Insulating supports for conductor rails of electric railways. Charles Haines and Joseph William Towill, 2, Byron-road, Harrow, Middlesex.

19259. Improvements in electric incandescent lamps and fittings therefor. Alfred William Hill and the Sir Hiram Maxim Electrical Company, Limited, 18, Southampton-buildings, Chancery-lane, London.

19264. Improvements in filaments for electric incandescent lamps and similar apparatus. The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (The General Electric Company, United States.)

19285. An improved arrangement of relay and fusible conductor for electric circuits. Gino Rebora, 4, South-street, Finsbury, London. (Date applied for under Patents Act, 1901, Sept. 23, 1904, being date of application in Italy.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 12.

1904.

18037. Transmission and distribution of electric power. Kruyswijk.

19923. Electromagnets having polarised armatures for use in apparatus operated by alternating current. Hommel. (Date applied for under International Convention, Dec. 21, 1903.)

19979. Magnetic wheels or electromagnetic motors. Everett and Newton.

20069. Electric telegraphy. Muirhead.

20549. Dynamo-electric machines. Carolan. (General Electric Company.)

21966. Electric heat alarms. Bill and Bill.

22702. Electricity meters. Chamberlain and Hookham, Limited, and Holden.

22983. Controllers for electric circuits. British Thomson-Houston Company, Limited. (General Electric Company.)

24379. Means for use in connection with electric motors and centrifugal separators, or other apparatus driven by such motors. Scott and Williamson.

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24700. Systems of electric motor control and apparatus therefor. British Thomson-Houston Company, Limited. (General Electric Company.)

24850. Instruments for detecting and measuring alternating electric currents. Fleming.

24857. Electricity meters. Capito.

24876. Electromagnetic speed-changing and reversing devices. British Thomson-Houston Company, Limited. (General Electric Company.)

25463. Brush-holders for dynamo-electric machines and electric motors. Moore and Bourne.

27707. Manufacture of an indestructible filament for gas and electric lamps for lighting and heating purposes Michaud and Delasson.

1905.

403. Electric heaters. British Thomson-Houston Company, Limited. (General Electric Company.)

1430. Method of compounding alternating-current machines Gaston Santter, Emile Harlé, and Jean Rey. (Date applied for under International Convention, Feb. 4, 1904.)

2001. Apparatus for the agitation of solutions and the like used in electro-deposition of all metals. Wood and Oakeford.

5582. Dynamo-electric machines. Lapeyrade. (Date applied for under International Convention, March 17, 1904.)

8168. Electric telegraph apparatus and devices for indicating at a distance the position of a pointer needle or the like. Usener.

8890A. Wireless telegraph transmitting apparatus. Shoemaker. (Date applied for under Patents Rule 9, April 27, 1905.)

11606. Telephone current retransmitting and reinforcing apparatus. Kingsbury. (Western Electric Company.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¾-6¼ xd
—— 6 per cent. Cum. Pref., 1-100,000	5	..	6¼-6¾
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	99-101
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2⅜-2⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1¾
—— 4½ per cent. 1st Debenture Stock	100	..	91-94
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	10-11
—— 5 per cent. Pref.	5	..	5⅜-5⅞
Crompton and Co.	3	..	1⅜-1⅞
—— 5 per cent. Debentures	100	..	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅛-1⅜
—— "A" Shares, 01-017,139	5	..	2-2½
—— 5 per cent. Debentures	100	..	89-94
—— 4 per cent. Deb. Stock, Red.	100	..	85-88
Electric Construction, Nos. 1 to 112,100	2	..	⅞-1⅛
—— 7 per cent. Cumulative Pref.	2	..	1⅞-2¼
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-101
W. T. Henley's Telegraph Works, Ordinary	5	..	12-13
—— 4½ per cent. Preference	5	..	5⅛-5⅜
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	99-102 xd
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	33½-35½
—— 5 per cent. Bonds	100	..	102-104

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Bournemouth and Poole, Ordinary	10	..	11¾-12¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red	100	..	106-108
Bromley (Kent) Electric Light and Power Co.	5	..	5⅜-5⅞
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	9¾-10¼
—— 7 per cent. Preference	5	..	9⅝-10⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9¼-9¾
—— Nos. 60,001-80,000	5	..	9-9½
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13¼
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-81,000	5	..	6¾-7¼
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5⅛-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	..	4½-5
—— ditto (1903) 40,001-80,000	5	..	4⅞-5⅛
Chelsea Electricity Supply	5	..	5⅝-6⅛ xd
—— 4½ per cent Debentures	100	..	109-111
City of London, Ordinary	10	..	11-11½
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104-106
County of London Electric Supply, Ordinary	10	..	8¾-9¼
—— 6 per cent. Cum. Pref.	10	..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent 2nd Debentures Prov. Certs	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5¾-6¼
—— 6 per cent. Cum. Pref.	5	..	6⅛-6⅝
—— 4½ per cent. First Mort. Deb.	100	..	106-108
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5¾
—— 4½ per cent. First Deb. Stock, Red.	100	..	99-102
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	8-8½
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	13/16-15/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	12-12¾
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10½
London Electric, Ordinary	3	..	2-2½
—— 6 per cent. Pref.	5	..	4⅞-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	10¾-11¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅝-6⅛
—— 3½ per cent. Mortgage Debenture, Red	100	..	99-101
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	100-102 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	..	7¾-8¼
—— do., 57,010-75,000	5	..	7¾-8¼
—— 5 per cent. Pref., 1-57,009	5	..	6¼-6¾
—— do., 57,010-75,000	5	..	6¼-6¾
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	100-102
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	..	6½-7 xd
—— 4 per cent. Debenture Stock	100	..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	101-104
Smithfield Markets Electric Supply, Ord 1-12,000	5	..	2¼-2¾
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3½-4
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-109
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	98-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4½-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5¼-5¾
Westminster, Ordinary	5	..	12¾-13¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6⅛-6⅝

Electric Tramways.—

Name.	Amount paid. £		Last price £
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5	..	5¾-6¼
—— Ord.	5	..	8 5/16-8 9/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	101-106
Barcelona Tramways, Ord., 1-20,000	10	..	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	93-101
—— 4½ per cent. Red Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	27/32-31/32
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜-13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	95-98
British Columbia Electric Railway Co., Ord. Def.	100	..	120-123
—— Ord. Pref.	100	..	104-107
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	103-105
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	..	99-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	9-9½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10½-11
—— 5 per cent. Perpetual Debenture Stock	100	..	123-125
—— 4½ per cent. 2nd Deb. Stock	100	..	99-101
Buenos Ayres and Belgrano Trams	5	..	3-4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5 11/16-5 13/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5½
—— 5 per cent. Deb. Stock, Red.	100	..	105-107
—— Prov. Cert., all paid	100	..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,268	5	..	9½-10
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1¼-1½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	3½-4½
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13½-14½
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5	..	2½-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	85-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9¾-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	101-104
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-106
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	1-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum Pref.	10	..	9¼-9¾
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9-9½
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,152 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.

Electric Railways.—

Name.	Amount paid. £		Last price £
Central London, Ordinary	100	..	90-92
—— 4 per cent. Pref.	100	..	101-103
—— ,, ,, deferred	100	..	79-82
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	111-113

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Name.	Amount paid. £	Last price. £
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— " " " '85	100	117-120
—— " " " '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-100½
Waterloo and City, Ordinary	100	93-92

Name.	Amount paid. £	Last price. £
Telephones.—		
National Telephone, Preferred	100	111½-112½
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref	10	13¼-14¼
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb Stock, Red.	100	99½-101½
—— 4 per cent. Deb. Stock, Red.	100	104½-106½
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 23	1,442	1,482	— 39	— 450h	25½	20⅝	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	Aug. 26	424	403	+ 21	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Sep. 24	1 015	1,053	— 48	— 493	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 2	373	293	+ 75	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 20	1,107	1,014	+ 93	+ 741	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 21	1,750	1,760	—	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 23	917	985	— 68	— 912	16½	16½	Dec 31	31 846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 24	1,887	1 850	+ 37	—	40	38	March 31	95.765	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 20	1,707	1,511	+ 196	—	16 83	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 23	4,560	4 774	— 214	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 24	1,058	1,052	— 3	+ 823	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 22	5,107	5,172	— 65	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 23	1,185	1 053	+ 132	—	10 60	10·60	March 3	—	—	—	—	—	—	—
Burton Corporation	,, 24	214	342	— 48	— 1,015	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 23	2,152	2,041	+ 141	+ 352	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 23	189	203	— 14	— 487	8·5	8 5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 23	6,175	6,397	— 222	— 1,774	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway	,, 21	2,628	2,673	— 45	— 558	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	Aug. 10	241	258	— 17	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	Sep. 21	505	519	— 14	+ 763	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 1	250	251	— 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Aug. 12	344	317	+ 27	—	4½	4½	,, 3	11,250	2,853,200	281,343	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Sep. 22	135	141	— 7	+ 404	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 21	3 841	3,973	— 132	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 22	983	1,086	— 103	—										
Dundee City Tramways	,, 20	1,039	871	+ 168	—	22	21	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 23	8 4	707	+ 147	+ 2,103	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 23	16,164	15 216	+ 948	+ 11,953h	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 13	1,491	1,531	— 40	—	35½	33	March 31	71,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 23	1,427	1,299	+ 128	+ 807	35	35	,, 3	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 23	2,148	2,111	+ 37	+ 509	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 20	116	147	— 31	— 657	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Aug 30	225	256	— 31	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Sep 23	6,018	5 815	+ 193	—	89	89	March 2[illegible]	298,233	64,223,6[illegible]6	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 16	10 851	11,645	+ 205	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 21	1,461	1,525	— 63	— 639h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	,, 16	15,278	13,907	+1,371	+58,332	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 21	147	172	— 25	—	2½	2	—	4,710	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 23	12 911	12 685	+ 226	+14,621	149*	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,299	6·99
Metropolitan District Railway	,, 21	6,839	7,105	— 215	— 3,494	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 24	17,264	17,083	+ 181	+ 70	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 23	142	127	+ 15	+ 222	—	2⅜	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 23	3,763	3,618	+ 145	+ 3,046	50	45	,, 31	197,849	43,069,934	4,336,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 11	1 511	1 142	+ 369	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 23	1,965	1,949	+ 16	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	336,547	1·24	9·24	1,102	7·82
Rotherham Corporation	Aug. 3	440	645	— 205	—	9½	7½	,, 31	23,569	5,251,472	593,054	1·07	9 55	2,612	7·49
Salford Corporation	Sep 25	4,206	4,366	— 160	—	70†	—	,, 31	214,111	39,213,560	4,884,580	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 21	4,873	4,517	+ 356	+ 5 843	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 20	1,024	1,054	— 30	— 541	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 15	796	563	+ 231	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 24	1,301	1,252	+ 49	+ 940	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	,, 20	208	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Wallasey U.D.C.	,, 23	773	758	+ 15	+ 641	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6 33
West Ham Corporation	,, 21	2.177	1.141	+1,036	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 20	828	768	+ 60	—	—	7½	,, 31	—	—	—	—			

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Alexandria Exhibition.—The British manufacturers' exhibition which was to have been held in Alexandria and Cairo at the end of this year has been postponed until the latter part of 1906, in consequence of the scheme having assumed much larger dimensions than was anticipated. It is proposed that the duration of the exhibition shall be about a month, and firms who contemplate exhibiting are invited to communicate with the secretaries of the British Manufacturers' Exhibition, Alexandria, or the London agent, Mr. D. S. Murray, 11 and 12, Foster-lane, E.C.

Electro-Harmonic Society.—Arrangements have been made for the twentieth season of this society, and meetings will again be held in the King's Hall, Holborn Restaurant, the appointed dates being Oct. 20, Nov. 17, Dec. 15, Jan. 26, Feb. 23, and March 30. Of these Nov. 17 and Feb. 23 are ladies' nights. As the committee have re-engaged the King's Hall, they trust that the heavy expense involved will be justified by a further increase in the membership, and considering the agreeable evenings provided by the Electro-Harmonic, the profession should rally to the society's banner.

Electricity in Coal Mines.—At the Philosophical Hall, Leeds, Prof. G. R. Thompson delivered the inaugural lecture in connection with the Department of Mining of the University of Leeds, his subject being "Some Recent Electrical Accidents in Mines." The professor pointed out that most of the electrical accidents, so far as they affected the health or safety of the workman, had been caused by neglect of precautions which were already well known and understood. Electricity had become of increasing importance in mines, and consequently people should know its advantages and disadvantages. It was only by careful organisation and method that accidents could be guarded against.

New Publications.—"Cement and Concrete," by L. C. Sabin (London: Archibald Constable. 21s.).—"Graphic Methods of Engine Design," by A. H. Barker (the Technical Publishing Company, Limited, London and Manchester. 3s. 6d.). This treatise has a dual object, the first being to give young mechanics an explanation, based upon the author's personal experience, of easy constructions for use in the drawing office; and the second, to show the intimate relation that must necessarily exist between the science of engineering and the exact principles of theoretical mechanics. The treatise includes a graphic treatment of the balancing of engines, and should be welcomed by the embryo engineer.

The Tramways and Light Railways Association.—The *Official Circular* for September contains notices regarding proposed lectures and visits to works, rear lights on slow-moving vehicles, and the Milan Exhibition. The paper by Mr. A. L. C. Fell on "Brakes" will give the results of the exhaustive trials still proceeding on behalf of the London County Council. The reports of Messrs. Beaumont and Sellon to the Oxford Corporation on the comparative merits of motor omnibuses and electric tramcars respectively are given in full, together with a table showing how they compare with the present horse tramways. These reports appeared in our issues of the 8th and 15th ult.

Glasgow Section.—This section will inaugurate the ensuing session by holding their fourth annual dinner at the Grosvenor Restaurant, Glasgow, on the 27th inst. It is anticipated that the Lord Provost of Glasgow will honour the dinner with his presence, so it is hoped that there will be a good attendance. Tickets, 7s. 6d each (after Oct. 20, 10s. 6d. each), can be obtained from the local hon. secretary, Mr. E. G. Tidd, 68, Gordon-street, Glasgow. The dates of the general meetings, which will be held at the Institution of Engineers and Shipbuilders, are as follows: Nov. 14, Dec. 12, Jan. 9, Feb. 13, March 13, April 10, and May 8, the last-named being the annual general meeting. The annual smoking concert will be held on Feb. 3 next.

Power Supply.—Mr. Joseph Hopper, a member of the Durham County Council, addressed a public meeting the other day upon the question of a municipal power supply for the county. In the course of his address, Mr. Hopper stated that municipal enterprise had been so successful as to justify the county in attempting an electric service. He was glad to say that a court of the County Council appointed to go into the question had ascertained that, instead of public authorities being the extravagant and incapable bodies which their critics would fain make them believe, they were throughout the country conducting their businesses with 30 per cent. more efficiency and success than the companies. However this may be, we do not think it would be advisable for the County Council to start a power supply scheme even if Parliament granted the necessary power, seeing that the County of Durham Electric Supply Company already provides a service, which is being rapidly extended.

Institution of Civil Engineers.—In addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, the council have made the following awards in respect of other papers dealt with in 1904 1905: a George Stephenson medal to Captain H. R. Sankey, R.E. (retired), London; a Watt medal to Dr. C. Chree, F.R.S, Richmond; Telford premiums to Messrs. W. E. W. Millington (Oldham), C. E. Stromeyer (Manchester), C. W. Hill (London), F. C. Lea (London), W. B. Cole (London), W. C. Popplewell, M.Sc. (Stockport), E. H. Rigby, B.Sc. (Tientsin), and W. O. Leitch, jun. (Tientsin). For students' papers the awards are: Miller prizes to Messrs. A. B. Potts (Macclesfield), W. M. Hayman (Glasgow), R. E. Bury (Calcutta), T. Lees, jun. (Winnipeg), T. L. Matthews (London), P. J. Risdon (London), F. E Tudor (Stevenage). The inaugural address for the ensuing session will be delivered by the president, Sir Alexander Binnie, on the 7th prox., when the awards will be presented.

New Post Office Power Station.—The half-completed chimney shaft on the south side of the Thames, near Blackfriars Bridge, marks the site of the new Post Office power station, which is to do the work at present performed by the machinery at St. Martin's-le-Grand. The new building, which is to be completed in about 18 months' time, will contain machinery of 2,500 h.p. Electric power will be provided for pneumatic tube work, lighting, lifts, fans for ventilation, for the work of stamping and obliterating machines, and for charging batteries for telegraph and telephone work. At present this power is obtained from the plant in use at St. Martin's and from the power station at Mount-pleasant, but the Post Office authorities consider that the larger engines and boilers in the St. Martin's building are a source of considerable risk and inconvenience. In addition, the present position does not admit of the extension which the immense amount of work devolving on the Post Office machinery necessitates. All necessary machinery will be duplicated, so as to obviate any stoppage. The whole of the work is to be done by English firms.

Municipal Electrical Association.—The council of this association paid its second visit to Barrow on Saturday. The president, Mr. E. A. Newington, of Edinburgh, was

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unfortunately unable to be present, but there were in attendance Mr. S. E. Fedden, Sheffield, vice-president; Messrs. J. H. Rider (London), J. F. C. Snell (Sunderland), and T. P. Wilmhurst (Derby), past-presidents; and the following members of the council: Messrs. J. Christie, Brighton; S. L. Pearce, Manchester; C. E. E. Shawfield, Wolverhampton; Councillor Sinclair, Swansea; Alderman J. P. Smith, Barrow; C. D. Taite, Salford; H. Talbot, Nottingham; G. Wilkinson, Harrogate; Alderman G. Pearson, hon. solicitor, Bristol; J. E Edgcome, hon. secretary, Kingston-on-Thames; and the secretary, C. McArthur Butler. Alderman Smith escorted the council, in the morning, through Messrs. Vickers, Sons, and Maxim's works, where they were greatly interested in the large amount of electrically-driven plant in use. The council then repaired to the town hall, where the business was transacted. Later the party were entertained to luncheon by the mayor, when complimentary speeches were exchaned.

Armatures.—A patent has been granted to Mr. W. B. Sayers for a type of tooth-cored armature, of which a description appears in the *Official Patents Journal* As shown, alternate teeth, 1, are made separate from the body of the core, which is formed with projections or teeth, 3. Channels, 4, are made in the core to receive the separate teeth. Fig 1 shows one method of securing the teeth, the stampings on each side of the ventilating space, 10, being kept in place by brass pieces, 11, 13, with a wedge, 14,

FIG.1.

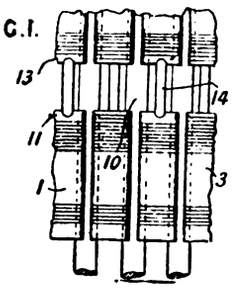
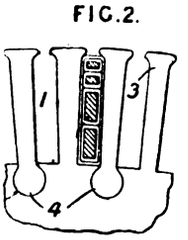


FIG.2.



between them. To facilitate insertion, each stamping may be slightly bent along its centre line and flattened when pressed into position. When all the teeth are separate from the core, the alternate channels, 4, for their reception are made at different depths in the core, alternate teeth being made of correspondingly varying lengths.

Electric Resistances.—A patent for electric resistances has been obtained in this country by the Chemische Fabrik Prometheus Company of Frankfort, and a description of same appears in the *Official Patents Journal* Silicon, the carbides of silicon, boron, and other elements, and similar substances are converted from the powdered condition into coherent resistance bodies at a temperature below their fusing point, preferably by heating them in an electric resistance furnace. The mechanical strength of the product may be increased by dipping it in difficultly fusible enamel and reheating, or by adding to the raw materials a flux, such as boracic acid, felspar, or borax. The first-named flux is preferred, as it increases the conductivity of the product. Instead of crystalline carbide, the mixture of raw materials used in the manufacture of the carbide, or, in the case of silicon carbide, the amorphous carborundum obtained as a by-product, may be used. The resistance bodies may be applied to the construction of resistances for arc lamps, preliminary heaters for Nernst lamps, filaments of incandescent lamps used for heating rather than lighting, and of regulating resistances. In the last-named case the contact springs may slide on a curved or straight bar of the substance.

Labour Difficulties.—The workmen having decided not to accept the terms offered by the leading Berlin firms, Messrs. Siemens und Halske and the Allgemeine Elektricitätsgesellschaft, these firms proceeded on Saturday from a partial to a general lock-out involving 33,000 people. The representatives of the workmen appealed to the standing Court of Arbitration, which at once invited the employers to take the same step. The employers declined to submit their case to the court as such, but intimated their willingness to hold a conference with the leaders of the men under the chairmanship of the president of the Arbitration Court. The conference met on Tuesday, and after a very long sitting adjourned till the next day, when the proceedings proved abortive. Later advices put the number of people out of employment at about 40,000, as declarations of solidarity with the workmen and promises of financial support have been received from various organisations in other trades. With the aid of the officials of the company and of numbers of "strike-breakers," the Berliner Elektriziltätswerke have hitherto been able to continue with comparative regularity their supply of electric power and light for the city, but the tramway service had to be curtailed for a few days. It is understood that a further effort has been initiated by the burgomaster to reopen negotiations between the employers and the workmen.

Motor Control.—A patent has been obtained by Mr. J. Bentley, of Manchester, relating to a motor with speed-control arrangements, having two sets of field magnets and two armature cores provided with a common armature

FIG.1.

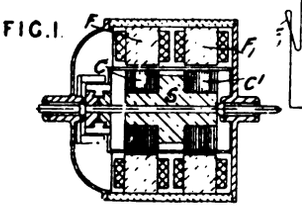
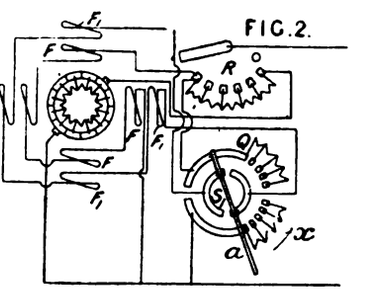


FIG.2.



winding, of which a description appears in the *Official Patents Journal*. The two sets of field magnets, F F_1, and armature cores, C C_1, mounted on a brass hub, S, form two separate magnetic circuits. The connections between the motor and the starting and regulating switches, R_1 S_1, are shown in the second diagram. The current in the field coils, F, remains constant, while the speed of the motor is increased from its lowest to its highest value, the current in the field coils, F^1, being varied by rotating the arm of the switch, S_1, in the direction of the arrow, *x*, from its initial position, *a*, to its final position, Q. When the arm is in the position *a*, the current flows in the same direction in the field windings, F F_1, the rotation of the arm first inserting resistance, then reversing the direction of the current, and finally cutting out resistance in the circuit of the winding, F_1.

Wireless Telegraphy.—The jury of award at the Liége Exhibition has given the highest award—the Grand Prix—to Marconi's Wireless Telegraph Company, Limited, for their exhibit of wireless telegraph apparatus. Wireless telegraph apparatus has for some time been installed on board the day steamers on the Flushing-Queenborough route, and will in a short time be installed on board all the night boats. The usual Continental rates for telegrams are charged. The Board of Trade have received from the Canadian Government a copy of the Wireless Telegraphy Act, 1905, which was assented to on July 20, 1905, and provides for the regulation of wireless telegraphy in Canada. By Section 3 of the Act it is provided that "no person shall establish any wireless telegraph station, or instal or work any apparatus for wireless telegraphy, in

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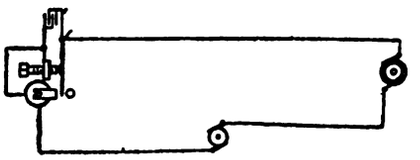
any place or on board any ship registered in Canada, except under and in accordance with a license granted in that behalf by the Minister of Marine and Fisheries with the consent of the Governor in Council." It is also laid down in the Act that where an applicant for a license proves that the sole object of obtaining a license is for the purpose of conducting experiments in wireless telegraphy, a license for that purpose shall be granted, subject to such special terms, conditions, and restrictions as the Minister thinks proper. It is reported that a somewhat remarkable extension of the distance at which steamers fitted with wireless telegraphy can communicate with the shore was made last week, when the "Lucania" on her outward voyage to New York got into communication with Nantucket lightship 803 miles to the east of that point.

Resuscitation from Electric Shock. — At the recent convention of the Ohio Electric Light Association an interesting paper on this subject was presented by Mr. E. E. Noble, of which an abstract appears in the *Electrical World* of New York. The paper gives an account of some researches of two Cleveland physicians as to the probable cause of death from electric shock. The conclusions are that death from the passage of heavy current through the body is due either to temporary stoppage of the heart or contraction of the muscular fibres of the heart, whose function is to force the blood to the general circulating system and the lungs. There is also a fall of arterial blood pressure. The physicians claim that their experiments showed that unless a relatively large part of the current passing through the body traverses the heart, the shock would not necessarily prove fatal, and that by the prompt application of artificial respiration a patient may be restored. It was stated that an examination of the blood showed that electric currents "up to 2,300 volts" cause no chemical or other changes in the blood itself, nor any change in the tissue of the brain or spinal cord or other nerve structures. Our contemporary notes that this is contrary to the evidence of autopses of criminals executed by the electric current, where the presence of numerous lesions were noted. The physicians recommend a method of resuscitation which is already well known to electricians, and the author of the paper suggests the wearing by those exposed to high voltages of a light metallic gauze jacket next to the skin, or a system of metallic bracelets worn around the upper arms and connected by means of flexible conductors, and a belt of some similar material worn around the waist or some part of the body below the heart.

Electricity for Motive Power.—Colonel Crompton succeeded in a rather difficult task at the Olympia Exhibition on Tuesday evening, when he made a technical subject, though not treated in that spirit, highly interesting to a large public meeting. The colonel emphasised the great interest attending the larger use of electric motors, as an increased load factor meant a cheapening in the supply of electricity generally. Current for lighting was necessarily dear while electricity was confined to that field, but there was no reason why electricity for lighting during daylight hours should not be as cheap as for power, provided that the demand did not encroach upon the hours of maximum demand for lighting, which only represented a small proportion of the whole. He considered that a two-rate meter would be the best method of promoting the use of electricity. Many authorities had already adopted a special rate for power purposes, but the colonel suggested that there ought to be a special rate for using current in the daytime. He waxed quite enthusiastic upon the possibilities of electricity in the household, and hoped that at no distant date the hand labour of the "general" would be replaced by electrical energy. Motors should be used to operate dish and bottle washing machinery, plate cleaning, meat and sausage chopping, dough kneading, and domestic laundry appliances. In addition to this he saw many opportunities for electric power in commercial fields where it is not at present employed to any extent, such as metal working, cutting and polishing jewellery, bookbinding, and cabinet making; while the use of motors to compress air would enable everyone to have a cold-storage room in his own house. The colonel touched upon the scheme of the Administrative County of London Company, stating that it was designed solely to promote the general use of electricity for power purposes. The lecture was evidently appreciated, and should assist in bringing home to the public the fact that by the general adoption of electrical power it would be possible to give a supply at cheaper rates.

Alternating-Current Rectifier. — An interesting form of alternating-current rectifier has been patented in the United States by Mr. J. H. Robertson, a description of the same appearing in the *Electrical World* of New York. While the operation of the device depends upon the opening and closing of a circuit at the desired instants according to the relative signs of the alternating E.M.F., no synchronous motor with revolving commutator or equivalent equipment is employed. The position of a vibratory contact maker is determined by the polarity of an electromagnet whose coil is subjected to the alternating E.M.F. The contact maker, which is mechanically connected to the polarised armature of a permanent magnet,



is normally held closed. During operation, the polarised armature is acted upon not only by the permanent magnet, but also by the electromagnet. When the polarities of these two magnets are of the same sign, the contacts are held tightly together. When, however, the electromagnet reverses its sign and becomes of sufficient strength, the polarised armature is repelled, and the circuit broken. Thus the circuit is closed when the E.M.F. is of one sign, and is open during the major portion of the time when the E.M.F. is of the opposite sign, so that the resultant current, although pulsating in value, is practically unidirectional. It is evident that a combination of two rectifiers with relatively reversed electromagnets will allow equal values of currents to be taken from the source of supply both when the E.M.F. is negative and when it is positive, so that the load on the supply system will be balanced with reference to the successive alternations. The device, which is illustrated in the accompanying diagram, is simple, of few parts, and quite compact. For charging the storage batteries of automobiles at places where only alternating current is available, the magnetic rectifier possesses the advantageous feature of being transportable by the automobile itself.

Series Alternating-Current System of Arc Lighting.—A system of series arc lighting circuits which may be readily operated upon a constant-potential supply has recently been developed by the Fort Wayne Electric Company. Its special advantages are its simplicity, the slight attention it requires, and its flexibility, permitting it to operate in parallel with an incandescent system, if desired. The system consists of a regulator for maintaining a constant current, a specially designed high-tension switchboard, a constant-potential transformer, and a series of arc lamps, in addition to which both sides of the line are

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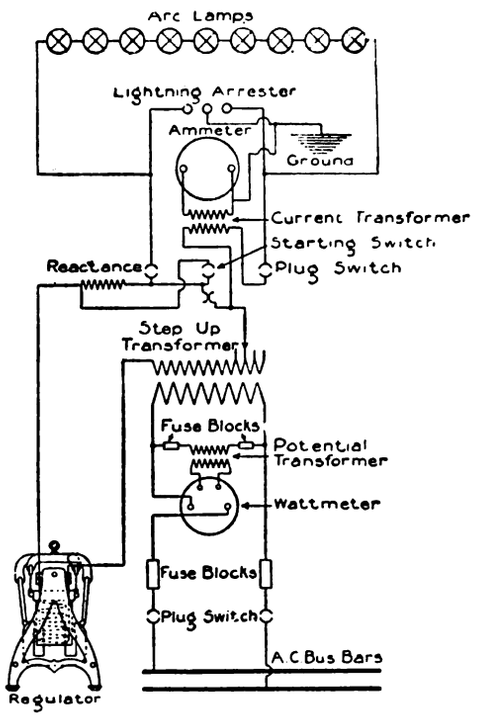
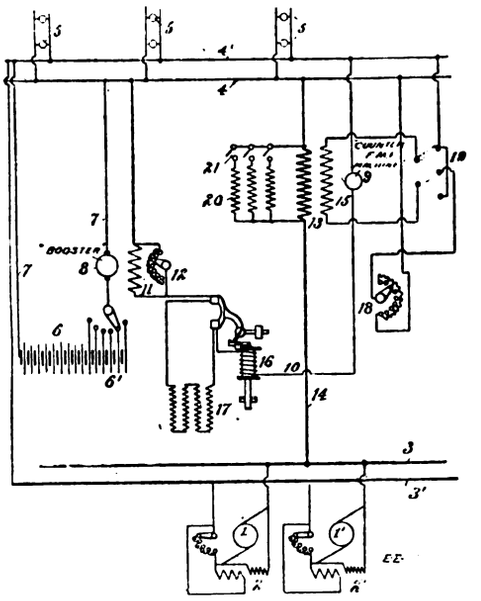
equipped with a lightning arrester peculiarly adapted to circuits of this nature. The accompanying diagram, which we reproduce from the *Western Electrician* of Chicago, shows the scheme of connections. The operation of the regulator designed for this system depends upon the automatic introduction of impedance into the lamp circuit whenever any decrease in the resistance of the latter would tend to cause an excessive current to flow therein. This impedance is introduced by the combined movements of a laminated iron core and impedance coil into such a position as to cause a greater magnetic flux to be cut by the current in the coils. This increase in the amount of flux cut by the line current produces a choking effect, reducing the latter to its normal value. Reference to the diagram will show the peculiar design of the switchboard, by means of which the system may be quickly started from the switchboard without paying any attention to the regulator and without causing any excessive rush of current through either the regulator or the lamps in so doing. The ability to thus start without any disturbance upon the line is one of the greatest advantages of the system. The starting switch, which is located in



the centre of the panel, should always be closed last, the closing being effected in three stages. The constant-potential transformer may step up or step down the 'bus-bar voltage, or may in some cases maintain the same voltage upon both primary and secondary in cases where it is introduced for insulation purposes only. The secondary of this transformer is provided in a number of taps, by the use of which the output of the station may be varied as more arc lamps are needed upon the circuit, maintaining at all times practically full-load efficiency and power factor. The system has been designed for either 60 or 140 cycles, and has been found to operate with complete satisfaction at either frequency, although the former is considered preferable.

Controller for Storage-Battery Boosters.—A patent has recently been granted in the United States to Mr. A. S. Hubbard, and assigned by him to the Gould Storage Battery Company, of New York, for an improved method of regulating the control of the booster in systems embodying the use of a storage battery and booster. In the accompanying diagram, which we reproduce from the *Western Electrician* of Chicago, the generators are indicated as connected to 'bus bars, 3 3', from which the current is taken to supply mains for a lighting or power circuit. The storage battery is provided with regulating cells, 6', and is connected across the mains in a circuit, 7, which indicates the armature, 8, of the booster. The booster armature is driven at the desired speed by suitable connection from any convenient source of power. The booster field, 11, is energised by the difference between the different potentials, which act oppositely thereon. The booster field coils are connected in a circuit of a counter E M F. generator, 9, the armature of which is connected across the mains, 4 4', so that the field winding is energised by a current due to the difference between the voltage on the mains and that of the counter E.M.F. machine. The field of the counter E M F. generator is provided with a coil, 13, which is so connected as to be traversed by the current supplied by the generators, being included, for example, in the connection, 14, between a dynamo 'bus bar, 3, and the corresponding side, 4, of the mains or work circuit. The effect of this field may be varied by means of any suitable devices, such as by shunts and their switches. Other field-regulating devices for the machine, 9, may be provided—as, for instance, a coil, 15, in a circuit connected, as shown, in parallel with the mains, so that the system may readily be adjusted for different generator loads by manipulating rheostat, 18, and pole changer, 19, included in the circuit.



In the operation of the system it will be seen that the field winding, 11, is energised by a voltage equal to the difference between the potential difference of the mains, 4, 4', and that of the machine, 9. In order that the field winding, 12, may be protected from abnormal increase of current, which obviously may occur through any derangement of the system that would materially affect or cut out either of the sources of potential difference affecting this circuit, there are provided means for increasing the resistance of the booster field circuit which act automatically when the electrical condition of the booster field winding circuit permits an abnormal increase of current. This is effected, preferably, by the resistance, 17, in series with the field winding, 11, and the circuit breaker, 16, connected in a short circuit around the resistance. Normally, as shown, the current to the booster field winding passes through the circuit breaker and the actuating coil. When however, the current increases to the desired limit the circuit breaker, 16, opens and the resistance, 17, acts to reduce it to a safe quantity. It will be observed that this insertion of resistance, in addition to preventing any actual burning out of the field winding, 11, has the advantage of preventing dangerous derangements of the

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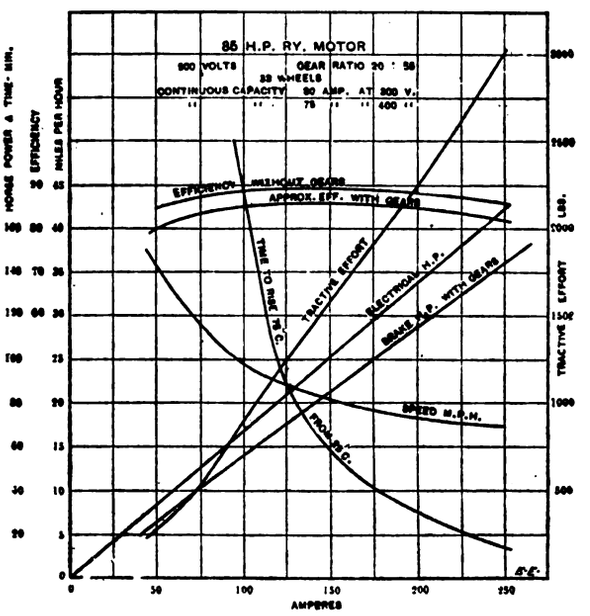
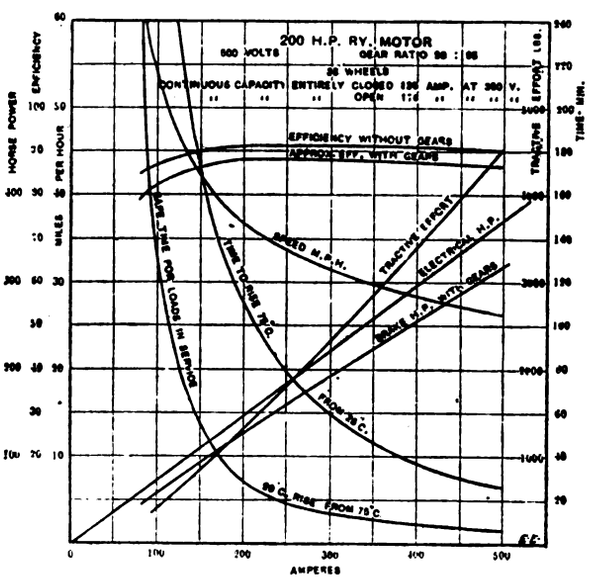
system due to abnormal changes of booster voltage. In the specific regulating apparatus shown the resistance also protects the counter E.M.F. generator, 9.

New Westinghouse Railway Motor. — The American Westinghouse Company have introduced a new line of motors for heavy traction, the sizes ranging from 75 h.p. to 200 h.p. Among the features of particular interest which characterise these motors may be mentioned the diagonally divided field frame, which makes every part accessible; the gear case, supported entirely at the ends, so as to avoid the side strains which have been the source of so much trouble; housings for armature bearings clamped between the two halves of the frame; generously proportioned bearings with a system of lubrication claimed to be the most effective yet devised; armature and commutator assembled upon a single spider; bar-wound armature with split coils; commutators with many bars; low current density in the brushes; bolted-in laminated poles; sealed field coils wound with strap; excellent commutation; high efficiency; low operating temperature and great mechanical strength. Limitations are naturally placed on the size and construction of a motor by the amount of available space on the truck of the car; therefore, the frame of square cross-section was adopted as



utilising this space most advantageously. By lifting off the upper half of the field casting the armature may be removed from the frame without taking the motor from the truck; or the motor may be removed from the truck by simply taking off the gear case and axle caps. Housings for the armature bearings are circular in form and are turned slightly larger in diameter than their seats in the frames, so that when clamped in place all the advantages of a press fit are obtained. The armature bearings are made of solid phosphor-bronze bushings finished all over, with a $\frac{3}{32}$in. lining of babbitt metal. If from neglect the bearing should become so hot as to melt the babbitt, the armature would be supported on the brass shell, and would not strike the poles. Both oil and waste lubrication are provided. The amount of oil in the reservoirs may be gauged so that it may be kept at the proper level for economical service. It is stated that with intelligent care these bearings will run 100,000 to 150,000 miles. The axle bearings are similar in construction to those of the commutator, except that split bushings are used. Here also lubrication is by means of oil and waste, the oil being supplied from below. This is the same method as that which has given such universal satisfaction in steam railway service. All bearings have generous dimensions, and the large surfaces readily dissipate the frictional heat and ensure cool running. The laminated pole-pieces are bolted to the top, bottom, and sides of the motor frame, which, being almost square in cross-section, permits the use of flat field coils. These coils are wound of copper strap insulated between turns with treated asbestos ribbon, and then carefully taped and given repeated dippings in specially prepared insulating compounds and varnishes, which makes them moisture-repelling and able to stand internal heat. The shaft is forced into the finished armature and keyed thereto, and may be removed, should necessity arise, without disturbing the windings or commutator. The armature coils are strap-wound, and made in two parts. As the top coils are more liable to injury, this design makes it possible to remove the damaged part without disturbing any other part of the winding. The coils are liberally insulated with mica, and sealed and further insulated by dipping in varnishes which are oil-proof and moisture-repelling. On each end the armature slots are made deeper and wider, thereby providing space for mica cells, which greatly reinforce the insulation at these points. As a further protection, fibre strips are taped to the upper sides of the top coils. A bell-shaped flange at the pinion end and a cylindrical flange on the commutator end form rigid supports for the windings. Countersunk bands of steel wire on the core hold the



coils firm and secure. Openings through the spider and core allow a free passage of air, which is thrown forcibly against the field coils, thus maintaining a low temperature throughout the motor. The brush-holders are of the sliding type, with springs of phosphor-bronze held in a harness which definitely fixes the radius of action of the spring tip, and is so constructed as to practically eliminate friction between turns, which gives a very uniform pressure upon the brush over a considerable range without requiring adjustment. The tension of the spring may be adjusted without removing the holder from the motor. The brush-holder proper is bolted to an insulated guide, and may be removed without disturbing the insulation or connections. Leads of frame-proof flexible rubber-covered cable are brought out at the front of the motor over the commutator through insulator bushings. Access to the brushes and brush-holders is provided through a large opening in the frame over the commutator, which extends well down the side, making inspection easy from the pit. A hole in the rear end bell and an opening under the commutator facilitate inspection of the clearance between the armature and field poles. The accompanying diagrams illustrate the characteristics of a 85-h.p. and a 200-h.p. motor respectively.

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ALTERNATE-CURRENT MACHINERY AT OLYMPIA.

BY P. R. FRIEDLAENDER.

The exhibition is rather disappointing as regards alternating machinery, for, in spite of the fact that during the last few years more advance has been made in this branch than perhaps in any other, only about a dozen firms exhibit this class of machinery, and in most cases these exhibits comprise quite small examples only.

Since the only alternating supply available at the exhibition is a single-phase one, all the alternate-current driving is done by single-phase induction motors, and several of Messrs. Langdon-Davies's well-known machines are to be seen at work on the stands of different exhibitors as well as on the company's own stand (No. 30). These motors are usually of the short-circuited rotor type, and are started by means of a simple throw-over switch, which on the "starting" side puts the starting stator winding direct across the supply mains, and the "running" stator winding in series with a non-inductive resistance also across the mains. This arrangement, in combination with the higher inductance of the "starting" winding, gives the necessary phase difference for starting purposes without the use of choking coils or condensers. On the "running" side of the starting switch (to which the handle may be moved as soon as approximately full speed is reached), the resistance in

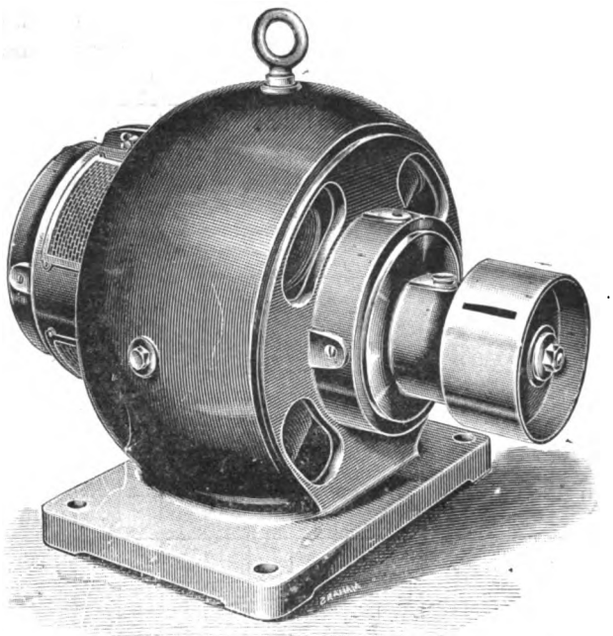

FIG. 1.—Langdon-Davies Single-Phase Motor.

the running winding is cut out, and at the same time the starting winding is entirely disconnected, so that the running winding alone remains in use, and is connected directly across the mains. This method of starting single-phase induction motors by the use of a resistance alone is adopted by several other firms, including the Fuller-Wenström Company and the Brush Electrical Engineering Company, and, in combination with a loose pulley, gives perfectly satisfactory results. Other makers—*e.g.*, Messrs. Crompton and Co. and Messrs. Siemens Bros.—employ a choking coil in the starting winding of the stator as an aid in producing the necessary phase displacement.

In place of the usual fast-and-loose pulley arrangement, Messrs. Langdon-Davies have recently brought out a neat friction clutch (Fig. 1), worked by hand by means of a lever on the bearing, whilst the Fuller-Wenström Company have a very simple automatic contrivance for the same purpose. This occupies no more space than the ordinary single pulley. It consists of a pulley keyed to the shaft, and against the rim of which four iron segments are held by spring pressure. This pulley revolves within a second pulley, which is free on the spindle, and on which the belt runs. As soon as full speed is reached the four segments fly outwards under the centrifugal action, and automatically clamp the two pulleys together by friction.

The Crypto Electrical Company show a number of small single-phase motors from ⅛ h.p. to 2 h.p., as well as small alternators and motor-generator sets. The motors are of the squirrel-cage type, and starting is accomplished by closing the main switch and pressing a button for a few seconds. The button puts the starting winding into circuit, and this is cut out again by releasing the button as soon as full speed is reached.

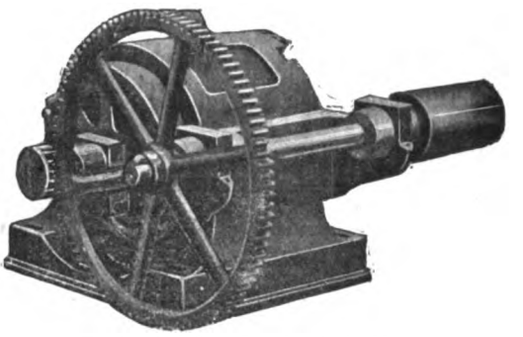

FIG. 2.—Back Gear, Langdon-Davies Moto

When motors with "wound" or slip-ring rotors are employed, as is the case whenever any considerable starting torque is required from either single or polyphase motors, the three-phase winding with three slip-rings seems practically always to be adopted, whatever the number of phases of the stator supply may be. Some makers—*e.g.*, Messrs. Vickers, Sons, and Maxim, the General Electric Company, the Lancashire Dynamo Company, etc.—place the slip-rings outside the bearing, with the connections to the rotor passing through the hollow spindle (see Fig. 3). This makes a very compact motor, although when placed *inside* the bearing (as in the motors made by the Brush Electrical Engineering Company, Messrs. Crompton and Co., the Phœnix Dynamo Company, and Messrs. Siemens Bros.) the rings and brush gear are better protected, and this is of some

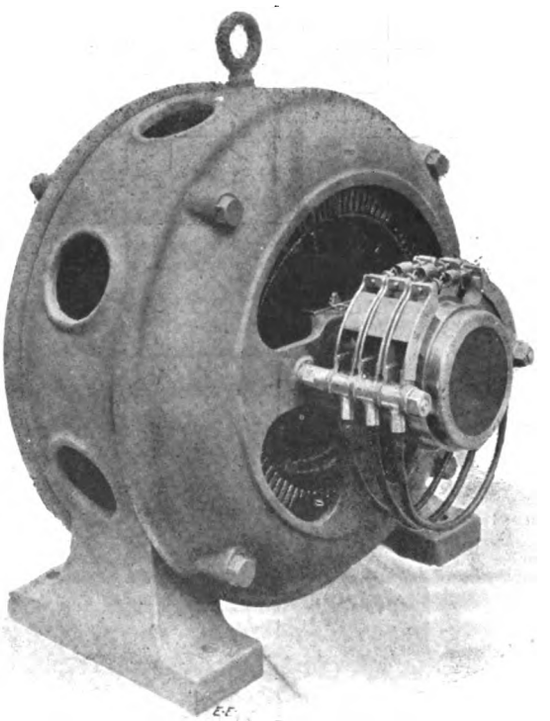

FIG. 3.—Three-Phase Motor made by Messrs. Vickers, Sons, and Maxim.

importance at starting, when considerable voltages sometimes exist between the rings. The starting and speed-regulating switches and resistances employed with these "wound" rotors are very varied in form, liquid resistances being occasionally used, though they are more commonly made up of wire spirals or cast grids.

Messrs Siemens Bros. have recently combined a "no-voltage" release with their rotor starting resistances, and samples of these are exhibited on their stand (Nos. 99 and 100). When the main (stator) switch of an induction motor is opened, or when the motor stops, due to accidental interruption of the supply, the rotor comes to rest with all its resistance cut out and the rings on short-

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circuit, so that if the main switch is once more closed an excessive starting current will be taken, and will probably cause the blowing of the fuses. This difficulty also occurs in the case of direct-current motors, and has been met there by the employment of automatic "no-voltage" release switches, but these have hitherto seldom been provided for induction motors. In Messrs. Siemens's arrangement the three-armed rotor switch is held in the "on" or short circuiting position against the action of a strong spring by means of a trigger controlled by a small three-limbed, three-phase electromagnet. This is excited by the rotor currents, and as soon as these currents fall below a certain value the magnet lets go and the switch flies back to the "off" position, at which the rings are on open circuit and ready for starting up again safely.

Messrs. Siemens also show a three-phase induction motor with a "wound" rotor, but without slip-rings (Fig. 4). The cutting out of the resistances and the final short-circuiting of the rotor windings is accomplished by means of a three-armed switch, rotating with the rotor and actuated whilst the machine is in motion by means of a sleeve and hand-wheel at the end of the spindle. The resistances in this case are in the form of metal grids, securely mounted inside the rotor core. This arrangement makes a compact self-contained motor, and also allows the rotor to be really short-circuited without the intervention of the usual brush contacts and leads between the motor and its starting switch, which often cause an appreciable reduction in efficiency.

FIG. 4.—Siemens Three-Phase Motor.

As regards mechanical design, the various makes of motors exhibited have a great deal in common. They are usually of the protected type, with the end covers carrying the bearings and attached to the ventilated cast-iron frame which supports the stator discs. The bearings are self-oiling, and, for the small sizes, ball bearings are occasionally used The induction motors made by the Lancashire Dynamo Company are provided with a useful bearing centre adjustment in the end covers. These end covers are made without registers, and the clamping bolts are an easy fit in the bolt holes, so that the exact position of the end covers (and rotor) relatively to the stator frame and discs is determined by three conical ended screws bearing on conical facings on the stator frame. When the motor bearings wear, therefore, it is only necessary to slacken the bolts, adjust the three screws until the air-gap is again uniform all round, and tighten up the bolts once more. As the rotor surface as well as the stator bore are ground smooth, it is an easy matter to decide when the air-gap is uniform by means of feelers inserted between rotor and stator.

Practically all the motors exhibited have half-closed slots on both rotor and stator. The winding is threaded through turn by turn from the end, and the tops of the slots are then closed by strips of fibre or presspahn, all binding bands being omitted.

Of the much-discussed single-phase series and repulsion type of traction motor the exhibition hardly shows a trace. The nearest approach to these is to be seen on Messrs. Crompton and Co.'s and on the Lahmeyer Electrical Company's stands. Messrs. Crompton show a 10-h.p. special type of repulsion motor (Crompton-Goldschmidt patent) fitted with four slip-rings, each of which is split into a number of separate segments not unlike a rudimentary commutator. The Lahmeyer Electrical Company show a single-phase reversible hoist motor of the Schüler "mixed action" type. The motor is fitted with a commutator (with short-circuited brushes) at one end and three slip-rings at the other end, whilst the stator is fitted with three single-phase windings One of these windings is in use for both directions of rotation, aided by one of the remaining windings for clockwise rotation, and by the other for counter clockwise rotation. When starting up, the slip-rings are connected through a high resistance, as in the case of an ordinary induction motor, and the greater part of the starting action depends on the commutator, the motor acting mainly as a repulsion motor. As the speed increases, and the resistance between the rotor rings is gradually reduced, the commutator takes less and less current and the rings more and more current until at full speed the commutator is practically idle, and the motor runs as an ordinary single-phase induction motor. These machines, however, are not what is usually called a single-phase traction motor, and although several English firms are undoubtedly making the latter type, if not commercially at least experimentally, it is not to be seen at the exhibition.

The Bat Electrical Company show two of their "permutators" for converting alternating current into direct current. These machines, which are being put on the market in sizes up to 200 kw., are in some respects similar to rotary converters, but the armature and commutator are fixed whilst the magnets and brush gear rotate. It is claimed that they are easily self-starting on the alternate-current side, and that their vertical arrangement reduces the necessary floor space to a minimum.

As examples of the larger sizes of alternate-current machinery, reference may be made to Messrs. Lahmeyer's 520 b.h.p., 10,000-volt, 50 ~, three-phase synchronous motor on stands No. 94 and 105. This is running during the exhibition as a three-phase generator at half speed, giving 2,000 volts at 25 ~ for use (after transformation to 220 volts) in driving the complete haulage gear shown in operation by this company. The haulage gear motor is a totally enclosed three-phase induction motor for 100 b.h.p. at 137 r.p.m., and is fitted with a "wound" rotor arranged for two phases. The speed of the motor is regulated within wide limits by means of resistances inserted in the rotor circuits. There are 15 resistance steps in each phase, so as to permit smooth starting and stopping, and the whole operation of the plant is carried out by a single controller lever. Moving the lever backward or forward stops or starts the motor, whilst sideways motion reverses its direction of rotation. The controller contacts work under oil, and the resistances are of metal immersed in oil and specially cooled by oil circulated by a small pump driven from the motor spindle.

Alternators are practically unrepresented, although one or two motor-alternators are to be seen—*e.g.*, on the Phœnix Dynamo Company's stands, Nos. 117 and 126. Messrs. Crompton and Co. show a 50-h.p., three-phase, slip-ring, induction motor used during the exhibition as a 30-h.p. single-phase motor driving a direct-current generator for arc lighting purposes. The Brush Electrical Engineering Company's exhibit includes one of the largest transformers yet made in this country. It is a three-phase oil-cooled transformer for an output of 500 kw., the primary being wound for 5,000 volts and the secondary for 500. The core has three straight vertical limbs of approximately circular section, connected at the top and the bottom by straight yokes of rectangular section, and it is arranged with oil-circulating passages throughout. The windings are divided into a number of well insulated sections, and alternate primary and secondary sections are placed side by side along each limb.

In conclusion, it must be admitted that the exhibition hardly gives an adequate idea, either as to amount or size, of the alternate-current machinery which British manufacturers are capable of turning out at the present time.

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SOME NEW DESIGNS IN ELECTRIC LIGHT FITTINGS AT OLYMPIA.

[BY OUR SPECIAL ARTIST.]

(Continued from page 446.)

The stand of the London Electrical Fittings Company, Limited, of 7A, Soho-square, W., is well worth seeing for the large number of beautiful fittings which they have on view and wired. Like with most other fittings makers, special prominence is given here to the Adams style, as

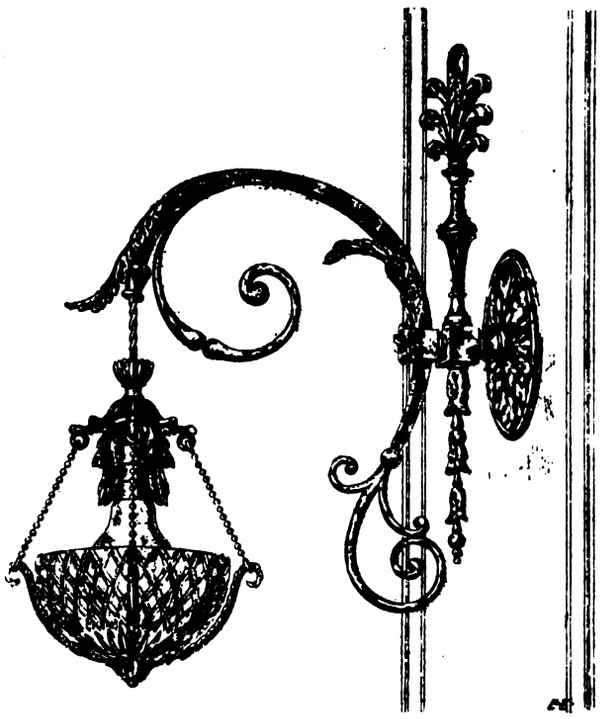

FIG. 10.

well as to the more modern fittings with graceful lines. A particularly charming bracket in the Adams style is shown in Fig. 10. This fitting is made in either dead gold or gilt, and the cut-glass bowl serves to reflect some of the light upwards. The whole bracket only projects 9in. to the holder, and is eminently suited for mounting on or between watered silk or other similar styles of panels now in vogue. Another bracket, which we illustrate in Fig. 11, is neat and pleasing, being specially suited for boudoirs, smoking-

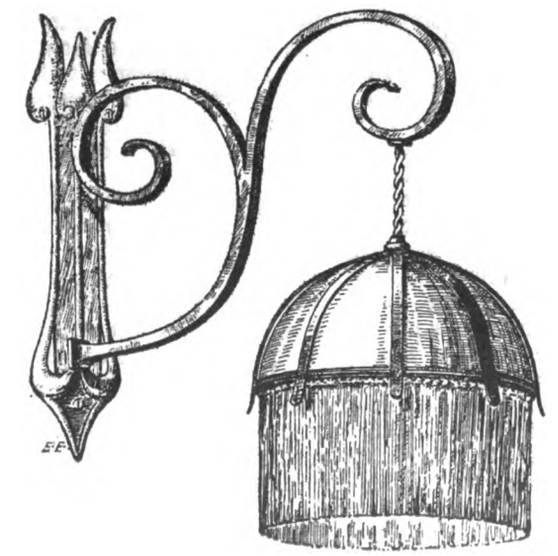

FIG. 11.

rooms, etc. The metal work can be finished in polished brass or oxidised silver. The projection to holder is only 8in.

Candle fittings are by no means relegated to the past. They naturally assume the Louis or Adams styles, and a particularly pretty one in the latter style is shown in Fig. 12 for mounting between two panels. This is made in dead gold and gilt finished. The company show a large number of lanterns for which the present farmhouse revival in architecture has created a demand. Space, unfortunately,

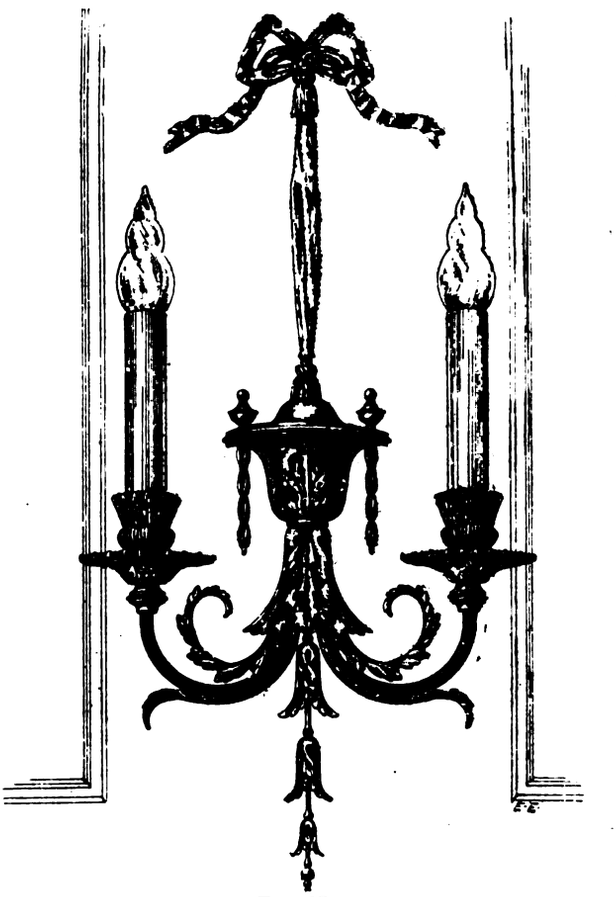

FIG. 12.

only permits us to show one design, which is made either in antique bronze or oxidised silver. As will be observed from the illustrations, the ornaments and glass have a neat floral design. All these illustrations are to scale, Fig. 13

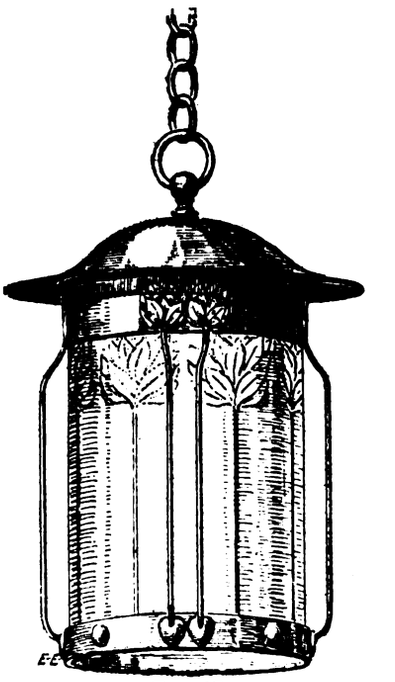

FIG. 13.

being one-sixth the full size, and the remainder quarter scale.

The exhibit of electric light fittings at the stand of the General Electric Company, Limited, of 71, Queen Victoria-street, E.C., gives no idea of the size of their showrooms and the business they do in this line. This is, no doubt,

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FIG. 14.

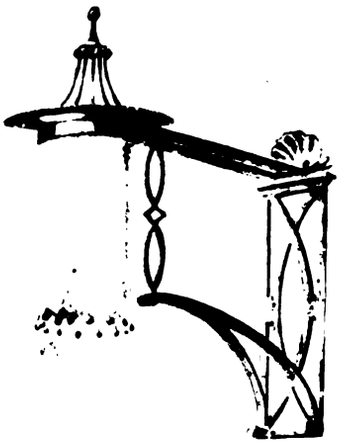

FIG. 18.

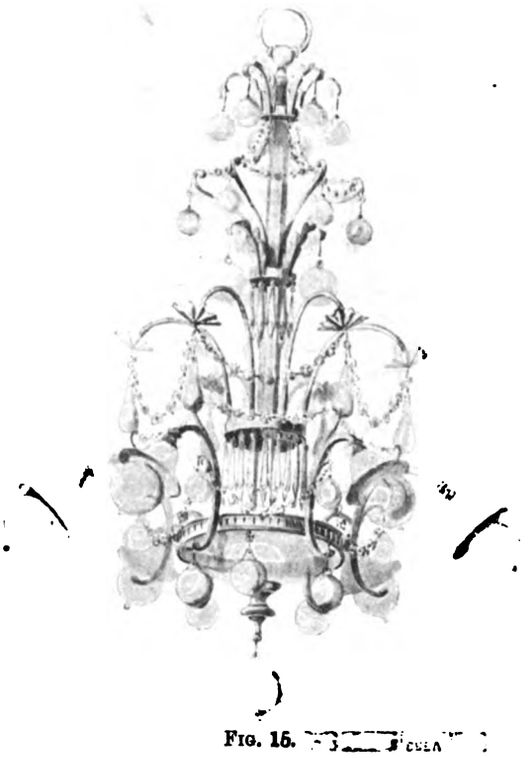

FIG. 15.

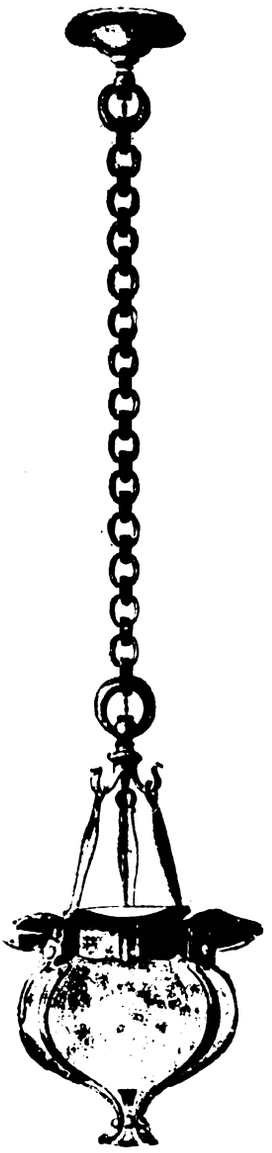

FIG. 16.

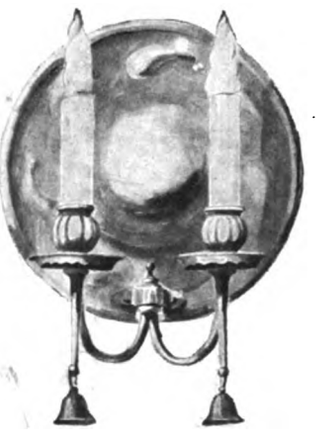

FIG. 19.

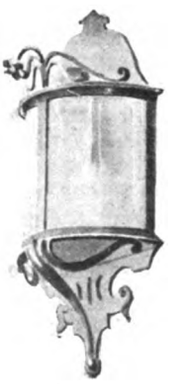

FIG. 20.

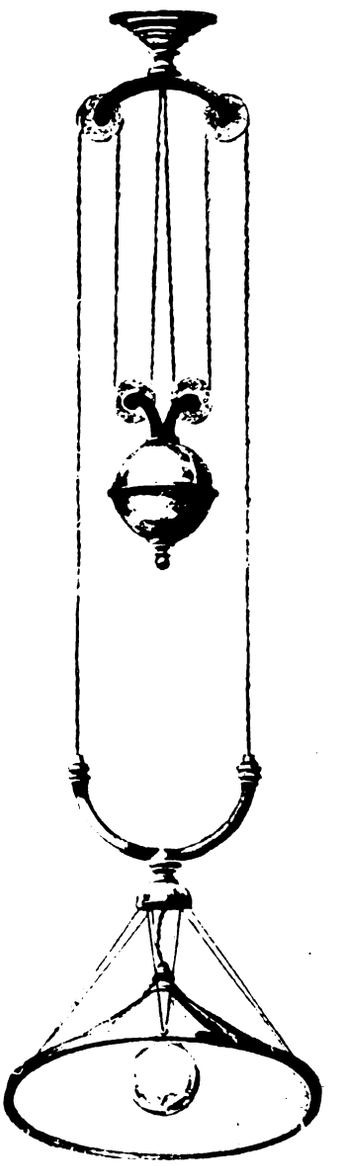

FIG. 17.

due to the fact that they make most other things, and the accommodation at Olympia is limited. But the General Electric Company's designs have an originality about them which makes it evident that a master-mind in the way of designer is behind the scenes. Fig. 14 illustrates an Adams dining-room pendant, or centre piece, with

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rise-and-fall arrangement. It can be supplied with or without the top lights. The finish is in rich gilt, and the design being simple, with characteristic details, makes up a fitting to suit the style of the room without being too insistent. Far different in style is the crystal drawing-room electrolier shown in Fig 15. It was said not long ago that drawing-room electroliers, as well as crystal fittings, had gone never to return. We are glad to note that if this style of fitting is with us again it has, at any rate, been shorn of the old-fashioned, heavy appearance of those which our youth knew. This particular one is made in polished or silvered brass. It is altogether dainty and unique in design.

A simple and novel pendant in planished copper and brass is shown in Fig. 16. It is provided with an opalescent or a cider bowl enclosed by divided straps, and is very suitable for a hall or corridor.

The dressing-table is represented by a simple tilting and counterbalancing pendant illustrated in Fig. 17. This has special advantages over other makes, in that it has only one counterweight, and that the fitting itself hangs perfectly plumb. It is made in polished brass.

Figs. 18, 19, and 20 shows some pretty designs in brackets. The first is in Sheraton style, ormolu finish, and only 8in. projection. In the same style dining-room centre lights and bedroom fittings are made to correspond. Fig. 19 shows a quaint old-fashioned sconce in hammered brass, with bold repoussé work and hanging bells. Fig. 20 is a neat and unobtrusive wrought-iron wall lantern, finished in black iron, armour steel, polished, bronzed, or antique brass.

The General Electric Company are now also making wooden fittings of simple design, which should be very successful as they can be selected to match the furniture, and cost less than the metal fittings. They are made of patent fireproofed wood. The same principle has also been extended to radiators.

(To be continued.)

PRIME MOVERS AND AUXILIARY PLANT AT OLYMPIA.

BY E. G. BEAUMONT, A.M.I.C.E.

(Continued from page 443.)

The longitudinal and transverse sections (Fig. 1) show the general arrangement of the three-cylinder compound engine referred to last week as among Messrs. W. H. Allen, Son, and Co.'s exhibits. It is representative of the double-acting forced-lubrication type, which has shown itself to be preferable for some reasons to the single-acting high-speed engine. It must now be recognised that the possibility of running the double-acting type satisfactorily at the same or at higher speeds of rotation than the single-acting type, and with equally good results, discourages the construction and use of the constant-thrust engine in which the necessary use of the air buffer cylinder or other means of maintaining the running parts in constant thrust imposes a limit to the power to be obtained in a given space. That is to say, the use of the forced-lubrication system, originating or first largely used by Messrs. Belliss and Morcom, makes it possible to construct high-speed double-acting engines of less weight and occupying less room per unit of power than any other type of reciprocating engine now in use.

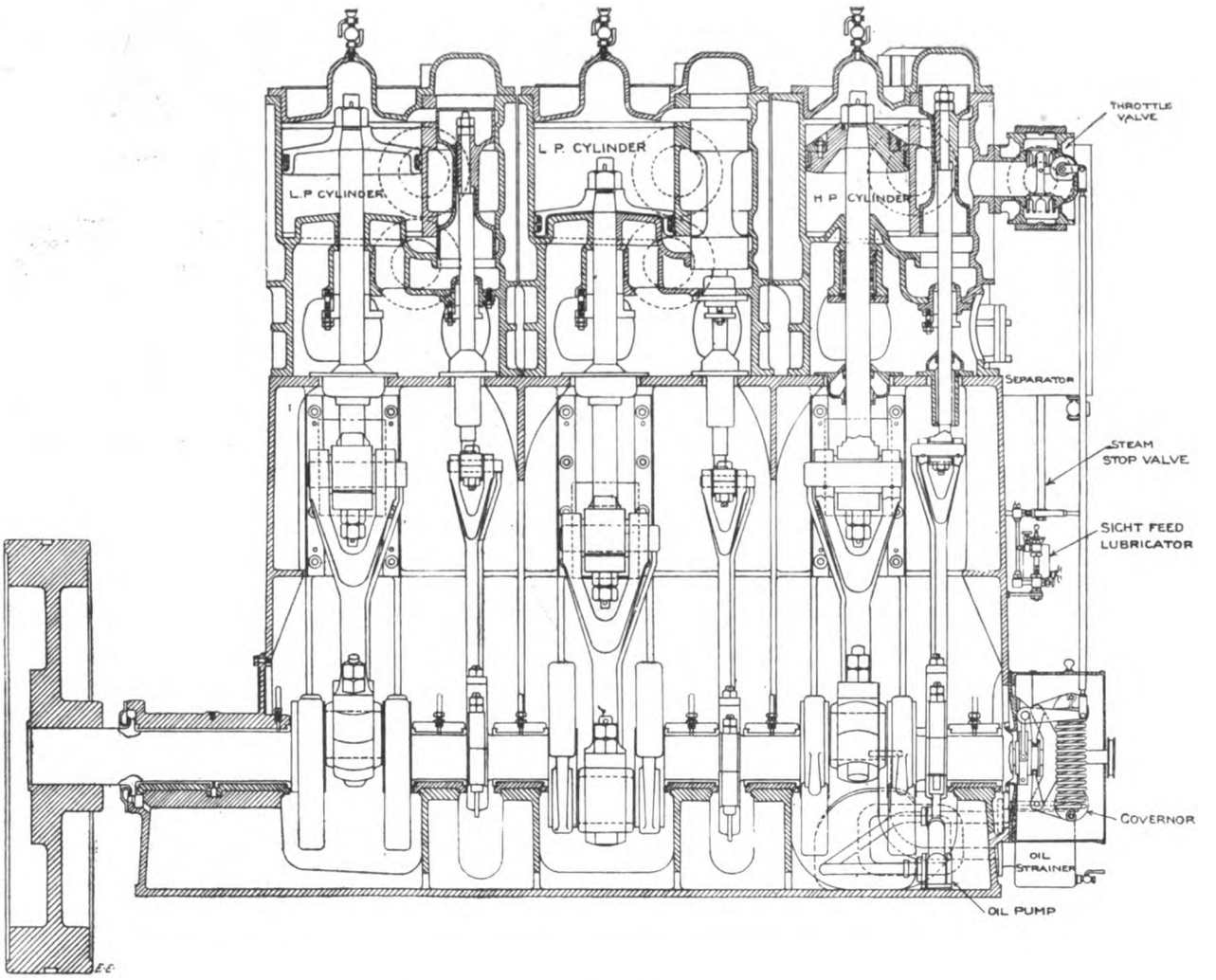

FIG. 1.—Section of the Allen Three-Cylinder Compound Engine.

The two important considerations of economical running and uniformity of turning effort have led to the design of the three-cylinder compound engine shown. For steam pressures of less than 150lb. per square inch, the useful range of expansion of the steam may be better obtained in two-stage or compound engines than in the triple-expansion engine having three cylinders, but with an equal division of work in the three-crank engine a more continuous or regular turning effort is obtainable. A compromise must therefore be made between designs involving the use of many cylinders to obtain the required division of work, but with lessened economy, and those requiring the use of few cylinders and permitting maximum economy,

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but accompanied with the disadvantage of less regular turning effort.

The 440-b.h.p. engine exhibited at Olympia has a high-pressure cylinder 16in. diameter and two low-pressure cylinders 18in. diameter, the stroke being 10in. and the speed 400 r.p.m. If a perfect division of work is to be obtained in this engine, obviously the power developed in the low-pressure cylinders must be twice that in the high-pressure cylinder, but it is difficult to effect this and to also obtain a suitable temperature range. From the indicator diagrams here shown (Fig. 3) some idea may be gained of the temperature and pressure conditions in an engine of this type. The set of diagrams are from a larger engine capable of developing 1,040 b.h.p. and running on an hydraulic dynamometer at the maximum load Messrs. Allen were able at the time to obtain, which was 765 b.h.p. The division of work as shown is apparently 44 per cent. in the high-pressure cylinder and 56 per

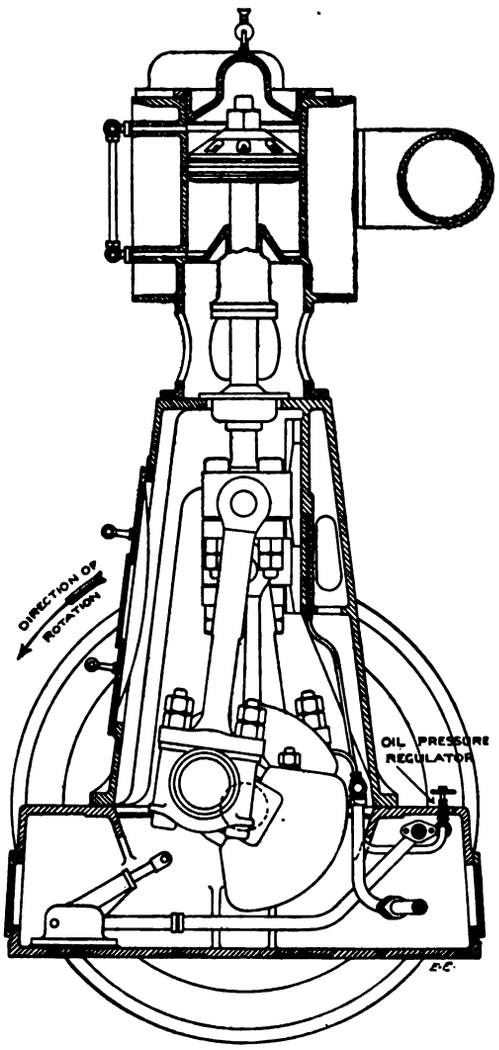

FIG. 2.

cent. in the low-pressure cylinders, but I hope to be able to show diagrams taken simultaneously which will more correctly show the work done in each cylinder and at a higher load. The engine was running during its six hours' test with a steam pressure at the stop valve of 130lb. per square inch throttled to 91lb., and this explains the sloping admission and expansion line on the high-pressure cylinder diagram. The weight of the pistons, piston rods, and connecting rods is the same at each line of the engine, and there are balance weights on the crankshaft webs. The disturbing forces productive of vibration are, therefore, to a large extent neutralised, and the engine is well balanced. The valves are of the solid piston type, and are free from the disadvantage attending the use of rings. The satisfactory use of such valves requires the very best class of workmanship and fitting and considerable experience to determine the possible closeness of fit for freedom of running without steam loss by leakage. The three cylinders are separate castings independently mounted on the crank chamber, and expansion may take place without change in the distance between centre lines and without interference with the freedom of running of the engine—a matter of importance with large engines and those running with high-pressure and superheated steam.

Mention has already been made of the 21·5-b.h.p. gas-engine and suction producer gas plant shown by Messrs. Crossley Bros. as a working exhibit. To those who have not seen this exhibit, or who are unacquainted with the general arrangement of such a plant, the illustrations here given will prove of interest. Referring to the sectional view (Fig. 4), it will be seen that the central cylindrical firebrick-lined producer chamber is separated from the outer containing shell, of cast iron in the smaller and built up of steel plate in the larger sizes, by an insulating filling or jacket of sand. The firebrick lining rests upon an annular ring or base-plate supported on two cast-iron superheater boxes upon a lower diaphragm plate. A central opening in this plate is occupied by the firebars, and the superheater boxes shown sectioned black are of segmental or semi-circular form in plan, and are exposed to the hottest part of the fire. At the top of the producer is a box through which the anthracite or coke fuel is fed to the hopper, and from which, as combustion proceeds, it descends through

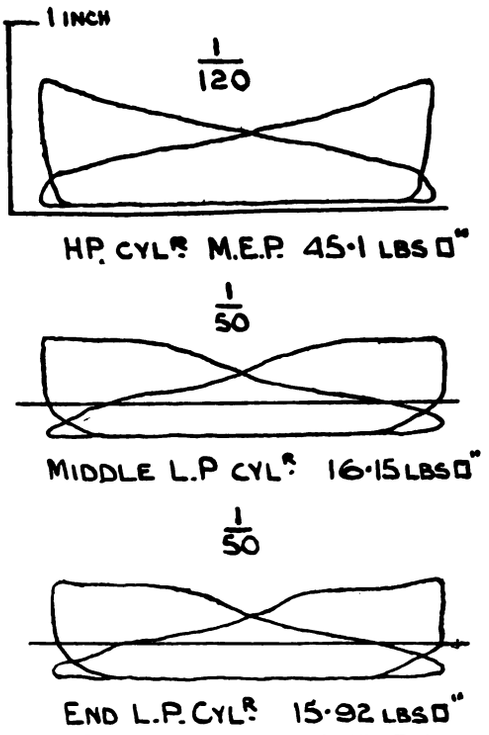

FIG. 3.—Indicator Diagrams from the Allen Engine.

the hanging neck or bell to the lower and hotter part of the producer chamber, finally becoming incandescent as it nears grate level. The quantity of fuel above the grate is determined by the downwardly projecting bell or neck of the hopper, and, as the latter must be kept charged while the plant continues in operation, the gas leaves the mass of fuel at the level of the lower end of the bell and passes upwards between it and the firebrick lining. Around the bell is an annular water chamber, forming part of the saturator or boiler, and in communication with the top vessel or saturator dish, the level of the water in the latter and the position of the water inlet pipe being indicated. There are, it will be noticed, baffle plates below the saturator dish, which cause the hot gas from the producer to take a circuitous path and to usefully give up heat to the water for the production of steam. The steam thus formed, together with air permitted to enter the saturator above water-level, passes downwards by two pipes, one of which is shown, to the superheater boxes, and leaving these at high temperature passes upwards through the grate as indicated by the arrows. The gas is thus obtained by the induced flow caused by suction from the engine of air and steam through the incandescent fuel. The process of formation is concisely stated by Messrs. Crossley Bros. Two simple reactions take place, expressed by

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to the hydraulic box containing water at a fixed level, upwards through a second scrubber, and thence to an expansion box or container of some capacity before reaching the engine. The expansion box is used to provide some storage for the engine to draw upon, and to some extent to relieve the producer of, and to damp down, the small continuous fluctuations of rate of supply, and the greater variation that would otherwise be felt

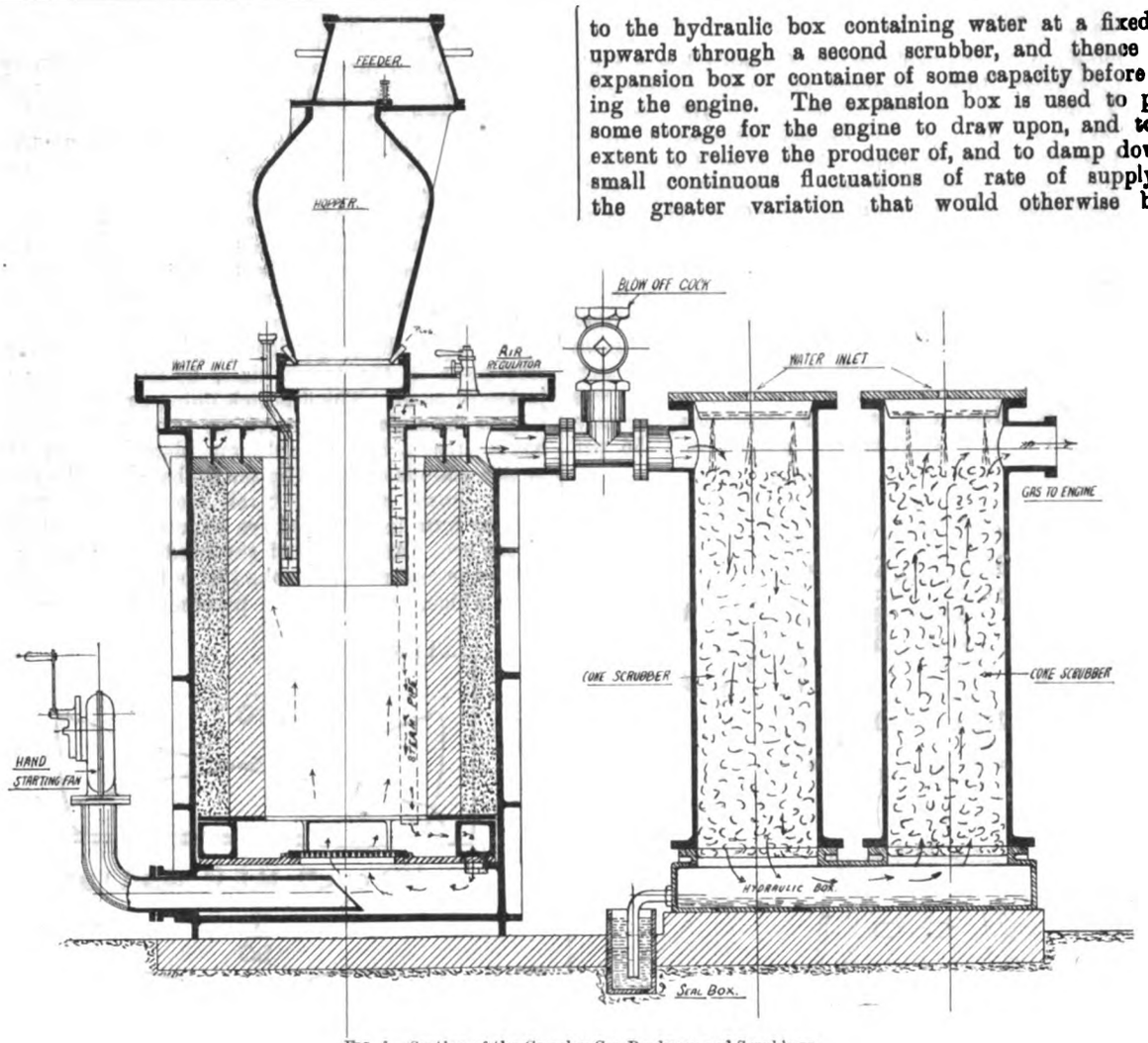

FIG. 4.—Section of the Crossley Gas Producer and Scrubbers.

$$2\,C + O_2 = 2\,CO$$

$$C + H_2O = CO + H_2$$

That is to say, the oxygen of the air combines with the carbon of the fuel to form carbon monoxide, and the water splits up to form more of the monoxide and free hydrogen. In addition to this a certain amount of marsh gas, CH_4, and carbon dioxide, CO_2, are formed, so that the ultimate composition of the gas is—combustibles CO, H_2, and CH_4, diluted with the non-combustibles, CO_2 and N_2.

when the engine is running on a variable load and with the governor cutting out working strokes. When the engine is to be stopped, the blow-off cock between the

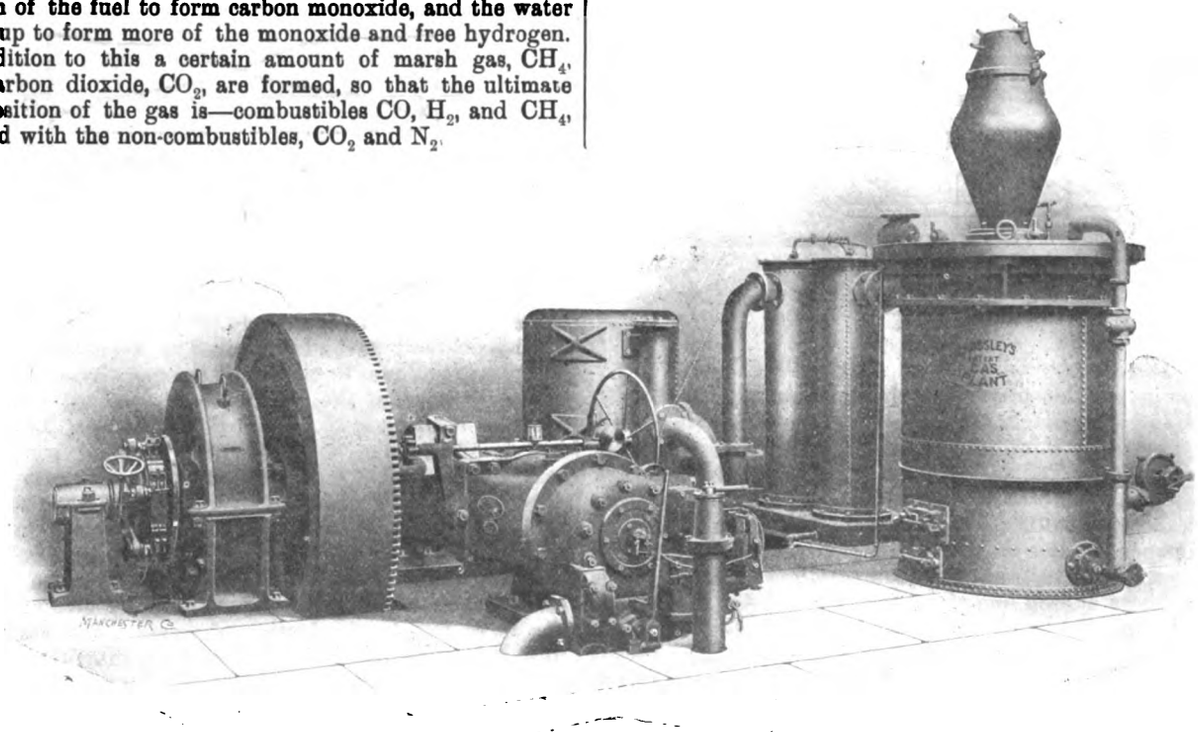

FIG. 5.—View of a Crossley Gas Producer Engine and Dynamo.

Returning to the sectional illustration, and following the course of the arrows, it will be seen that the gas successively passes downwards through a coke scrubber or washer

producer and the scrubbers is opened. Slow combustion continues in the producer, and after a stop, if it may be a day or longer, the fire may be got into condition for

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restarting the engine by use of the starting fan. The suction producer is thus structurally simple; no part of it is under pressure, it may be readily examined and kept in an efficient condition, and as a power plant it is free from the objections that may be raised to other systems requiring the use of many vessels and pipes under high pressure.

Gas-engines of large and small powers have now been running for a sufficient length of time to show that the suction producer is practically and commercially satisfactory, and with the growing recognition of their successful use there will, without doubt, be a rapid increase of their use. Fig. 5 shows a producer plant designed to supply gas obtained from common gas coke as fuel to the 80-b h.p. engine to which it is shown connected. The engine is direct coupled to a 55-kw. Crompton multipolar dynamo, and the plant is one of three sets constructed for the Howrah station of the Calcutta Electric Supply Company. The following figures, selected from the results of a test conducted by Messrs. Crompton under the superintendence of Mr. H. Stevenson, M.I.Mech.E., are interesting. Gas coke having a calorific value of 12,411 B.Th.U. per pound was used.

Total fuel consumed	488lb.
Total kilowatt-hours	368·4
Fuel per hour	81·33lb.
,, kilowatt-hour	1·325 b.
,, indicated horse-power hour	0·779 b.
,, brake horse-power hour	0·91lb.
Mechanical efficiency of engine	85·57 %
Thermal efficiencies—	
Electric energy at terminals / B.Th.U. in fuel	20·8 %
B.H.P. energy / B.Th.U. in fuel	22·71 %
I.H.P. energy / B.Th.U. in fuel	26·54 %
Heat efficiency of producer plant calculated from the known efficiency of the gas engine with a cold start	89·5 %

These figures clearly establish the heat economy of such a plant supplied with inferior fuel. With plants designed to use bituminous fuel a more extended process of scrubbing and washing is required to free the gas from tarry matter, and to avoid trouble by deposition on the valves and a dirty internal condition of the engine.

Messrs. Crossley call attention to the means by which they overcome the difficulty, common to suction producer plants, of variation of the quality of the gas when the engine is running at a varying load. It may happen that a period of heavy working is followed by an idle period, during which formation of steam in excess of that required at the moment occurs. This results in the production momentarily of very rich gas, followed by cooling of the fire and the generation of gas of a poorer quality. By the use of one or more cocks opening to atmosphere and communicating with the air space above the water in the saturator dish the temporary excess of steam is discharged, and does not interfere with the steady working of the producer.

(*To be continued.*)

RECENT PROGRESS IN ELECTRIC LIGHTING AS INDICATED BY THE OLYMPIA EXHIBITION.

BY FRANCIS H. DAVIES.

(*Continued from page 442.*)

The most startling lighting innovation of recent times is undoubtedly the mercury vapour arc, with its characteristic colour, exceptional diffusive qualities, and remarkable efficiency of from six to seven times that of the incandescent lamp. At Olympia it is, at the time of writing, represented solely by the Bastian mercury vapour lamp, for which Messrs. Rumney and Rumney are agents; but the Cooper Hewitt lamp, which figured so prominently at the Holborn and Paddington exhibitions, is expected shortly to make an appearance at the stand of the Electrical Power Storage Company. It is unnecessary to dwell upon the early history of the mercury vapour lamp and the difficulties which were met with in its development. It is only needful to point out that these difficulties have been overcome, and that the mercury vapour lamp nowadays is thoroughly practical, and represents in respect of efficiency the greatest advance which has been made in artificial lighting. At the present time it is suitable only for direct current. Work, however, is proceeding, and developments in the direction of a practical alternating-current lamp may be anticipated.

The colour of the mercury vapour light, due to the almost entire absence of red rays in its spectrum, is against it from the æsthetic and in some few cases also the utilitarian point of view. But the advantages it offers in efficiency and diffusion are substantial enough to outweigh this consideration in the majority of cases. Determined attempts have been made to overcome this colour difficulty, three methods having been employed. The first and most obvious is to mix with the mercury electrodes chemicals—notably cadmium—which give a yellow or red tinge to the light. Mr. Bastian has long experimented in this direction with very favourable results, and he anticipates shortly to produce a commercial lamp of this description. The second method—one much in evidence at Messrs. Rumney's stall—consists in combining with the vapour lamp in the same lantern a small incandescent lamp, which, being rich in red rays, tones down the actnic qualities of the pure mercury vapour light. This is termed the "Daylight" combination, and is most satisfactory. With a slightly opaque shade the effect is very similar to that of an arc lamp, the combination being at the same time more efficient, as it is stated to consume only ·7 watt per candle-power. Even better results are obtained by the use of a tantalum lamp with its high efficiency, the consumption then working out at ·5 watt per candle-power. The efficiency of the mercury vapour lamp is, of course, lowered by any such combination, but, as will be seen, not to an undue extent. The third method is based on the reflected light system, and is both simple and effective. Underneath the lamp is fixed a large reflector painted internally with rhodamine, a dye which possesses the peculiar property of transforming any light impinging on it into red light. The result is that the reflected light has a decidedly red tinge, the proportion of which may be varied to any desired extent by altering the size and disposition of the reflector.

It will be seen from the above that the colour improvement of the mercury vapour light is by no means an impossibility; rather, it is an accomplished fact, not only scientifically but commercially, which is perhaps the chief consideration. Mr. Bastian's exertions in this direction have been most persistent, and it is a pleasure to record that they have met with so much success. The mercury vapour lamp appears to be one of the best weapons wherewith to combat high-pressure gas for outdoor lighting, and any improvements in it should be accorded a hearty welcome by electrical engineers.

It may not be out of place to point out the difficulty which is met with in photometric work with mercury vapour lamps. Owing to the distinctive colour of the light, a photometric comparison with a known standard is of little value, and in this respect the vapour lamp is in the same position as the arc. Results obtained vary very largely with the distance at which they are taken, and bear no definite proportion, but it has been definitely ascertained that the mercury vapour light has by far the greatest penetration, particularly in fog, owing to its actinic nature.

While on the subject of mercury vapour lamps, the great progress made by the Cooper Hewitt lamp in all purposes appertaining to photography should be noted. These lamps are now adapted in special outfits to every branch of such work, and the economy they effect in current consumption over systems employing the arc lamp is as marked as the better quality of the work they produce. It is interesting to note that with the Cooper Hewitt lamp no condensers are required in the making of lantern slides or bromide enlargements, the interposition of an opal or ground glass between the negative and the lamp being sufficient. The diffusive nature of the light is, of course, of the greatest value in photographic work, and this, in conjunction with its other characteristic features, gives the Cooper Hewitt lamp a high place in the record of progress. The large area from which the light emanates in this lamp is responsible partly for the unusually good diffusion, which makes it

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specially suitable for the illumination of large open spaces with single lamps.

The tantalum lamp, which is shown at Messrs. Siemens's stall, is arousing much interest, as, despite its present limitations, it is a lamp full of promise. Tantalum, the metal of which the filament is made, has about the same electrical resistance as platinum, the same hardness as mild steel, and a tensile strength somewhat greater than the latter. It makes up into a strong filament, but softens with use, and becomes somewhat friable. Being a metal it is by no means strong when in a state of incandescence, and for this reason will not stand vibration and shocks which would leave the ordinary carbon-filament lamp unaffected. The resistance of tantalum wire being practically the same as that of platinum, a considerable length has to be disposed of in the lamp globe, and this has proved one of the chief difficulties in the construction of a commercial lamp. Many schemes have been tried, but the present one, which consists of looping the filament in a birdcage fashion over wire arms fixed in a central rod of glass, has proved the most satisfactory, and gives a good distribution of the light. According to Prof. W. Ambler, who has recently read a paper on the subject before the Ohio Electric Light Association, a filament for a 110-volt lamp of 22 c.p. requires a wire 65cm. long and 0·05mm. in diameter, having a weight of 0·022 of a grain.

The great advantage of the tantalum lamp lies in its extremely high efficiency. It takes only half the current of an ordinary carbon-filament lamp of the same voltage and candle-power; consuming at the beginning of its life about 1·7 to 1·93 watts per candle-power, as against 3·5 to 4 watts per candle-power, the usually accepted figures for a good incandescent lamp. Its present high price of 4s. is, therefore, not such a great disadvantage, as the economy of the lamp saves more than the difference in prime cost in a short time. From all accounts the life of the lamp is rather short, about 500 hours; but there appears to be very little authoritative information on this point, and in some places an average normal life of 1,000 hours is claimed. The falling off of candle-power with age is about the same as that of the carbon-filament lamp, but it is claimed for the tantalum lamp that it is entirely free from blackening of the globe, which is a very good feature. The great disadvantage at present lies in its unsuitability for circuits of over 125 volts. On the ordinary commercial 220 or 230 volt circuit two lamps have to be burnt in series, which, of course, means alteration of existing wiring, besides the other disadvantages attached to series running. In the case of new private plants these objections do not hold, and the lamp might be used in this field with advantage. There is every reason to anticipate a reduction in its price, since the present high amount is due chiefly to difficulties in manufacture which presumably will be overcome, and not so much to high cost of material. The behaviour of the lamp as regards variation of efficiency and candle power with voltage is shown in Fig. 2, which contrasts the performance of carbon-filament and tantalum lamps in these respects. It will be noted that the efficiency of the tantalum lamp varies only slightly with the voltage as compared with the carbon-filament, and that the candle-power also is not so much affected. The reason of this is that the resistance of the tantalum filament increases with heat, whereas that of the carbon filament decreases. This figure is based upon the curves given by Prof. W. Ambler in his paper above referred to.

The osmium lamp, which is being shown by the General Electric Company, has been brought to its present position, verging upon practicability, by Dr. Auer von Welsbach, of incandescent gas fame. Many difficulties have been encountered in the making of an osmium filament, owing to the extreme brittleness of the metal. An ingenious method has, however, been devised, whereby powdered osmium is mixed into a paste by the assistance of an organic binding material, and a filament produced by the forcing of this paste through a die. It then passes through various processes, and, finally, is sealed into an exhausted globe in the same manner as the carbon incandescent lamp. Difficulty was experienced in the early days in making a lamp capable of working at any commercial pressure, and the first osmium lamp to be produced was suitable only for a 37-volt circuit. This, however, has been improved upon, and 110-volt lamps are now made with a spiral filament of considerable length. Like the tantalum lamp, the resistance of the osmium filament increases with heat, and it is, therefore, less susceptible to voltage variations than the carbon lamp. An efficient life of 2,000 hours seems to have been frequently attained, and in some cases even 5,000 and 6,000 hours have been reached. Fig. 3 is self-explanatory, and gives a good idea of the effect of age upon the efficiency and candle-power of osmium lamps. The curves were plotted from results obtained at the Technologischen Gewerbe Museum of Vienna, where severa lamps were tested of the original 35 volt class; but it stated that the recent lamps of higher voltage show equally good characteristics. Although carbon-filament lamp makers have nothing to fear from either the tantalum or osmium lamps at present, it would be rash to conclude that

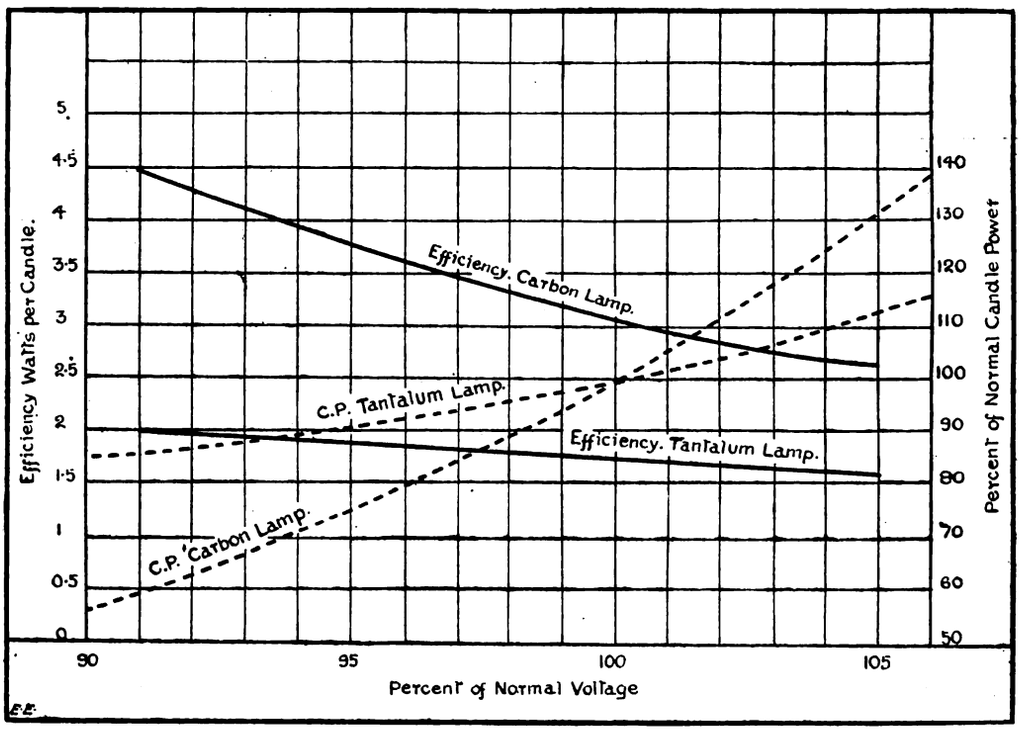

FIG. 2.—Curves showing comparative Variation of Candle-Power and Efficiency with Voltage. Carbon Filament and Tantalum Lamps.

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such will always be the case. It is conceivable that the difficulties with which they are hedged round will in time be conquered, and if one is prepared to go so far as to expect confidently that this will ultimately be the case, the only logical conclusion to draw is that the carbon-filament lamp in its present form is doomed.

The Nernst lamp, which is very much in evidence at the exhibition, has made steady progress in popularity, particularly in the last year or two. It has upon many occasions saved the situation where street-lighting has been in danger of a relapse to gas, and there is no doubt that for this, and, indeed, most illuminating purposes, it is a decided success. Its future, like that of the carbon-filament lamp, is bound up in the success or failure of lamps of the tantalum and osmium class, and perhaps the mercury vapour lamp; and very decided advances will have to be made in many directions if it is ultimately to compete with these lamps accentuated in value by improvements which may denude them of all their objectionable features. It is quite impossible and futile to predict what may happen in this direction, but there can be little doubt that developments will be made, and that these will probably take a somewhat startling form. A notable improvement of the Nernst lamp is the type called the "Express," as it gets over the difficulty of slow lighting up. It is fitted with two ordinary incandescent lamps at the sides which light immediately the switch is closed, being cut out automatically directly the glower has attained the necessary temperature.

The ordinary carbon-filament lamp appears to have progressed chiefly in the direction of cheapness, owing to improved methods of manufacture. Other advances have been made, but with the exception of such improvements as turn-down lamps, and devices such as the "linolite," they are not particularly noteworthy. The mechanical pump has almost entirely replaced the mercury pump for exhausting the globes, and the working exhibits of the Ediswan and Robertson Companies afford excellent examples of the improvements effected by its use. Small details of lamp manufacture are always varying, but on the whole there does not appear to have been anything startling in the way of progress during the last few years. Life and efficiency remain about the same, and the price seems to have reached a dead level. Several firms now make incandescent lamps which, instead of diffusing their light more or less equally in all quarters, throw it chiefly in the direction where it is most needed, and this certainly constitutes an improvement for many purposes.

The Linolite Company's exhibit is interesting, and affords an excellent opportunity for appraising the value of their

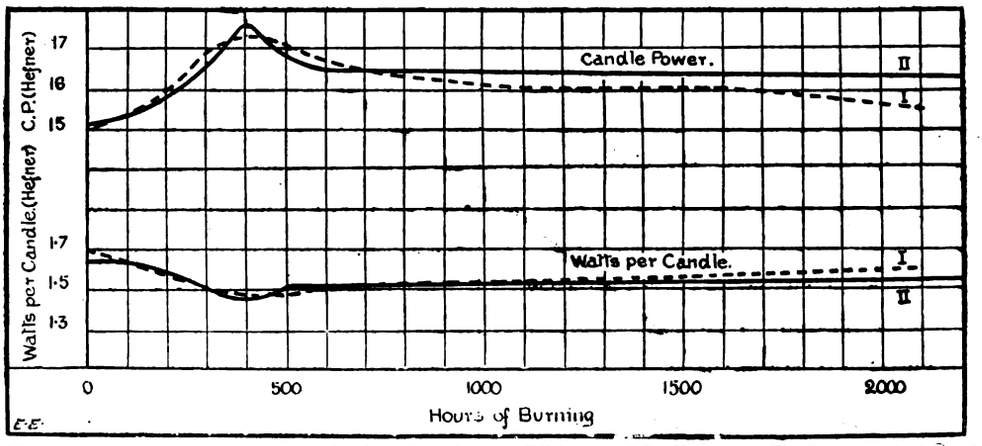

FIG. 3.—Tests of 16-c.p. (Hefner) 35-volt Osmium Lamps, showing effect of Age on Efficiency and Candle-Power. The Curves marked I. and II. represent the average behaviour of two batches. N.B.—One Hefner unit = ·877 of the British standard candle.

speciality. That this is considerable is obvious to any observer, and, if proof were wanted, it is at hand in the popularity which the system has attained for shop-window lighting. There is no question that for many purposes it is superior to the ordinary incandescent lamp, even when the latter is shaded by a reflector, since the diffusion of the light is better. The company are publishing some remarkable photometric tests, made at the Manchester Municipal School of Technology, which show that the efficiency of the Linolite system is extremely high as compared with that of the ordinary lamp. There is no doubt that the reflected light system comes the nearest to the ideal, and the Linolite Company's method is, indeed, a very good example of it.

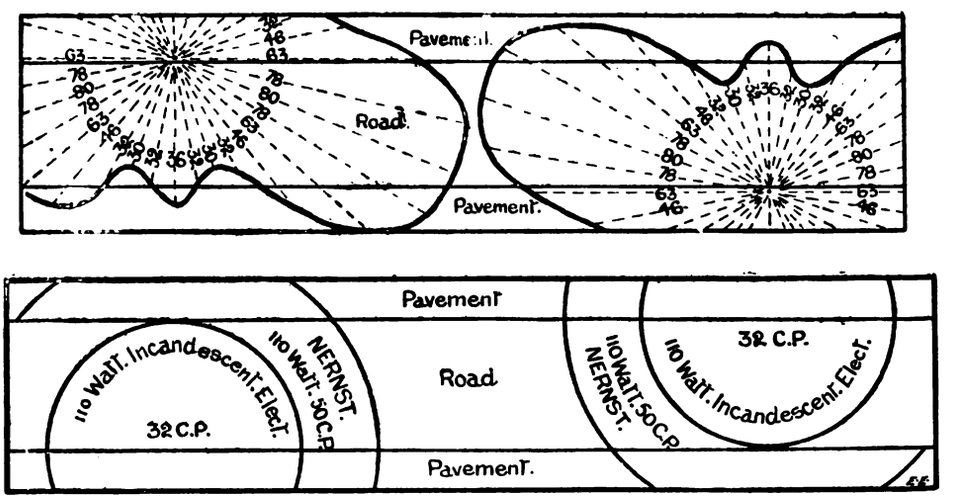

FIG. 4.—Diagram comparing the Lighting Effect produced by Street Lamps provided with good Reflectors and Plain Lamps.

Their manner of expressing the cost of lighting in terms of yards run of lamp per hour is singularly apt, and just the way to appeal to laymen. The figure given is 1d. per yard per hour with current at 6d. per unit.

Street-lighting by incandescent or small candle-power lamps is a subject which has received special attention by many firms, notably Messrs. Drake and Gorham and the Reason Manufacturing Company. Much progress is shown here, fittings of many descriptions having been devised with a view to making the most of the light and throwing it in the directions where it is most needed. It is well known that in street illumination by plain lamps much of the light is wasted—part being projected upwards, and so

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absolutely lost, and part falling on house fronts, where it is little needed, and to a great extent lost unless these happen to be white and reflective. To cope with this waste, reflectors are now commonly used, and if well designed and tended, they considerably improve the general effect by distributing the light in a proper manner. The results obtained with a good reflector and with a plain lamp are compared in Fig 4, which is based upon tests carried out by the Reason Manufacturing Company on one of their latest type of reflecting fittings. The upper diagram gives the light distribution in candle-power for two 16-c p. lamps and reflectors; the lower shows the results which are obtained when using Nernst or incandescent lamps absorbing the same energy but without reflectors. It will be noticed that the lighting effect is much better in the former case, being greatest in a direction parallel with the road, and least at right angles with it.

Although arc lighting generally was dealt with in the first section of this article, it may not be out of place to call attention here to the two large "Excello" arc lamps recently erected since the exhibition opened by the Union Electrical Company. These are probably the most powerful automatic arc lamps in existence, as the light they give is stated to amount to 20,000 mean hemispherical candle-power. The lamps require 25 amperes at 70 volts across the terminals, and they therefore possess the remarkably high efficiency of about 10 c.p. per watt. Direct current for these lamps is obtained from the Diesel oil-engine set.

In the foregoing survey of electric lighting progress as shown by the Olympia Exhibition it has been impossible, from considerations of space, to mention all and sundry of the improvements in lighting there on view. Not one, but many visits must be made to gain even a general idea of the advances which have taken place in the last few years. Engineers will, of course, be familiar with most of these, if not personally, at least through the columns of the Press.

The exhibition, however, affords an opportunity of seeing them actually in operation, which is far better than any amount of written description. It leaves one with the impression that the outlook for electric lighting is better than it ever has been, and the exhibition should prove a most useful object lesson to those in authority who have lately been considering the advisability of a retrograde step to gas for street-lighting. If such a step be taken, there can be no doubt that it will be regretted. Flame and midget arcs, the mercury vapour lamp with red rays, and the latest forms of incandescent lamp are comparatively new things, and some of them have scarcely issued from the experimental stage. All, however, are either more efficient or more suitable for street-lighting than the appliances we have been using so far, and it is only fair, and only common sense, that these and their possibilities should be carefully looked into before any decision—such as a relapse to gas—involving radical alterations and large expenditure is arrived at. That such a step, if taken, could only be temporary is every day becoming more apparent. Electrical men are alive to the necessity for improvement, and improvement there will be.

(To be continued.)

IMPERIAL NOTES.

AUCKLAND, NEW ZEALAND.

Auckland is the chief city in the provincial district of Auckland. It is situated on the southern shore of the Waitemata harbour, and adjoining it are the suburban boroughs of Grey Lynn, Parnell, and Newmarket, whilst on the opposite or northern side of the harbour are the boroughs of Birkenhead and Devonport, the means of communication being by ferry service. Auckland is most fortunately placed in having such a magnificent harbour opening upon the east coast, as well as a harbour at Onehunga, which opens on to the west coast. This latter port is but eight miles from Auckland, and is connected with it by both railway and electric tramway. The city was founded in 1840, and was the capital of the colony until 1864, when the seat of Government was removed to Wellington. The population of the city, together with its suburbs, is approximately 70,000.

Tramways.—Auckland was the first city in New Zealand to establish a system of electric tramways. A concession for a period of 32 years was granted to the Auckland Electric Tramways Company, Limited, by the City Council and by the councils of the adjoining suburban boroughs. This company was formed in 1899, and acquired the old horse tramways (about 10 miles of single track)

Permanent Way and Equipment.—The length of single track is about 30½ miles, laid along a street route of over 18 miles, and extends as far as Onehunga, the port for Auckland coastal steamers on the west coast. The gauge is 4ft. 8½in., and the tracks are laid 6ft. apart. The rails used are of the flanged girder type, and for the most part weigh 92lb. per yard, but for special work at curves the weight is 95lb. per yard, all in lengths of 37ft. The sharpest curve has a radius of 40ft., and the steepest grade, about nine chains in length, averages 1 in 8·8, although there are much longer grades of 1 in 11. The rails are laid upon concrete foundations 18in. wide by 9in. deep, the track between these concrete foundations being formed with 9in. of broken metal. The rails are protected on each side by a row of stone setts laid alternately header and stretcher. To this class of construction and to the treacherous nature of the earth foundations must be attributed the frequent and expensive lifting and relaying of the track, although the lines have only been open to traffic for so short a time. In Queen-street, the main street of the city, the tracks are paved with Neuchatel asphalt on a 6in. concrete foundation. The points used are 7ft. 5in. in length, curved, the facing points being connected and fitted with the usual spiral spring and lever arrangement. The tracks are well drained at frequent intervals by transverse culverts connected with the street gullies. In the greater part of the track iron centre poles are used, whilst at junctions and curves, and in some few districts, the method of supporting the trolley wire is by means of span-wire construction, and again, in some instances, side poles and bracket arms have been adopted. In the outlying districts the poles are of Totara timber. The trolley wire is No. 00 B S G. Here, as in the case of Wellington, considerable expense has been incurred in raising the telephone and telegraph wires, which are all overhead. In the central part of the city the feeder cables are laid in underground conduits of earthenware, and outside, and as far as possible, these feeders are carried overhead on cross bars attached to the poles, and are of bare copper wire No. 4/0 B S.G. The trolley wires are divided into half-mile sections by the usual boxes.

Power Station.—The power station is situated near to Queen-street and to the harbour. It is built in two levels, the engine-room, 104ft. by 53ft., being on the higher level, and the boiler-house, of the same dimensions, on the lower level. The building is erected in brickwork with steel framing. In the engine-room there are three engines of the horizontal, cross-compound, Corliss type, each of 475 i.h.p. with normal load and 700 i.h.p. with maximum load, running 100 revolutions, with 150lb. steam pressure. The maximum steam consumption at full load working with condenser is 14½lb. per indicated horse-power per hour. There are three 300-kw. continuous-current generators capable of a 50 per cent. overload, one 25-kw. generator, and four boosters, and recently an additional 600-kw. generator has been installed. The switchboard consists of 17 panels of marble, and there is a 20-ton travelling crane. In the boiler-house there are four Babcock and Wilcox water-tube boilers, each with over 2,000 super feet of heating surface, and fitted with chain-grate stokers. The economiser is one of Green's, the scrapers of which, as well as the feed pumps, are worked electrically. In addition there are the usual injectors, filters, hot-well, piping, etc. The chimney stack is of steel (lined for one-third of its height), 125ft. high and 7ft. diameter. The condensing water is obtained from the harbour, some considerable distance away, by means of two electrically-driven centrifugal pumps, each capable of delivering 500 gallons per minute. The two surface condensers are capable of condensing 35,000lb. of steam per hour, and these, together

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with the air-pumps, are placed in the basement part of the engine-room.

Car-Sheds.—There are two car-sheds—one at Ponsonby and the other at Alexandra Park at Epsom. The former is the principal depôt and contains all the repairing shops, etc. This shed is constructed in two divisions, each 39ft. wide by 354ft. and 328ft. long. There are six track lines with inspection pits under. There are also the usual machine, blacksmiths', painters', and erecting shops, stores, etc., fitted with overhead traveller, lathes, drilling machines, and other necessary tools and appliances.

Rolling-Stock.—The rolling-stock of the company consists of 55 cars of various designs, including double-deck bogie cars to seat 80 passengers, with four motors; single-deck bogie cars to seat 48 passengers, with two motors (these cars are of the combination type, with open ends and closed centres); single-deck four-wheel cars to seat 32 passengers, with two motors (these cars are divided into two compartments). The seating of these cars cannot be regarded as comfortable, an effort having been made to accommodate as many passengers as possible at the expense of passage room. The wheel base of the bogies is 4ft 6in. and of the single-truck cars 6ft. 6in., and the motors are 40 b.h.p. Owing to the severe grades the cars are fitted not only with the hand brake and electrical emergency brake, but also with a slipper brake on each truck. The cars are fitted with guards at each end, which drop automatically when they come into contact with any resistance. The cars commenced running on the section of the system first opened in November, 1902, and at the last annual meeting of the company it was reported that the traffic receipts for the year had been £110,573, and that over 18 million passengers had been carried in that period, or equal to 250 times the population served. The greatest number carried in any one day was 98 023. The net profits for the year amounted to £26,275, and a dividend of 6 per cent. on the share capital has been paid.

Destructor.—The Corporation have recently completed a refuse destructor at a total cost, exclusive of land, of £16 000. This is one of Messrs. Meldrum's Simplex type, and the contract was carried out by their Sydney agents, Messrs. J. Barre Johnston and Co. It is intended to utilise the power derived from the destructor in the generation of electricity.

Christchurch, New Zealand.

In reference to our note about Christchurch in last week's issue it should have been added that the gasworks are in the hands of a private company, the price charged per 1,000 cubic feet of gas being 6s. 3d. net. The City Council have set up a committee to consider the advisability of purchasing the company's property. The paid-up capital is placed at £120,000, and the present market value of the shares at £225,000.

Wellington, New Zealand.

Similarly, it might have been added in regard to Wellington that the gasworks there are also company owned. The Council promoted a Bill in the last session of Parliament for the acquisition of these works, the value to be fixed by arbitration. The Bill was, however, not reached. To ordinary consumers the net price of gas is 5s. 10d. per 1,000 cubic feet.

A Complaint from Canada.

Electrical machinery of English manufacture seems to have gained ill-repute in some quarters through causes which are not far to seek. It is a thousand pities, since pronounced failures, although they may be confined to a particular type of machine, are apt to reflect unfavourably on the source of supply as a whole. Following is a case in point. A correspondent writes to us from a town, which shall be nameless, in the province of Ontario, Canada, that electrical machinery sent out there from this side has not always been to the credit of English manufacturers. A number of English machines which have been placed in the district during the last two years have given very poor satisfaction, being too light of build, and not possessing, it is claimed, the staying power of Canadian machines, such as are supplied by the Canadian General Electric Company, Peterborough; the Westinghouse Electric Company, Hamilton; and the Bullock Manufacturing Company, Montreal.

From his own observations our correspondent concludes that the English manufacturer not only builds a much lighter machine, but sells it at a lower price than his Canadian competitor, and while the English machine compares favourably in regard to electrical efficiency with that of Canadian make, when it comes to continuous wear the former has relatively little staying power and breaks down—then begins the repair bill. As a typical instance he mentions the case of a 1,000-kw. English machine installed three miles distant from his own plant, which latter is a 1,500-kw. Canadian General Electric machine. Both machines are now running in their third year. The Canadian-built machine, although carrying a heavy load continuously, has never cost a cent for repairs or caused a single stoppage, whereas the English machine has burnt out more coils than it originally had, and has been almost constantly under repair, the coils for replacements having, in addition, to be sent out from England. In another case, where a contract was secured by an English firm for a 400-kw. machine, the price was 3,000dol. less than the Canadian manufacturers quoted. Moreover, the English machine was nearly 3,000lb. less in weight than the Canadian, and, while it has been in use but a year, has already burnt out several coils.

Our correspondent says he could give other instances of a similar nature, and further contrasts this state of things with his experience of operating over 1,000 kw. in electrical motors of Canadian manufacture during the same time without having had a single burn-out, notwithstanding that the age of some of the motors is over eight years. They are all of the alternating-current induction type. Now it is evident that this correspondent has a very poor opinion of English-made electrical machinery, and not, apparently, without reason, for there is nothing impossible in the experience recounted above. It is only rough that electrical plant of English origin should be thus condemned wholesale as the result of the failure, presumably, of a type which is no longer in vogue even here. For without seeking further details it is easy to designate the type of machine which has caused this complaint. There was a time not far past when a tendency existed to make every consideration in the design of alternate-current generators secondary to that of electrical efficiency, and the ease of replacing armature coils. It amounted almost to a craze with some inventors, and extremes of efficiency were obtained at the expense of mechanical rigidity, the greater importance of reliability being lost sight of. Then came the reaction and inductor alternators without moving coils, which found many advocates—machines which possessed the maximum possible staying power, but were of comparatively low electrical efficiency. The final outcome is a compromise between the two types, combining good electrical qualities with mechanical stability sufficient for all requirements. Modern electrical plant of English manufacture need fear no comparison with Canadian or any other productions, either in respect of electrical or mechanical design.

Our friend's conclusion that English machines are generally of too light construction is obviously wrong, and can be based only on exceptional experience. The description was true of a certain type which is no longer in vogue, but does not apply to-day.

FORTHCOMING EVENTS.

Monday, Oct. 9.

Lancashire Electric Power Company.—At 1 p.m., opening of the Radcliffe power station by the Earl of Derby.

Wednesday, Oct. 11.

Dynamicables.—At 7 p.m., dinner at the Electrical Exhibition, Olympia.

Thursday, Oct. 12.

Institute of Sanitary Engineers.—Visit to Lots-road generating station.

Institution of Civil Engineers.—Nov. 7, at 8 p.m., inaugural address by Sir Alexander Binnie and presentation of awards.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EDUCATIONAL.

Our reviewer on another page calls attention to the strong opinion of Prof. R. H. Smith upon an educational question expressed in his recently issued book on "Electric Traction," and admirably exemplified in his treatment of the subject. Prof. Smith's view is that "constructional principles and details" form only one moiety of technical education, and that "commercial results and economic conditions" form the other moiety. As we understand the view, it recommends teachers and books to combine the constructional and commercial. We agree with our reviewer that the combination will not commend itself generally. Of course, the economical moiety is of more importance to one class of men than the constructional, and *vice versâ*. The value of a knowledge of the laws of economics, like a knowledge of history, or geography, or language, is of great importance not only to technical students, but to all business men, and so convinced is the present writer of this that some forty years ago he prevailed upon the late Prof. Thorold Rogers to discourse upon the best methods to be pursued in getting the subject taught generally in our schools. We believe the lack of knowledge relating to economics is the cause of much or most of the misery and unemployment in the world. The late H. T. Buckle, in his "History of Civilisation," states truly and concisely the law relating to wealth. On p. 195, *et seq*, vol. i., of his history he discusses the work of Adam Smith and free trade. The latter we are not discussing here and now, but may say we entirely agree with Adam Smith, with Buckle, also with Chamberlain, and imagine there is no difficulty in reconciling the positions of these three giants. What, however, we desire to call attention to is the following (pp 197-8, vol. i., of Buckle): "But when it was once clearly understood that gold and silver are not wealth, but are merely the representatives of wealth; when men began to see *that wealth itself solely consists of the value which skill and labour can add to the raw material* [the italics are ours], and that money is of no possible use to a nation except to measure or circulate their riches," etc. So far as the majority of technical students are concerned, the law "that wealth itself solely consists of the value which skill and labour can add to the raw material" is all they can need. The economics that lead to success in business are of a distinctly different calibre, and should be thoroughly known to those responsible in commercial transactions. Skill and labour both have quantitative values — the more skill and the more labour the better the result. Labour unskilled has little or nothing to do with technical education, but skilled labour is in a different position. Technical education tries to show how labour can be used to the best advantage, and how skill and experience may lead to improvements. Of course, economics underlie all this, but it is not necessary for a student to trouble himself about the economics of commerce to use his skill and his labour to the best advantage. If Buckle's interpretation of Adam Smith's teaching is correct, what a degenerate age is the present, when labour, skilled or unskilled, thinks that a minimum rather than a maximum is worth striving for, and that minimising labour of the individual is the way to give labour to more individuals. A more incorrect view of the realities of the case could not be suggested. Confining the view to labour, the proper position for the wealth of the individual and of the community is to be found when each individual produces to the best advantage during his working years. Just in the same way, the greater the individual skill and the better its application, the greater the benefit to individual

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and community. Skill and the best methods to apply it is the work of our technical schools—or, rather, they should give the training which will be best adapted in practice to obtain a maximum result from the individual.

THE DYNAMICABLES.

In olden days, when exhibitions came thick as autumn leaves in Vallombrosa, the Dynamicables were always well to the fore, and did their level best to assist in the success of the show. We are glad to find that the present committee has risen to the occasion, and is engineering a dinner to be held at Olympia on Wednesday next, the 11th inst., at seven o'clock. It is pretty generally known that the society is limited to a hundred and one members, but each member can invite as many guests as he likes, and dining accommodation will be found by Messrs. Lyons and Co., who catered for the society at the Trocadero. We trust that members will make a great effort to attend and introduce as many guests as possible, in order to show appreciation of the excellent electrical exhibition now open, and to encourage promoters and exhibitors, who in these days require all the encouragement they can get.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ALL-STEEL RAILWAY CAR.

SIR,—All-steel railway carriages are no novelty, as they were tried over 50 years ago in England with disastrous results. The carriage constructors at that time had as extravagant hopes as the Brush Company now have, but railway passengers avoided the cars as they would a pestilence. The extreme sensibility of steel to heat and cold makes it an undesirable material for anything in railway-carriage construction save the framework, and the discomfort and awful feeling of shivering and cold which a winter journey in the all-steel carriages produced was quite sufficient to soon cause passengers to hate the cars. Comfort in every sense is the main thing that attracts passengers, and no material for car finishing affords this in so high a degree as wood does, because wood neither attracts nor retains heat or cold as steel does, and non-inflammable wood is even less conductive than ordinary wood.

I am afraid that the Brush Company and the new tube companies are making a costly error in adopting for car interiors a material which will chill passengers to the marrow in winter and give them an unwanted Turkish bath in summer, and that the doctors and undertakers will reap far bigger profits than the owners of the cars are ever likely to see.—Yours, etc., EXPERIENCE.

FEED WATER.

SIR,—In a supplement to the *Electrical Engineer* of Jan. 31, 1902, an article upon "Boilers and Water Supply," by F. G. Ansell, is written, and a part of the paper reads: "The effect of any such water upon a boiler may be ascertained by merely plunging a clean knife blade into the suspected sample and leaving it there for a few hours. If the knife blade has been attacked in the least, the polished surface will easily show it, *and that water should not be allowed to enter a steam boiler* until it has been properly treated to render it alkaline." This effect we get from our condensed steam. What is the remedy? Can F. G. Ansell or any reader tell us?—Yours, etc.,

JAMES CONWAY, S. T. and M. E T. Co.

Stockton-on-Tees, Oct. 3, 1905.

Derby.—The Town Council have accepted the tender of Milnes, Voss, and Co., Birkenhead, at £3,745, for the supply of six cars, with top covers; and that of W. Walkerdine, at £2,298. 12s. 3d., for the extension of the car-sheds and the provision of a shed for sand drying.

WIRELESS TELEGRAPHY.

BY W. DUDDELL, M I E E.

A course of popular lectures on the uses of electricity is being given under the auspices of the Institution of Electrical Engineers at Olympia in connection with the Electrical Exhibition. The following is a condensation of a lecture on wireless telegraphy—the first of the course—which was delivered on Friday evening last, Sept. 29, by Mr. W. Duddell, M I E E.

The subject on which I am going to address you to-night is wireless telegraphy It is called wireless telegraphy, perhaps, rather inappropriately, because in actual use a great deal of wire is employed in this form of telegraphy; nevertheless, the term has been adopted for telegraphing between two stations which are not connected by ordinary wires—that is, wires on poles, like the ordinary telegraph wires that you so well know Wireless telegraphy is really of great antiquity Probably some of our earliest forefathers used wireless telegraphy, for there is not much doubt that they signalled to one another, if they were at a distance, by using their hands or other things, and had no wires to connect the two places between which they signalled. In fact, if the ordinary method of signalling had been this wireless telegraphy that I am going to demonstrate to you to-night, and anybody had come forward, as they did early last century, and invented telegraphing with wires, nobody would have thought it very wonderful, whereas, owing to the advance made during the last century in telegraphing with wires, we have become so accustomed to every message we send travelling that way that it is looked upon as something strange if we say we shall signal from here to York without any wire.

The very earliest systems in use for signalling without wires were systems which employed the leakage of an electric current through the earth and also the magnetic effect of an electric current. I am going to show you presently some of these effects experimentally, and as I know some of my audience here are technical men, I shall use technical terms in the course of the lecture, but as there are many who are not technical men, I shall have to enter a great deal into details in order to explain the operation of this form of signalling. Well, as I said, the earliest forms of signalling were carried out by means of currents. If you put an electric current into one place in the earth and take it out at another, the current will flow in a straight line between these two places, but at the same time it will extend in all directions, and if a suitable apparatus is connected between two points in the earth you can pick up these signals. When an electric current passes through a wire, there extends round that wire what has been called the magnetic field. That fact, by use of suitable sensitive apparatus, has been utilised for signalling between very far distant stations.

In the early days Sir William Preece, then engineer-in-chief to the Post Office, took up this method of signalling, and he developed it with the assistance of his staff very considerably, and successful communication was carried out at, I believe, a distance of seven or eight miles. This method of signalling has been overshadowed of late years by a method which has been largely brought to the front by Mr Marconi, and although signalling by means of leakage currents or magnetic induction is still in practical use at a few places, it has been largely overlooked by the public in view of the greater distances and the greater apparent wonder of signalling by means of Hertzian waves, and, therefore, I shall make no apology to you to-night for devoting the major part of my time to considering the method of signalling by means of Hertzian waves. I have already shown you, by means of a simple needle, that when an electric current flows through a wire it exerts a force outside the wire. This action has very much occupied the attention of scientists during the last century, and even before that, for you have here a wire carrying an electric current, and it is capable of exerting a force and doing something at a distance. What is there between the wire and that something which enables the current through this wire to do the something away from the wire at a distance? Scientists, in order to explain this, have assumed that all the space around the

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earth and around all bodies is filled with an all-pervading substance which they call ether, and that it is this ether which enables the current to create the force and turn the needles at a distance. If I charge any body with electricity, it also is capable of exerting a force. This is known as electrostatic force, and that produced by a current or a magnet is magnetic force.

Having mentioned these primitive details, I will now refer to the work of Prof. Clerk Maxwell. Prof. Clerk Maxwell, considering these magnetic electric forces produced in this body called the ether, which the scientists have assumed surrounds the earth and pervades all bodies, came to the conclusion from mathematical reasoning that if you could produce an electric force which was not constant, but by breaking you could make it alternate sufficiently frequently, then there would be produced in this ether a sort of wave which would have all the properties of light In fact, he gave a complete explanation of all the phenomena of light based entirely on considerations of these electric and magnetic forces. This early work of Prof. Clerk Maxwell was verified experimentally by Heinrich Hertz, who demonstrated all the properties of these electric waves, and actually showed that you could perform with these waves all the ordinary experiments that can be performed with light, such as reflection, as a beam of light is reflected with a mirror; that you could concentrate them with lenses, and that you could measure their velocity in travelling from one place to another. He also showed that they travel with identically the same velocity as light. In fact, the only difference between the waves in the ether or the Hertzian waves and the waves made by light in the ordinary way was that the Hertzian waves were many thousand times longer than the waves of light.

Now, Hertz for his early experiments had not available a very sensitive means of using these waves and recording them. He employed a ring of metal with a little joint in it, such as a piece of wire with the two ends almost touching, and he said if the waves came past that loop of wire there would be a tiny spark between the ends. This method was not at all a sensitive method of observing the waves; nevertheless, it was used by Hertz.

At a later date Mr. Branly discovered a new phenomenon which has enabled wireless telegraphy to be carried out at enormous distances. This phenomenon is that if you take any two pieces of metal which touch one another lightly, should a wave come in the direction of these metals a curious effect will be observed For instance, supposing I take two pieces of wire—this is the original experiment as carried out by Hertz—two pieces of ordinary copper wire which have been made somewhat dirty and let them rest against one another, and then connect to them an ordinary electric bell and a battery, that electric bell will not ring, because, if the wires are dirty and touch one another lightly, they will not make what is called a good contact. Now, the primary discovery was that if electric waves fall on a joint of that sort the bell will ring. So that if I can generate an electric wave and get a delicate contact of two wires touching one another lightly, when the waves fall on that contact it will cause the bell to ring. That is the fundamental experiment of wireless telegraphy—the use of two pieces of metal which are not touching sufficiently well to allow the current to flow through them, but which directly you generate any waves will at once send an electric current through them. This experiment is very delicate to carry out, as the least vibration when the two wires are touching will cause them to touch sufficiently firmly to send the current through to ring the bell. In this experiment, as shown by Prof. Lodge at the Royal Institution in 1894, Prof. Lodge succeeded, I believe, in so arranging his apparatus that, when the bell rang, its own vibration was sufficient to stop it ringing again. And then when he sent a second spark the bell again rang, and after a few moments stopped itself. I shall not attempt to perform the experiment to-night of making the bell shake the contact, because in a building like this where there is so much vibration going on it is almost impossible to carry it out successfully. But that experiment was really the fundamental one in the early method of detecting electric waves. Prof. Branly also experimented as to what would happen if he tried to send an electric current through a tube containing metal powder or filings. He found that should an electric wave fall on the tube it would at once render the powder conductive, and you would be able to send an electric current through them.

Before proceeding any further with the modern side of the apparatus, I should like to refer to the early predictions of how you could produce an electric wave. Prof. FitzGerald, in describing the work of Prof. Clerk Maxwell, said that if you could by any means produce a spark between the outside and the inside of a Leyden jar, that ought to produce an electric or, as it is now known, a Hertzian wave. In order, therefore, to produce a wave, firstly, we need a jar or bottle which can be charged with a large quantity of electricity, and we need two knobs, or some other means, by which a spark can pass in order to let the electricity inside the jar flow to the outside coat of the jar. But when the electricity from the inside flows outside, it will flow a little too far—that is to say, a little more will flow out than ought to, and it will swing backwards and forwards between the inside and outside of the jar, and will thus produce a current which will oscillate—that is to say, it will first flow in one direction and then in the other alternately, and it will do this with extreme rapidity. It is quite easy to arrange a jar with wires connected with the outside and the inside in which the electricity will flow first in one direction and then in the other many millions of times in one second. If we can produce this current flowing from the outside to the inside and back again many millions of times in one second, we produce around the wire an electric force first in one direction and then in the other, and we also produce a static force. These are exactly the conditions that Clerk Maxwell set down mathematically as necessary to start an electrical wave in space, or what is known as a Hertzian wave.

I should like to refer to a most remarkable article by Sir William Crookes which appeared in the *Fortnightly Review* in 1892 In this article Sir William Crookes predicted that it would be quite possible to communicate from one place to another by means of electric waves without any wires between the two places, and he predicted that it might become the most important method of telegraphing In 1894 Sir Oliver Lodge gave his well-known lecture at the Royal Institution, at which he showed all Hertz's experiments and a few others. In 1896 Signor Marconi, an Italian engineer, came to this country with an apparatus for signalling at a distance. He took that apparatus to the Post Office. The Post Office officials, and Sir William Preece in particular, were very much impressed with the necessity of being able to signal to a distance without having to lay wires, because they had had great difficulty in putting wires from the stations round the coast to the lightships. It was, therefore, very necessary to be able to communicate with the lightships without using cables. Sir William Preece had been working for many years trying to devise a system to overcome this difficulty, but not with complete success, owing to the conductivity of the sea-water and its effect on the magnetic conductor that was then used. The Post Office, therefore, took up and experimented with Signor Marconi's invention, and in 1897 Sir William Preece gave a lecture in which he described the results which had been obtained. These results were looked upon with a great deal of interest, and the Press took up the matter and wrote leading articles on it from day to day. And from that time to the present the developments have gone on steadily, until from signalling over a distance of two or three miles, as was the case in 1897, Signor Marconi has now succeeded in signalling to America, which is 3,000 miles.

I now propose to show you some of the more modern developments of wireless telegraphy, starting with the original form of apparatus for producing electric waves. In the early days it was proposed to use a Leyden jar to produce the electric waves, but they may be produced by any two bodies that can be charged, and I have here a piece of apparatus which has been lent me by the courtesy of the Post Office, and which is of great historical interest, although it is only about eight or nine years old. In fact, this is the actual oscillator which was used in the early experiments

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of Signor Marconi when he was working at the Post Office. In order to greatly increase the distance at which signals can be given, it has been found necessary to improve all the apparatus piece by piece. In this work a large number of experimenters have been engaged, and they have succeeded in constructing a great variety of apparatus for producing electric waves, for conducting them and for measuring their length and intensity, and it is largely due to the development of different parts of the apparatus that they have succeeded in telegraphing over such great distances.

One of the first developments in order to produce greater sensibility in the receiving apparatus was the reduction in size of what is called the coherer. Removing the air from the tube and the great reduction in size has resulted in producing a coherer which is extremely sensitive. If you want to signal over great distances you have to collect the electric oscillations, and therefore it is necessary to employ some form of wire to the coherer which will be acted upon by the electric waves, and which will have produced in it an E.M.F. that has a pressure of electricity, and that will cause the coherer to become conductive. For this purpose Signor Marconi connected to the terminals of the coherer a horizontal wire stuck out at each end, which helped to collect the electrical waves. In later experiments he found it much better to connect a vertical wire to one terminal of the coherer, and to connect the other terminal to the earth or to a plate fixed in the earth.

For ordinary telegraphy you want a permanent record. Now, when you come to deal with very sensitive coherers, you cannot put a large current of electricity through them It is therefore necessary to arrange a second circuit, so that the coherer has a small current through it, which can be turned on and off with an ordinary switch which works a bell or a printing apparatus. This switch is technically called a relay. I have a relay here made by Mr. Sullivan, and he tells me that he is able to make a relay which will work with about $\frac{1}{300000}$ part of an ampere. It is necessary to have an apparatus of that sort to print signals. Before showing you actual apparatus in operation, I wish to show you some diagrams of how the wires are usually arranged for producing electrical waves.

The lecturer then illustrated his remarks by a number of experiments, diagrams, and lantern slides, including portraits of Marconi and Hertz, and gave some technical details of the functions and operations of the different parts of the apparatus used in wireless telegraphy. He also described the various kinds of transmitters and receivers used by the different wireless telegraphy companies, and exhibited apparatus lent him by the Lodge-Muirhead Company, by Mr. Sullivan, Mr. G. S Brown, and Mr. Bowron, as well as that lent by the Post Office. The lecturer concluded by describing some of the tests carried out by Mr. J. E. Taylor and himself, under the superintendence of Mr. Gavey, engineer-in-chief to the Post Office, between Howth in Ireland and the cable ship "Monarch," during which tests actual measurements were made not only of the current in the vertical wire at the transmitting station, but also of the very minute currents in the receiving wire. These tests established the relations existing between the strength of the received signal, as well as the distance and the height of the vertical wire and its resistance. He believed that these results would prove of great practical value in designing stations for wireless telegraphy.

CABLES FOR ELECTRIC DISTRIBUTION.

(Specially Contributed.)

The Electrical Exhibition at Olympia affords a good opportunity for reviewing the present practice of cable manufacture and of systems for the distribution of electrical energy. The last electrical exhibition at the Crystal Palace, held in 1892, came at a time when there was a great deal of uncertainty as to the best means of insulating street mains. The use of indiarubber had already been proved unsatisfactory, but it was then still being employed by many engineers. A perusal of Mr. Hamilton Kilgour's book on electrical distribution and the descriptions in it of the systems existing in 1892 is interesting, as showing what was then being done. Thus it is to be noticed that a large variety of street mains with bare copper conductors and porcelain and air insulation were introduced. These have not survived to any considerable extent owing to various causes The space required was considerable, and the systems were hardly practicable enough to meet the conditions which exist under the pavements in a busy town. Of insulated cables the book gives several descriptions, amongst which is one of the original paper-insulated mains used by Mr Ferranti for high-voltage transmission between Deptford and London. These mains may be looked upon as the parents of the paper-insulated cables now so universally employed. Practically every cablemaker exhibiting at Olympia uses paper insulation for their high-tension conductors. The cables vary amongst themselves as to the quality and class of materials employed in manufacture of the paper and in the impregnation of the same. They are all, however, the outcome of Mr. Ferranti's pioneering work at Deptford. The use of this insulation has necessitated lead sheathing, and quite a large portion of distribution cables used to-day are also armoured and then laid direct in the ground.

The type of main laying which has not been altered during the past 13 years is the Callender's solid system. Thus the following is a verbatim extract from p. 352 of the above book, which our readers will see would do as a specification of the same system to-day: "In the Callender solid system of underground electric mains the

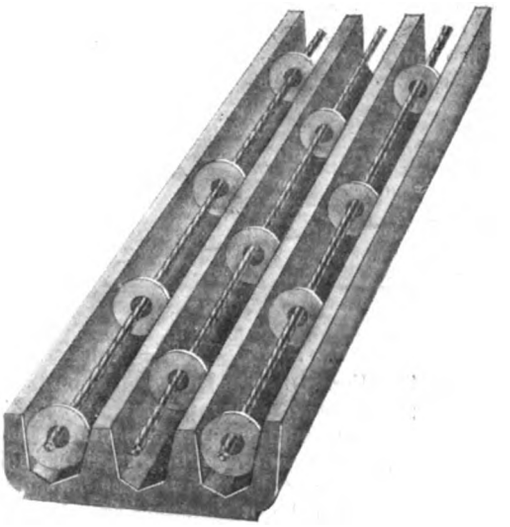

FIG. 1.—"Imperishable" System. Trough showing Conductor in position ready for filling

cables, heavily insulated, are laid in suitable troughs, generally of cast iron, placed in trenches under the street, and the whole of the vacant space in the trough round the cables is run in solid with refined bitumen. All the bitumen employed is genuine natural Trinidad bitumen, free from any admixture of gas, tar, and pitch. The whole forms a solid and compact mass, into which neither gas nor water can possibly penetrate, and which itself forms a very high electrical insulation. There are few substances more durable than this bitumen, and with cables thus embedded there is little probability of any deterioration taking place in mains when once laid, while thorough mechanical protection which is ensured reduces to a minimum the liability of injury from exterior causes. Mains laid on this plan are permanent, and form a sound engineering job. It is, of course, clear that such mains should only be laid when the conditions do not require that the capacity of the cables should be afterwards altered."

Another old idea which, while not successful at the time, is now being revived, is that of Mr. T. Tomlinson's, a description of which may be found on p. 274 of the above-mentioned book. His idea was to construct a concrete trough under the street and to introduce into it bare copper tubes. These were then to be filled up solid with a special composition of asphalt, which was to afford the necessary insulation. The idea of using a tube was to allow of the section of the conductor being increased, as more copper could be drawn in as required. Two firms

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are showing at Olympia systems similar to this as far as insulation is concerned. The first of these is the Simplified Underground Conductor Company, Limited, who on Stand 107A show a variety of troughings into which bare copper mains can be laid and filled in solid with their special composition.

Another type of system on the same general principle is that known as the imperishable system, exhibited by Messrs. Alexander Duckham and Co. In this, as illustrated in Fig. 1, the troughings are made of reinforced concrete, with a separate way for each main. They are supported on porcelain insulators, and run in solid with a special box compound.

(To be continued.)

THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.

BY ALFRED STILL, M.I.E.E., A.M.I.C.E.

(Continued from page 454.)

Rise of Pressure at the Distant End of a Long Transmission Line.—A slight modification of the diagram (Fig. 9) will clearly show the well-known effect of a *rise* of pressure occurring at the far end of a line *when the load is very small* provided also that *both self-induction and capacity are present*. We shall still suppose the arrangement to be as shown in Fig. 8, with the one exception that the transformer and load at the receiving end are entirely disconnected. We shall also suppose the capacity and self-induction to be greater than in the previous example, so as to magnify the effect.

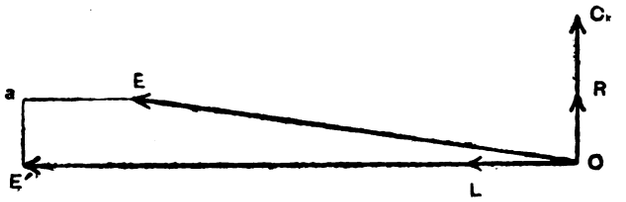

FIG. 10.

Draw O E' in Fig. 10 to represent the pressure at the distant end; then O C_k (at right angles to O E'—in the forward direction—and equal to $2\pi n$ K E') is the capacity current which, under the condition of open circuit at distant end, is also the total current flowing in the wires. We now proceed with the construction exactly as in Fig. 9, making E' *a* (in phase with the current) equal to $C_k \times 2r$, and *a* E (at right angles to the current) equal to $2\pi n \times C_k \times 2$ L. The vector O E, which, it will be seen, is *smaller* than O E', is the necessary pressure at generating end. It will be noted that, if self-induction were absent, the pressure at generating end would be O *a*, which is practically equal in length to O E'; but, since the E.M.F. of self-induction, O L (for this particular state of things) is *in phase with* E' it stands to reason that the necessary pressure at generating end will be *reduced* accordingly.

Rises of pressure at the end of long underground feeders are by no means uncommon, and they may also occur on long-distance overhead lines. Indeed, a rise of 8 per cent. has been observed on a 40-mile 25,000-volt line when the circuit was open at the distant end. It should be mentioned that the pressure rises due to the combined effects of capacity and self-induction are often greater in practice than would be indicated by the construction of a diagram such as Fig. 10. But this diagram is based on the assumption of the E.M.F. wave being a sine curve, and the abnormal effects sometimes met with in practice are almost invariably due to peaked or irregular wave forms. These may lead to enormously increased capacity effects, which, unfortunately, cannot be predetermined with any degree of accuracy. The writer does not see that there can be any insurmountable difficulties in the way of designing alternators to give E.M.F. waves approximating to sine curves; careful attention to the arrangement and shape of the pole-pieces should lead to the desired results. That such a wave form is desirable in nearly all cases there can be little doubt, yet few manufacturers of alternating-current generators appear to have given special consideration to the matter. The essential point to bear in mind is not that the wave should exactly coincide with the theoretical sine curve, but that, *especially on open circuit*, it should be free from ripples or peaks.

With regard to *electrical resonance*, this is generally supposed to be responsible for nearly all unlooked for and, at first sight, unaccountable capacity troubles; but exactly what they mean by resonance, few, if any, electrical engineers are able to explain. There are, no doubt, certain scientists and mathematicians who have a clear understanding of the causes which lead to resonance effects, but they have not yet succeeded in expressing these ideas in popular language. The writer prefers, if possible, to avoid any reference to electrical resonance, because of the indefinite if not erroneous ideas which the expression suggests. It would, however, seem as if every transmission line had a certain natural period of wave oscillation, with the result that, when the periodicity of the supply synchronises with it, abnormal pressure rises may occur. This synchronism might occur not only with a definite alternator speed, but also through ripples or irregularities in the wave form; and this is an additional reason why machines giving sine curve waves under all conditions of load would seem to be the ideal generators for the purpose of power transmission.

TRANSMISSION BY TWO-PHASE ALTERNATING CURRENTS.

Let us first assume, as when dealing with single-phase transmission, that not only the load at the distant end, but also the transmission line are without self-induction or capacity. If we run four conductors as in Fig. 11, keeping the two phases entirely separate, the arrangement resolves itself into the transmission of two distinct single-phase

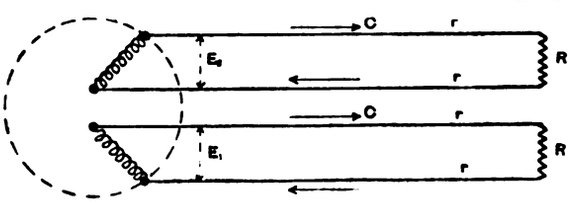

FIG. 11.

currents; and if the load is equal on both sections the total power transmitted will be

$$W = 2 E \times C,$$

or,

$$2 \times C^2 \times (R + 2r),$$

where E = the terminal pressure of each section, and
C = the current in each section.

The pressure lost in transmission will be $2r \times C$, where r is the resistance of a single conductor, and the necessary weight of copper in the conductors for a given pressure drop (or loss of power) will be the same as for a single-phase transmission scheme. It is, however, evident that by combining two of the conductors to form a common return, the transmission of two phase currents can be effected with only three wires, as shown in Fig. 12.

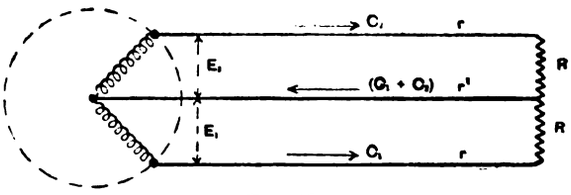

FIG. 12.

The vector diagram for such a system of transmission is very simple *if we can assume the resistance, r', of the common conductor to be negligible*, and it has been drawn in Fig. 13. Here the phase difference of a quarter period between the two E.M.F.'s is represented by E_1 being drawn 90 deg in advance of E_2, and since the circuits are balanced—*i.e.*, since the load is the same as both phases—we may write

$$C_1 = C_2 = \frac{E_1}{r + R} = \frac{E_2}{r + R},$$

and as we are not taking into account either capacity or self-induction, the two currents will be in phase with the respective E.M.F.'s, and the return current in the common

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conductor will be 45deg. in advance of E_2 and 45deg. behind E_1: its value (owing to O C being the hypothenuse of a right-angled triangle) will be $\sqrt{2}$ times C_1 or C_2.

We shall now see how the problem is somewhat complicated as soon as the common return conductor has appreciable resistance.

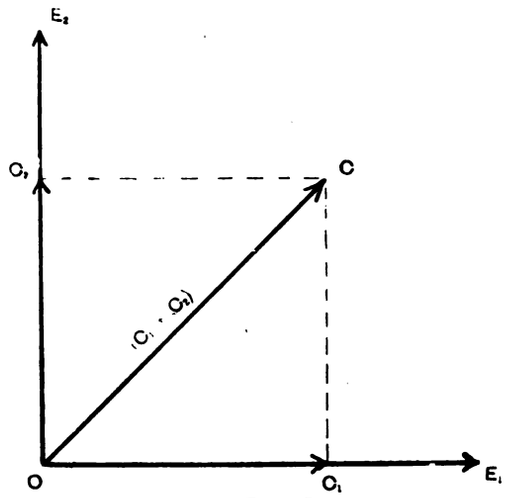

FIG. 13.

For the purpose of drawing the diagram Fig. 14, we may suppose the E.M.F.'s, E_1 and E_2, at generating end to be the same as in the previous diagram, but the pressure drop will be greater, owing to the resistance of the common return, and—for the sake of exaggerating the alteration in the diagram—we shall assume this drop (in the middle wire alone) to be as much as half the impressed voltage—*i.e.*, $\frac{1}{2}$ E_1 or $\frac{1}{2}$ E_2. Owing to the load being balanced and the connections symmetrical, the fact that the middle conductor has appreciable resistance will not alter the phase relation of the total current, which will still be midway between the two E M F.'s, as in Fig 13, and since the component of the E M.F. required to overcome the resistance, r', of the middle conductor must be in phase with this total current, we may draw O a_3 to represent this component in such a direction as to make an angle of 45deg. with O E_1 and O E_2, and of a length equal to one-half of either of these vectors.

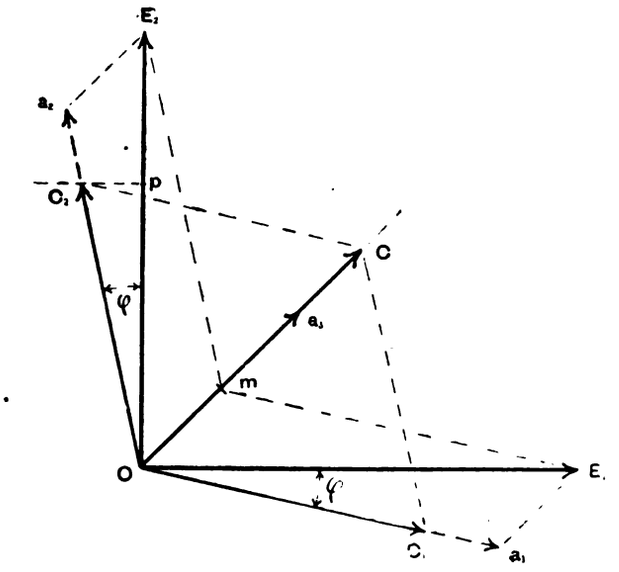

FIG. 14.

Again, on account of the symmetry of the arrangements, half of this component of the necessary total E M F. may be considered as being provided by E_1 and half by E_2. We must, therefore, bisect O a_3 at m, and complete the parallelograms O m E_1 a_1 and O m E_2 a_2, which will give us the E M.F. components, O a_1 and O a_2. These are evidently the components of the total E M F.'s, E_1 and E_2, which are necessary to overcome the resistance, r, of the outer conductor and, R, of the load, and send the two separate currents through this portion of the circuit before they unite to flow back through the common conductor (see Fig. 12). The currents C_1 and C_2 must, of course, be drawn in phase with a_1 and a_2 respectively. As to the magnitude of these currents, this will depend upon the value of $r + R$; but, on the assumption of a given *power* to be transmitted—equal, let us say, to the power transmitted in the arrangement to which Fig 13 applies—the projections of O C_1 and O C_2 on the corresponding E M F. vectors, O E_1 and O E_2, must have a definite value. If the point p in Fig. 14 corresponds to the point C_2 of Fig. 13, we have merely to erect the perpendicular p C_2 to O E_2, and the point C_2, where it meets O a_2, gives us the vector O C_2, representing the current in the outer conductors corresponding to the particular amount of *power* which each phase has to transmit. (The vector O C_1 is obtained in a similar manner, being equal to O C_2 in the case of a balanced load such as we are considering.)

The total current ($C_1 + C_2$) is obtained by compounding C_1 and C_2, and is represented by the vector O C; and we now have all the necessary particulars to enable us to calculate the required section (or resistance) of the lines for a given loss of power in transmission. (It should not be necessary to point out that the resistance, r', of the common conductor $= \frac{O\,a_3}{O\,C}$, while $(r + R) = \frac{O\,a_1}{O\,C_1}$).

The important conclusion to be drawn from the diagram Fig. 14 is that the arrangement of a two-phase transmission line with a common return conductor, although it effects a certain saving in the necessary weight of copper, leads to *an increase of the phase angle between the two currents*. It is true that the displacement is somewhat exaggerated in the diagram, which is based on the assumption of an abnormally large resistance drop, and, in actual practice, the angles ϕ—with a reasonable $C^2 r$ loss, and the same current density in the three wires—would probably never exceed 5deg—that is to say, the phase difference between the currents, at times of full load, might be 100deg. instead of 90deg. As a matter of fact, long-distance transmission by two-phase currents is usually carried out by four wires, partly because of the above objection to the common conductor, but also because there are certain advantages in keeping the two phases entirely distinct. We may, therefore, save ourselves the trouble of constructing further diagrams, on the lines of Fig. 14, but very much more intricate in appearance, which would take into account the effects of self-induction and capacity.

Everything that has been said in connection with single-phase transmission being applicable to the case of two-phase transmission with four wires, there is very little more to be added. It is true that, in addition to the self-induction of the lines, each circuit will have a certain inductive effect upon the other, especially when (as is usually the case) the two circuits are supported by the same set of poles. But, with a reasonable distance between the wires of the two circuits, the effects of mutual induction, even on a long line, are negligible. If necessary, it would be easy to cross the wires of one of the circuits at the middle point of the line, which would practically eliminate these effects.

Self-Induction of Two Phase Line with Common Return.—As the calculation of the *self induction* of a two-phase line with common return may present some difficulties, it is proposed to deal briefly with this question before passing on to the subject of three-phase transmission. In order to simplify the diagram, we shall make the assumption that the middle conductor is without resistance, but that the whole of the resistance of the line is divided equally between the two outer conductors.

In Fig. 15, O E'_1 and O E'_2 are the pressures at the distant or receiving end of the line. There is an angle of 90deg. between these vectors to represent the phase difference of a quarter period. The two currents, C_1 and C_2, which will flow in the outer wires, are shown lagging behind their respective pressures by an angle θ depending upon the power factor of the load. The dotted vector, O C, gives us the magnitude and phase of the resultant current in the common middle conductor, of which the resistance is supposed to be negligible. The drop of pressure due to the resistance of the outer conductor conveying the current C_2 will be O e, but as regards the drop due to self-induction

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this may be considered as the resultant of two E M.F.'s—the first, O M, calculated on the assumption that the total magnetism in the loop is due to C_2, and the second, O N, calculated on the assumption that the total magnetism in the loop is due to the current, C, in the common conductor. Each component E M F. must evidently be drawn 90deg. behind the current to which it owes its origin, and by compounding these we get O P as the total E M.F. of self-induction. We are now in a position to draw the vector O E_2, representing the pressure at the generating end of the line. It is obtained by adding to O E'_2 the three forces: E'_2 A equal to O e; A B, equal but opposite to O M; and B E_2, equal but opposite to O N. The vector O E_1 for the other phase is obtained in a similar manner.

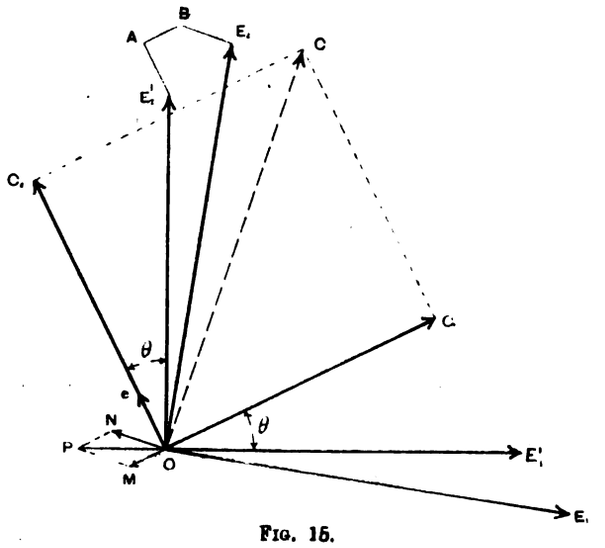

FIG. 15.

With regard to the actual calculation of the lengths O M and O N, it will be remembered that the curve (Fig. 4) gives us the coefficient of self-induction per mile of *single conductor*. The advantage of this will now be apparent, as we have merely to calculate the E M F's on the supposition that each wire forming the loop is producing a magnetic field independently of the other; bearing in mind that the E M F. component, O M, is due to the current, C_2, in one of the wires, while O N is due to a current equal to $C_2 \times \sqrt{2}$ in the other wire, these two E M.F.'s being compounded in the usual way, as indicated in Fig. 15.

TRANSMISSION BY THREE-PHASE ALTERNATING CURRENTS.

We shall again assume, in the first instance, that the line is without self-induction or capacity. If we were to run six separate conductors—*i.e.*, two for each phase—we should merely be transmitting three independent single-phase

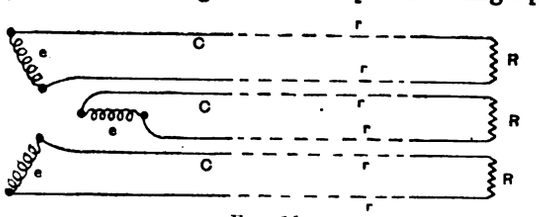

FIG. 16.

currents, the arrangement being as shown in Fig. 16; and if

e = the potential difference at the terminals of each circuit;
C = the current in each wire;
r = the resistance of each wire;
R = the resistance of the "load" on each phase;

then the total power transmitted would be

$$W = 3\,(e \times C),$$

or,

$$W = 3 \times C^2 \times (R + 2r).$$

The pressure lost in transmission would be $2r \times C$, and the total power lost in the lines would be $3 \times C^2 \times 2r$.

Let us now see what is the effect of providing a common return for these three circuits. The arrangement is shown in Fig. 17. The pressure at generating end between the three terminals of the alternator and the common return or neutral point is still e volts, and the total power transmitted is still $W = 3\,(e \times C)$, but, owing to the fact that the sum of the three outgoing currents is zero (seeing that they differ in phase by 120deg, as shown in Fig. 18, and that any one current, such as O B, is exactly equal and opposite to the resultant of the other two currents), there will be no current flowing in the common return conductor, and both pressure drop and $C^2 r$ losses in lines are, therefore, reduced to *one half* of what they were with the arrangement of three separate circuits, the power loss in the lines being now $3\,C^2 r$. This clearly shows how the transmission by three-phase currents is more economical as regards line losses than single-phase transmission. But it must not be overlooked that, in order to obtain a reduction by half of the weight of copper in the lines, the pressure between wires is greater on the three-phase system than on a single-phase system transmitting the same power. Thus, the pressure, E (Fig. 17), between any two of the three transmission wires is equal to $e \times \sqrt{3}$, as shown by the

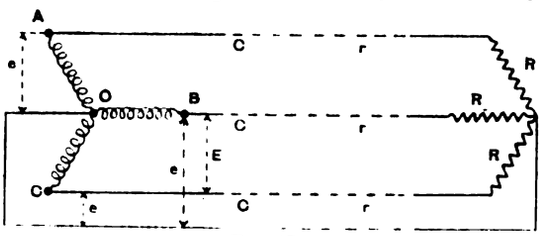

FIG. 17.

diagram Fig. 19. Here the E.M F.'s in the three sections of the alternator windings are represented by O A, O B, and O C, and since the E M.F., E, between any two terminals, such as B and C (Fig. 17), is the resultant of the E M F.'s acting in the two windings, O B and O C, connected in series, we must subtract one of these, O C, from the other, O B. Thus the resultant O E (Fig. 19) is obtained by *adding* to the vector O B an imaginary vector, O C', exactly equal but opposite to O C. This

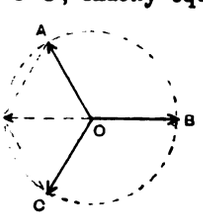

FIG. 18.

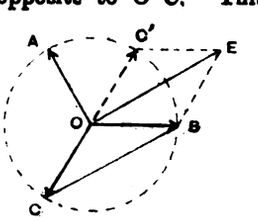

FIG. 19.

resultant is evidently equal and parallel to the line, C B joining the ends of the two vectors O B and O C, and it can be shown to be exactly $\sqrt{3}$ times the length of either of these vectors. We may, therefore, write $E = 1{\cdot}732\,e$

The *power* of a three-phase circuit, which is equal to three times $e \times C$, can evidently also be written

$$W = 3\left(\frac{E}{\sqrt{3}} \times C\right),$$

or,

$$W = \sqrt{3}\,E \times C,$$

where E is the pressure between the wires.

(To be continued.)

PERSONAL.

Mr. J. A. Squire, assistant at Maidenhead electricity works, has resigned.

Mr. E. Edwards has resigned his appointment as general manager of the Gloucester Corporation light railways.

The Loughborough Town Council have increased the salary of their electrical engineer. Mr. W. H. Allen, from £120 to £150 per annum.

The Aberdeen Town Council have awarded Mr. Caird, interim superintendent of the tramways, £100 honorarium for extra duties performed while the Council are without a superintendent.

Mr. Walter J. Bache, M.I E.E, has taken up his work as borough electrical engineer of Cheltenham, and Mr. G. R. White, the assistant engineer, has been requested to take charge of the Gloucester electricity works.

The Rathmines Urban District Council have granted Mr. Pilditch, of the electric light department, an increase of £25 to his salary in connection with his increased responsibilities as electrical engineer, and £25 in connection with his duties at the refuse destructor.

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ELECTRIC POWER DISTRIBUTION FOR THE RAND.

BY ROBERT HAMMOND, M.I.C.E.

(*Concluded from page 456.*)

In an electricity works it is obviously far more economical to generate a given number of kilowatt-hours by working at full load throughout the 24 hours than it would be to attain the same output if 90 per cent. of the load came on to the works for three hours per day, and the remaining 10 per cent. were spread over the remaining 21 hours. In the latter case the plant installed would not only be 7·2 times the size of one working on full load the whole 24 hours, but for 21 hours a day it would practically be running idle and most uneconomically. Obviously the 24 hours ideal is rarely attained, and the latter case closely corresponds to the conditions under which many lighting stations are working. The load factor under these conditions would be described as ·1388, or 13·88 per cent. In the supply of power naturally the conditions are more favourable. As has been already pointed out, most of the operations on the Rand are continuous during the 24 hours, and as a result the load factor of the individual mines is often as high as ·5 or ·6. The "load factor" of any works, therefore, furnishes an index of the conditions under which the plant at the central station has to work, and whether it is working at a varying and uneconomical rate or not. The "diversity factor," on the other hand, relates to the maximum load which the works will be called upon to supply at any one time when dealing with a number of consumers whose respective maxima are known.

The demand of all power users must fluctuate to some extent from time to time, and even in kindred industries it is inconceivable that all the consumers would attain their maximum demand at precisely the same moment. Hence the capacity of the generating plant necessary to supply those consumers is not arrived at by adding together all the individual maximum demands. The term "diversity factor" is used to denote the ratio of the maximum load to be supplied by the central power plant to the sum of the individual consumer's maxima. Its value depends, of course, upon the extent to which the various consumers' demands overlap one another.

The writer agrees that in practice it is impossible to obtain a load factor of 100 per cent., but he points out that the greater the number of consumers and the more diverse the purposes for which the power is used, the more will the resultant load on the generating station approach the ideal one shown. A certain degree of overlapping cannot be avoided, but the percentage effect on the total load would be small. The writer instances the load obtained at a tramway generating station. In a small works with but a few cars running the load varies between enormous limits. On a large system, however, the total load is almost constant.

Turning now to the conditions under which a power station for the Rand would have to work, it is evident that a very favourable load factor would be obtainable. As stated above, the load factor of the plant at many of the mines is as high as ·5 or ·6, but, of course, it would be too sanguine to trust that all the consumers' demands would be as favourable. The writer is inclined to think that it would be on the safe side to assume that the average of the consumers' load factors would be 40 per cent., equivalent to an average use of the maximum power for 9·6 hours per day. On the basis of a consumption of 300,000,000 units per annum and a 40 per cent. load factor the sum of the consumers' maximum demands would be 82,200 kw. On the assumption of a diversity factor of 60 per cent. and a 20 per cent. loss in distribution and transformation, a plant capacity at the generating works of 60,000 kw. would be required.

Capital Outlay.—The engineers to whom the carrying out of the scheme was entrusted would have to give very careful consideration to the question whether the generation to the question whether the generators should be steam or gas driven. In designing the power-house for the supply of electric power to the trams, and for the lighting in the future of the city of Johannesburg, the engineers recommended that preference should be given to gas-engines on the ground that electric energy could by their use be generated more cheaply and as efficiently as with steam plant. The writer, therefore, deems it prudent to figure on the more expensive steam plant, thereby providing for the possibility of a reduction upon his figures if the scheme were carried out by the use of gas-driven plant.

Power House.—Dealing, then, with steam generators, provision should be made for seven generating sets, each of a capacity of 10,000 kw., each set being capable of sustaining an emergency overload of 20 per cent. On the assumption that one set would be occasionally laid off for overhaul, there would always be available for active use six sets with a total normal capacity of 60,000 kw., and an overload capacity of 72,000 kw., amply sufficient to cope with the estimated present requirements and the estimated output of 300,000,000 units per annum. The cost of the power-house, including steam generators, boilers, pumps, condensing plant, switchboard, and erection, is estimated at £980,000.

Transmission and Distribution.—The estimate is drawn upon the basis that the primary voltage would be 6,600 volts, the mines within a radius of nine miles of the central station being supplied at that voltage. For the more distant consumers, step-up transformers would be used and energy transmitted at 30,000 volts to transforming sub-stations. Two such sub-stations would be required, one on the East Rand and one on the West Rand. The energy would be transformed down to 6,600 volts, and distributed to consumers at that pressure. For the purpose of the estimate a power factor of 85 per cent. is assumed, bare copper overhead wires used throughout, carried on steel structures. The loss in transmission which has been worked to throughout is about 7 per cent. The 30,000 volt feeders to the east and west sub-stations are each arranged so as to be 50 per cent. in excess of requirements, so as to provide for reserve. The 6,600-volt lines radiating out to consumers are able to transmit the energy with a 7 per cent. loss over five miles, if load is taken off at one end, or a course of 10 miles if tapped off evenly all the way. Ample provision is made in the estimate for the transformers necessary to give consumers, especially those who already have electrical systems at work, a supply at any voltage they may desire. The sum included for the electric lines, transformers, sub-stations, etc., is £340,000.

Water Storage Tank.—In order that the plant may work at full efficiency, an ample supply of condensing water is necessary. Provision is therefore made for a tank to hold 100,000,000 gallons, the sum included for its construction and filling being £300,000.

Land and Roadmaking.—A sum of £60,000 is included under this head. The complete estimate is as follows: power-house, £980,000; electric lines, transformers, sub-stations, £340,000; storage tank, £300,000; land and road-making, £60,000; contingencies, engineering, and supervision fees, etc., £170,000; working capital, £150,000—total, £2,000,000. Which it is suggested might be raised in the form of: 5 per cent. debentures, £660,000; ordinary capital, £1,340,000—total, £2,000,000.

Costs of Working.—These are compiled on the basis of an output of 375,000,000 units, made up as follows: used by consumers, 300,000,000 units; loss in distribution and transformation, 75,000,000 units—total, 375,000,000 units. With a maximum load of 60,000 kw. the resultant load factor would be: the output in units multiplied by 100 divided by the maximum load in kilowatts and the total number of hours in the year—viz,

$$\frac{375\,000\,000 \times 100}{60{,}000 \times 8{,}760} = 71 \text{ per cent.}$$

With such a magnificent load factor as this, very low costs of generation are attainable.

Coal.—As the sets of plant would during the bulk of the 24 hours be running at full load, the consumption of coal should not exceed 4lb. per unit generated. The price is taken at 10s. 6d. per ton of 2,000lb.

Water.—A storage tank is provided for under the capital outlay, containing 100,000,000 gallons. This would be drawn upon for the condensing water, which would be pumped from one spot and returned to the tank at the most

* Paper read before the Engineering Section of the British Association at Johannesburg, Aug. 30.

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distant spot from the intake. It is estimated that there would be required to supply the loss by evaporation, etc., 1¼ gallons per unit of electrical energy delivered to the mains, and this is estimated to cost 3s. 6d. per 1,000 gallons.

Remaining Items.—These will be seen by referring to the full estimate, as follows:

Costs of Generation and Distribution of 375 000 000 Units per Annum.

Coal on the basis of 4lo. per unit and 10s. 6d. per ton of 2,000lb.		£393,750
Water (to make up for condensing and for boiler feed), 1¼ gallons per unit at 3s. 6d. per 1,000 gallons		82,031
Oil, waste, and stores		3 125
Wages		52,000
Management, rent, rates, insurance, etc.		12,000
Repairs and maintenance, ½ per cent. on capital outlay—viz.	£2 000 000	
Less working capital	150 000	9,250
	1,850,000	
		552 156
Add 5 per cent. for contingencies		27 607
		579,763
Capital charges—5 per cent. on £660,000 debentures and 10 per cent. on £1,340,000 ordinary capital		167,000
Reserve fund—for depreciation and antiquation fund and 2 per cent. on capital outlay on plant		37,000
Total		783 763
Margin to the good		91 237
		£875,000

Revenue.

300,000,000 units delivered to consumers at ·7d. per unit ... £875,000

Financial Results.—It will be seen that on the basis of a payment by the consumers of ·7d. per unit, there would be sufficient profit to provide 5 per cent. on £660,000 of debenture capital and 10 per cent. on £1,340,000 of ordinary capital, after setting aside the sum of £37,000 per annum to a reserve fund to cover the depreciation and antiquation of the plant. It will, I think, be agreed that these figures are sufficiently favourable to support the idea of one central electric station for the Rand; but it will be seen that they are based on the assumption that water storage of 100,000,000 gallons is possible, and that a matter of 470,000,000 gallons of water per annum, or, say, 1,300,000 gallons per day, are available for making up the losses by evaporation. In making-up the estimate of cost of working it is presumed that this quantity of water will be available at a cost of 3s. 6d. per 1,000 gallons. Doubtless, if a good supply of water were available, it could be secured at a lower figure, but the serious question in such quantities at one central spot is to permit of the daily evaporation of so large a quantity. Assuming that the demand from mines on the east of Johannesburg would roughly be double that from the west side, the ideal position for the power-house is about eight miles to the east of Johannesburg. Is water available in that vicinity in sufficient quantity? If not, where can it be obtained, and at what cost? Let us presume for the purpose of illustration that ample water were available at Vereeniging, at a distance of, say, 35 miles from Johannesburg. In this case it would be necessary to add to the estimate of capital expenditure a sum of, say, £80,000 for the construction of a weir dam to provide a reservoir as a stand-by in times of drought, and of the necessary line of pipes for inlet land return to the lower level.

The generating station would be alongside the river, and the whole of the energy would be transformed up to 70,000 volts. The whole 50,000 kw. would be transmitted to a central point in Johannesburg by means of three sets of transmission lines, each consisting of three cables. Six of these cables would be sufficient to transmit the whole 50,000 kw. with a loss of only 6·7 per cent. The other three cables are, therefore, available as spares. In addition to the central transforming station at the Rand to which the trunk lines would be connected, two other sub-stations would be provided, as was the case with the central generating station, one of these being situated on the East Rand and one on the West Rand. Calling these stations A (west), B (central), and C (east), the whole of the energy would be received at B at 70,000 volts, and rather more than one-third of it would be transformed down to 6,600 volts, and this would be distributed to consumers within a radius of about eight miles at that pressure. The remainder of the energy would be transformed down to 30 000 volts, and would be transmitted at that pressure to A and C. Here, again, a further transformation would be made to the distributing pressure at 6,600 volts. The total cost of the trunk feeders and poles, additional transformers, and sub-stations would amount to, on a liberal estimate, £200,000. On the other hand, the outlay of £300,000 on the storage tank would be avoided. There would, of course, be an increase in the cost of the transmission of the energy, but this would be more than compensated for by the lower price of the coal and water at Vereeniging, always presuming that arrangements could be made for the use of the Vaal River.

If such arrangements could be made, the future central power distribution station for the Rand will probably be situated there, and the supply given at ·6d. per unit. The question will then resolve itself into a purely commercial one, and the mine owners throughout the Rand will have to decide whether it will pay them better to draw their supplies from a central station or to combine to use their own electric installations. There is little doubt that those who are at present only using steam power would find an economy in adopting electric power. In this connection it is significant to note that on the north bank of the River Tyne, in spite of coal being available at very low rates, 50,000 h.p. of steam have been displaced by electrical power during the last two years, the supply being drawn from the central power distribution works situated in Newcastle-on-Tyne.

In conclusion, the writer desires to express his great thanks to the engineers and managers of the Rand mines, who so heartily and fully responded to his requests for data as to the present methods. He especially thanks the following: Mr. Wager Bradford, Langlaagte Deep, Limited; Mr. T. P. E. Butt, Randfontein Estates; Mr. H. Y. Clayden, Consolidated Main Reef; Mr. Percy Cazalet, Nourse Deep; Mr. J. Davies, Goldenhuis Deep; Mr. J. A. Dennison, Rand Mines; Mr. P. Fuller, Princess Estate; Mr. M. Ford, Meyer and Charlton; Mr. E. E. Hardach, Knights Deep; Mr. C. E. Hutton, Van Ryn; Mr. T. Johnson, Rose Deep; Mr. H. C. McDonald, Durban Roodepoort; Mr. David T. Morton, Vogelstruis Estates; Mr. C. J. Price, Village Deep; Mr. H. B. Price, Bonanza, Limited; Mr. Frank G. A. Roberts, Witwatersrand Deep; Mr. H. L. Sapte, Consolidated Gold Fields; Mr. H. Ross-Skinner, Durban Roodepoort; Mr. Edward J. Way, Kleinfontein; and Mr. L. Wilms, East Rand. And he only trusts that the arguments that he has induced in this paper will prove convincing to them, and add another step in advance in the methods of working the Rand mines, which methods in the hands of the very able engineers in charge have already merited so much praise throughout the engineering world.

For the following abstract of the discussion we are indebted to the *Transvaal Leader*:

Mr. SIDNEY JENNINGS said one of the important points to be considered was as to whether enough allowance was made for antiquation of plant. It was a matter of pounds, shillings, and pence to the capitalist and to the engineer who advised him. If it could be proved without doubt that a central power station would be vastly more economical, then he thought the capital, although huge, would be forthcoming. He thought the electrical engineer must recognise that capitalists were timid folk, and that they wanted not only estimates which were apparently correct, but some demonstration to prove that their estimates would be borne out in practice. They had on these fields central power stations of very much smaller proportions than the one advocated by Mr. Hammond. The price they received for their power was something like six times the price at which Mr. Hammond estimated it could be delivered on a very large scale. In other words, the Rand Central Electric Works were selling at 4 1d. per unit, whereas Mr. Hammond suggested that on a very large scale it should be generated and sold for 0 7d. per unit. As to electric winding and air compressing by means of electricity, he last year paid a visit to the chief collieries in West Australia and in Belgium, and he was immensely impressed by the power and facility with which electric winding could be applied on these fields. It was again a question of cheapness. There was no doubt, to his mind, that electrical winding could be made easy, and that the handling of a motor was within the

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range of the ordinary intelligent engine-driver's capacity. In conclusion, he thanked Mr. Hammond for his exceedingly valuable paper.

Mr. G. HENNING said it was easy to find fault with the Rand engineers for not putting larger distribution power into use, but they should remember a few years ago there was no Rand, and plants had to be put down step by step. They should also remember that the work had been restricted, as each particular group had its own interest and its own policy. If there was to be a central plant they should go the whole length, and have the one plant. As regards Mr. Jennings's statements regarding air-compressors, he did not agree. He was quite certain that if Mr. Hammond were to offer them power at the price he mentioned, they would all take his power. They would be very glad to have such a distribution company.

Mr. E. P. RATHBONE pointed out that with the power contralised in the way proposed, if anything went wrong with the centralisation the whole of the mines would be dislocated. Such a company would have to consider the indemnifying of mine owners if such occurrences happened.

Mr. A. SIEMENS said they had heard every speaker say that the real criterion as to whether the thing ought to be introduced or not was, in commercial and industrial matters, the cost. In electricity, where the capital outlay was so very heavy, the charges in interest and antiquation were the main factors in deciding the matter. Mr. Hammond had told them that the load factor in the mines or group of mines as at present constituted was at present very high—·5 or ·6. What would they gain if they made a central power station? Mr. Rathbone had emphasised the danger of putting all their eggs in one basket. He, for one, did not believe that that wonderful economy could be effected simply by increasing the plant to wonderful sizes. He thought, personally, that 2,000-kw. or 3,000-kw. units were big enough, and they were handier. Mr. Hammond quoted Newcastle-on-Tyne, and said that the North-Eastern Railway Company there were taking their supply from the central power station. He (Mr. Siemens) believed they paid ·45d. per unit. He had been over the Liverpool and Southport Electric Railway, and he was told that they generated their electricity for ·33d. per unit. They had placed their station halfway between Liverpool and Southport. In consequence they had hardly any taxes to pay, and got water for nothing. His argument was that everything depended on the cost. It had not been at all proved that that high-power central stations would necessarily be cheaper than smaller stations. If they could make smaller stations with a good load factor of ·6 or ·7, they could get their electricity as cheap as any big station could give it.

Mr. SPENGEL (Rand Central) pointed out that on the Rand they had comparatively modern plant. On some mines particularly the machinery was most modern, and, therefore, the chance of saving much from electric power supply was not quite so favourable. It seemed to him at first sight that the cost of £30 per kilowatt was very small. However, it might possibly be done. The total working costs appeared to be correct, and it might, therefore, be possible to supply from a plant having a capacity of 60,000 kw. at ·6d. But this was based entirely on the assumption of a large load factor, and if he were advising a financier to put up his money, he would say: "If you can guarantee that load factor, and are able to sell up to 60,000 kw., it would be a safe proposition." But what were they going to do until this state was reached? There was probably no mine which would enter into contract with them now for, say, over 1,000 kw., and new mines generally started at 15 kw. or 20 kw. Until the full load was reached the fixed charges per kilowatt would be rather high, and in that he saw a commercial difficulty.

In replying, Mr. HAMMOND said he did not think his estimate of 70 per cent. for the load factor was too high.

The PRESIDENT (Sir C. Scott-Moncrieff) proposed a hearty vote of thanks to the lecturer, hoping that the paper would raise a general discussion in South Africa.

BURNLEY ELECTRICITY ACCOUNTS.

The accounts of the Burnley electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £87,765. Abstracts of the revenue account and balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5,632	11	10
Distribution of electricity	542	12	6
Attending and repairs to public lamps	28	9	2
Rents, rates, and taxes	849	9	3
Management expenses, salaries, etc.	1,114	7	1
	8,167	9	10
Amount carried to net revenue account	13,119	5	4
	£21,286	15	2

Cr. Income.	£	s.	d.
By sale of current, less discounts and bad debts	21,013	18	6
Rental of meters	110	0	1
Charges for work done	151	5	8
Motor rentals, less depreciation	0	16	0
Arc lamp rentals, less depreciation	10	14	11
	£21,286	15	2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	64 318	17	6
Sundry creditors	1,158	11	4
Reserve fund account	7,683	1	7
Depreciation fund account	1,086	4	5
Contingencies account	500	0	0
Sinking fund	14 205	2	6
Amount owing to borough fund	12,275	9	5
	£101,227	6	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	87,765	18	7
Stores on hand	2,254	9	4
Sundry debtors for current supplied	3,667	18	10
Reserve fund investment account	7,539	0	0
Cash on hand	10	0	0
	£101,227	6	9

CROYDON ELECTRICITY ACCOUNTS.

The accounts of the Croydon electricity department for the year ended March 25, 1905, show a total expenditure on capital account to that date of £305,574. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	16,360	6	11
Distribution of electricity	1 437	0	2
Attending and repairs to public lamps	1,196	15	10
Rents, rates, and taxes	2,400	19	10
Management expenses, salaries, etc.	2,611	12	1
Special charges, insurance, etc.	293	13	3
Special expenditure	499	4	4
	24 799	12	5
Amount carried to net revenue account	24,800	0	0
Balance to be carried to next account	76	3	0
	£49,675	15	5

Cr. Income.	£	s.	d.
By sale of current by meter, less allowances	41,179	18	10
Balance from last account	58	1	1
Ditto for public lighting	7,627	18	1
Rental of meters and other apparatus	633	16	11
Sundry receipts	154	7	6
Rents	21	13	0
	£49,675	15	5

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Redeemable stock and debenture bonds	303,739	0	0
Revenue account	76	3	0
Net revenue account	2 233	19	9
Interest accrued	4 934	15	11
Reserve fund	12,655	19	6
Sundry creditors	10 694	8	11
Consumers' deposit account	1 337	14	7
Bankers' overdraft	5,269	18	7
Surplus account	32,097	3	11
	£373,029	4	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	305,574	12	6
Costs of issue, etc., capitalised	13,297	0	0
Cottage and land, Addiscombe	728	12	6
Stores on hand	1,415	7	11
Sundry debtors for current supplied, etc.	15,566	1	4
Other debtors	564	2	10
Reserve fund investment account	7,514	12	11
Cash in hands of engineer	64	10	3
Contributions to consolidated loans fund	28 514	3	11
	£373,029	4	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			4,84 ,074
Quantity sold	Private consumers by meter	1 652 354	
	Traction	1,575,098	3,917,937
	Public lamps	692,485	
Quantity used on works			418,739
Total quantity accounted for			4,336,676
Quantity not accounted for			505,398
Maximum supply demanded (kilowatts)			2,507

Number of public lamps: 410 arcs, 87 incandescents.

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LEGAL INTELLIGENCE.

THE ELECTRICAL CONSPIRACY CASE.

At the London Guildhall William Leslie, Francis Cheeseman, George Webber, and Richard T. Rosenberg were again charged with being concerned in obtaining goods and money by false pretences to the extent of about £33,000 from various City and provincial firms in connection with the Electrical Accessories Co. After further evidence had been given, the case was again adjourned.

CHARGE OF EMBEZZLEMENT.

Mr. J. W. Eudean, the ex-manager of the Devonport Tramway Co., was brought before the Devonport magistrates last week to answer four charges of embezzlement. It was stated in evidence that Mr. Eudean had issued a number of season-tickets without the authority of the company. He pleaded guilty to two charges, and the two other charges were withdrawn. He was sentenced to six months' imprisonment.

VALUATION OF ELECTRIC WORKS.

At the Valuation Appeal Court, Hawick, the appeal by the Parish Council against the valuation of the Urban Electric Supply Co.'s premises being fixed at £800 was heard. The Council contended that, were the profits of the company taken as the basis, the valuation ought to be at least £1,350 The company submitted that were due allowance made for depreciation of plant and machinery, and for repairs, even £800 was far too much. Mr. Park, assistant assessor, said that the assessor originally valued the works at £877 and the mains at £439—a total of £1 316—but a compromise was made in court. After evidence had been given, the Court unanimously dismissed the appeal. The Council asked that a case be stated, as they proposed to appeal to the Court of Session. This was agreed to.

COMPANIES' MEETINGS AND REPORTS

WILLANS AND ROBINSON.

The ordinary general meeting of this Company was held on Wednesday at Cannon-street Hotel, E.C., Mr. Mark Robinson presiding. Particulars of the report appeared in our last week's issue.

The CHAIRMAN said that in the unanimous opinion of the Board the Company was moving, slowly as yet, but moving towards renewed prosperity in the future. The Company was not poorer in cash by the half-year's trading, except to a small amount. A loss due chiefly to depreciation was not a loss which called for counsels of despair, and it was useful to point them out; but, on the other hand, until the earnings were more than sufficient to cover the natural depreciation of the Company's property, due to lapse of time and other causes, there could be no pretence that the Company was making a profit. The Company's high-speed engine business was, unfortunately, very unprofitable, for prices continued extremely low. On its gas engine business no final judgment could yet be passed. The Company had made some successful engines as regards design and working, and had the best prospects of a technical success, the only question, as he had said before, being whether anyone would pay enough for such engines to make their manufacture profitable. That question could not be answered yet, but there was one unfavourable fact to be reckoned with, and one which had evolved since the Company undertook that branch of its business. The Company took up the gas-engine as a matter of prudence, because the large gas-engine threatened to supplant the large reciprocating steam-engine. The steam-turbine now threatened that result even more seriously, and so, in turn, the Company had taken up the steam-turbine. The success of the steam-turbine was clearly assured, and there seemed no reason to doubt that the Company would play an important part in developing it. A turbine of 1,400 kw. had been running for some months in one of the lighting stations of the Corporation of Glasgow, and the Board believed its running had been entirely satisfactory to the Corporation and its officers. Another turbine of 3 000 kw. was being installed in the same station, and was nearly ready for steaming, and a third, of the same power as the second, was near completion. Four other turbines which the Company had put to work elsewhere had given satisfaction, and the Board might safely say that the Company was fairly embarked in the turbine manufacture on commercial lines, and might look forward with confidence to a satisfactory business, not less important than that it had enjoyed at any previous time. The manufacture of the Diesel engine, to which reference had been made on former occasions, had just been commenced. Queen's Ferry had been referred to in the report. The directors were satisfied that the proper course was being followed there—that was, not to shut it up, but to develop it gradually. Every effort was being made to keep down the working expenses, as well as the cost of manufacture, and in the last some important economies were in view. The new vanadium steel, a speciality of the Queen's Ferry Works, was rapidly taking an important position in industry. Referring to the accounts, the chairman stated that in the Company's prosperous days the directors wisely put back into the business no less than £134,822 of the Company's profits. Not until the loss exceeded that amount—and the Board confidently looked for the Company to be "round the corner" before any such amount was reached—they would have to face an actual loss of capital.

No criticisms being forthcoming, the resolution that the report and accounts be adopted was put to the meeting, and declared carried unanimously.

MERSEY ELECTRIC RAILWAY.

At the half-yearly meeting of this Company, whose report we published last week, Mr. JAS. FALCONER, the chairman, said the increase in the number of passengers was very interesting, having regard to the change from steam to electric traction. The number of passengers carried had steadily increased from 2,844,708 in the second half of 1902 to 4,862,378 in the first half of 1905, an increase of 2,017,670, or 71 per cent. Those were booked passengers, quite distinct from season-ticket holders, and the receipts from season tickets had steadily increased ever since the line was opened for electric traction. They had stopped the issue of second-class tickets, but the first and third had gone on increasing. As the tramway system of Birkenhead did not afford all the facilities which passengers travelling on their line required for getting to and from the stations, the Board had resolved to provide a service of motor 'buses.

A shareholder inquired whether it was possible to diminish the working expenses, as they still stood at a very high figure. He also asked what the proportion was per train mile in the cost of working by steam to electricity.

The CHAIRMAN pointed out that they were giving more than double the service of trains now that they used to give when the line was worked by steam, and the cost was practically the same. The cost per train mile had been enormously reduced. When steam traction was used it amounted to about 1s. 2d. per train mile, whereas to-day it was about 6d.

DICK, KERR, AND CO.

The ordinary general meeting of this Company was held last week, Mr. John Kerr, M.P., presiding. Particulars of the accounts for the past year appeared in our issue of the 28th ult.

The CHAIRMAN, in moving the adoption of the report, stated that efficiency had been maintained, and everything that could make for economy of production had been studied and given effect to. He remarked that it was desirable that the youth of this country should show a higher appreciation of the technical education which was within the grasp of most of them. During the year the Company had been carrying out operations in almost every part of the world, except in the highly protected countries of Europe and America, where they could get no footing, and they expected none. In this connection he was strongly in favour of a mutual preferential tariff. He asked the shareholders to support the board in setting aside the considerable sum of £40,000 for depreciation, as changes in machinery occurred with frequency in these days. Their order-book was fuller than it was last year, but it was a question whether the percentage of profit was as great. The business was expanding in many directions, and if in the near future there should be less to do at home, their foreign connection might more than fill up the gap.

The motion was adopted, and special resolutions were afterwards passed to alter the articles of association.

MEXICO ELECTRIC TRAMWAYS.

At the annual meeting of this Company, whose report we published in our issue of the 22nd ult., the CHAIRMAN (Sir Charles Euan Smith) drew attention to the need of putting more money into the venture in order to make out of it that good return which everyone considered to be possible. The result of his visit to Mexico was a confirmed opinion that they not only had a valuable property out there, but that the country was also in a state of prosperity and advancement. One thing that must make for the general good of all who had business transactions with Mexico was the fact that the Government there had decided on a fixed value for the Mexican dollar. It was proposed in the near future to extend the Company's lines and ramifications, for which there was very ample room, and this would necessitate additional capital. Prominent men in Mexico were interested in the Company, and were assured of its success and of the need of extended working.

Mr. LUDWIG BREITMEYER seconded the motion, which was carried unanimously.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The report for the year ending June 30, to be submitted on the 12th inst, states that the sum of £47,898. 0s. 2d. has been brought forward from profit and loss account. Interest on debenture stocks has absorbed £18,760. 18s. 4d., £12,000 has been set aside as depreciation on freehold and leasehold property, plant, machinery, and tools; £1,552. 18s. 5d. has been applied in writing down values of stocks; and the sum of £2,677. 3s. 3d. has been reserved on account of bad and doubtful debts. A further sum of £1,000 has been added to the reserve for future stock depreciation. The result as shown in the net revenue account is a credit balance of £11,907. 0s. 2d., to which must be added the sum of £5,302. 2s. 11d. brought forward from the previous year, thus making a total of £17,209. 3s. 1d., out of which the directors recommend the payment of a dividend for the year on the A shares at the rate of 2½ per cent., amounting to £9,586. 19s., leaving a sum of £7,622. 4s. 1d. to be carried forward. During the year £43,947 of this Company's debenture stocks have been purchased and cancelled, resulting in a profit of £6,970. 9s. in addition to that shown in paragraph 2. This amount has been appropriated partially by way of discount on amounts owing by debtors, and partially as a reserve against stock depreciation. Cost of establishing the business, goodwill, etc., £443,451. 8s. 1d., has been brought forward at the figure standing in the last balance-sheet. The freehold and leasehold property, plant, and machinery have also been brought forward at the value stated in the last balance-sheet, with the addition of the amount expended to June 30, 1905, less depreciation charged in net revenue account. There has been expended on capital during the

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year ending June 30. 1905, £2,395. 16s. 8d. The shares of the Altrincham Electric Supply have been taken at par, as in previous years. This concern continues to show satisfactory progress. Its indebtedness to this Company has been reduced during the year by £3,265. 8s. 6d. The following resolution, or a resolution to the like effect, will be submitted to the meeting, with a view to its subsequent confirmation as a special resolution: "That the capital of the Company be reduced from £961 090, divided into 150,000 A shares of £5 each, 26,436 B shares of £5 each. and 23,564 B shares of £2. 10s. each, to £888,071, divided into 150,000 A shares of £5 each, 25 436 B shares of £5 each, and 23 564 B shares of 5s. each, and that such reduction be effected by cancelling paid-up capital which has been lost, or is unrepresented by available assets, to the extent of £2. 5s. per share on each of the 23 564 B shares which have been issued and are now outstanding, and by reducing the nominal amount of each of such 23,564 B shares to 5s."

CITY OF BUENOS AYRES TRAMWAYS.

At a general meeting of this Company for the purpose of receiving the liquidators' account and fixing their remuneration, it was stated that the transfer of the undertaking to the Anglo-Argentine Tramways Co. had been accomplished most satisfactorily. The sum of 300 guineas was unanimously voted to each of the liquidators as remuneration.

WEST LONDON AND PROVINCIAL ELECTRIC SUPPLY.

The report for the 12 months ending Dec. 31, 1904, states that the earnings of the Company are dependent on the business done by the Chiswick Electricity Supply Corporation, whose shares the Company owns, and the report of the directors with the accounts and balance-sheet of that corporation accompany the present accounts. From these it will be observed that during the year satisfactory progress has been made by the undertakings worked by the corporation. The corporation accounts, after paying interest on debentures and other charges, show a profit balance of £2,673, which the directors propose to apply to the payment of a dividend at the rate of 4½ per cent. on the ordinary shares. This will be paid over to the West London Company, whose accounts herewith show a balance at the credit of the profit and loss acount in the balance-sheet of £1,953. 4s. 4d. The directors propose to apply this amount to the payment of a dividend on the cumulative preference shares at the rate of 6 per cent. per annum for the year ending Dec. 31, 1900.

CHISWICK ELECTRICITY SUPPLY.

The report for the 12 months ended Dec. 31, 1904, states that satisfactory progress has been made during the year. The business of the Corporation shows a steady increase, and to meet this extensions have been made from time to time. During the year £10 937. 10s. 9d. has been expended on capital account for new machinery, mains, etc. At Chiswick at the end of 1904 the equivalent of 29 668 lamps was wired to the mains, as compared with 25 159 at the end of 1903, and at Aberystwyth the equivalent of 11,902 lamps, as compared with 11,286. Chiswick being a rapidly growing district, there is every reason to believe that the rate of progress indicated by these figures will be fully maintained. During the year the capacity of the Chiswick generating station was increased by the addition of a new 500-h.p. generating set. The station can now supply 50 000 lamps connected to the mains, and efforts are being made to get the new machinery well loaded up without delay. The economy effected by the use of the condenser which started working a year ago will be apparent from the accounts. The total profit made by the Corporation for the year amounted to £4,370. 19s. 8d. Out of this sum interest on debentures and loans, amounting to £1,513. 8s. 2d., has been paid £184. 11s. 6d. has been carried to depreciation reserve account, a balance of £2 673 being carried to the credit of profit and loss account. This latter the directors propose to apply to the payment of a dividend on the ordinary shares at the rate of 4½ per cent. per annum for the year.

APPOINTMENTS VACANT.

Premium Pupil, Electricity Works, Canterbury. See advertisement.

Improver, Perth Corporation electricity works. Wages 12s. per week. See advertisement.

Electrical Foreman. Applications to Box P 50, *Electrical Engineer* Office. See advertisement.

Switchboard Attendant. Wages 20s. per week. Applications to Engineer, Electricity Works, Canterbury, by Oct. 14. See advertisement.

Junior Engineers for a company in the Metropolitan district Apply to B. W., *Electrical Engineer* Office. See advertisement in last issue.

Junior Assistant, Aldershot Urban District Council electricity works. Salary £65 per annum. Applications by Oct. 18. See advertisement.

Assistant for electrical estimating department in large switchworks. Applications to Box H 2, *Electrical Engineer* Office. See advertisement in last issue.

Electrical Engineer, West Ham Borough Council. Salary £350 per annum, with annual increments of £50 to £500 per annum. Applications by Oct. 12.

NEW COMPANIES REGISTERED.

New Arrol-Johnston Car Co, Limited.—Capital, £100,000. Object: to carry on the businesses of engineers, electricians, etc. Registered office: Underwood-road, Paisley.

Nelson Patent Lighting Co., Limited.—Capital, £2 000. Object: to adopt an agreement with J. Blakey, J. Carter and T. Rycroft, and to carry on the business of gasfitters, electricians, engineers, manufacturers of and dealers in electricity for motive power and light, etc.

Neophone (1905), Limited.—Capital, £70,000. Object: to acquire from the Neophone Co., Limited, their rights, title, and interest, subject to a royalty in favour of Dr. W. Michaelis, in certain letters patent for improvements relating to sound-producing and recording apparatus. Registered office: 22, Philpot-lane, E.C.

Newport (Mon.) Motor Supply and Garage, Limited.—Capital, £3,000. Object: to carry on the business of motor garage proprietors, mechanical and electrical engineers manufacturers, builders, and repairers of, agents for and dealers in, motorcars and cycles, etc. Registered office: Cambrian-chambers, Cambrian-road, Newport (Mon.).

CONTRACTS FOR ELECTRICAL SUPPLIES.

Paris.—The Post and Telegraphs Department, 13, Rue de Grenelle, require tenders for copper and bronze wire and other telegraph material. Tenders by Oct. 9.

Prestwich (Lancs.).—The Urban District Council invite tenders for the installation of electric light in their Council Offices, Prestwich. Tenders by 12 noon on Oct. 9.

Chantilly.—Tenders are required for motors, pumps, and generators for the service at the reservoir. Particulars appear in the *Journal des travaux publics* (Paris) of July 20. Tenders by Oct. 12.

Madrid.—The Public Works Department require designs for a scheme of electric tramways in the town. Particulars from Direccion General de Obras Publicas, Madrid. Tenders by Nov. 27.

Utrecht.—The Government Railways require tenders for Contracts 215 219—for steel plates, tirefonds, bolts, etc. Specification (1s.) from the Chief of Works and Stores, Morcelse Park, Utrecht. Tenders by Oct. 24.

Paris.—The Colonial Office, 4 rue Jean Nicot, Paris, require tenders for galvanised iron wire for the Indo-China telegraph service. Tenders by Oct. 10. Specification from Inspection Générale des Travaux publics, room No. 146, at above address.

Great Western Railway.—The directors of this company invite tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1906. Specification, with forms of tender, may be obtained at the office of the Stores Superintendent at Swindon. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Oct. 16.

Leeds.—The Guardians invite tenders for the wiring and installation of subway and underground concentric mains for the electric lighting and power for the pump-house and imbecile wards at the workhouse. Send names to Messrs. T. Winn and Sons 84, Albion-street, Leeds, by Oct. 11, when specification and full particulars will be duly forwarded. Each application must be accompanied by a deposit of £2. 2s., which will be returned on receipt of a bona fide tender.

RESULTS OF TENDERS.

Grays (Essex).—The Urban District Council have accepted the tender of H. H. Carter, of Grays, at £485, for extension of the electric lighting station.

Chelmsford.—Two tenders have been received for lighting the public streets and public clock for a period of three or five years from March 25, 1906—viz, from the Chelmsford Electric Lighting Co. and the Chelmsford Gaslight and Coke Co. The Lighting Committee have the tenders under consideration.

Gloucester.—The City Council have accepted the tender of A. Crane for the supply and delivery at the electricity works, during the ensuing six months, such coal as may be required of the kinds mentioned and at the following prices: Wimberry small at 10s 7d., Princess Royal small at 10s. 4d., and Lydbrook small at 10s. 4d. per ton.

Ashton-under-Lyne.—The Electricity Committee have accepted the following tenders for (Section A) one 500-kw. D.C. generator; (B) one water-tube boiler, with superheater, to be worked in conjunction with a refuse destructor; (C) two superheaters for Lancashire boilers: Bellis and Morcom, engine; Dick, Kerr, and Co., dynamo; Babcock and Wilcox, boiler; W. B. Haigh and Co., superheaters.

Accumulators.—The A.B.P. Accumulator Co., Stockton-on-Tees, notify the following new contracts: 54 17 plate S type cells for Portishead; 55 seven-plate S-type cells for Chester; and 54 11-plate S-type sections for Wilmslow, near Manchester. They have also just completed contracts for a number of batteries for Blackpool Winter Gardens, Handsworth Urban District Council, Barry Railway Co., Silksworth Hall, Brompton, Ivybridge, and for the s.y. "Calanthe."

Pembroke (Ireland).—The Electric Lighting Committee of the Pembroke District Council have accepted the following tenders for the extensions of the electricity supply undertaking: Callender's Cable and Construction Co., London, E.C., at £14,624. 18s. 4d., for electricity supply mains; W. Lucy and Co., Oxford, at £1.132. 10s., for arc lamps, pillars, and accessories; Chamberlain and Hookham, Birmingham, at schedule rates, for house meters; Nalder Bros. and Thompson, London, E.C., at £472, for extension of switchboard.

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BUSINESS NOTES.

TRACTION.

Lincoln.—The Corporation's newly-electrified trams are expected to be running this month.

Dundee.—Terms "fairly" satisfactory to the tramway employés have been agreed upon.

Bangkok.—Electric tramways were formally inaugurated by the King of Siam on Tuesday.

Portsmouth.—The inhabitants of Milton have appointed a deputation to interview the Corporation relative to an extension.

Southend.—The Town Council are expected to further consider this week the question of extending the tramways along the sea-front to Shoeburyness.

Glasgow.—The receipts on Monday, the 25th ult., constituted a record, the amount being £3,884, which was £560 more than the corresponding day of last year.

Derby.—The receipts for the nine weeks ended Sept. 23 were £27,723. 11s. 1d., an increase of £1,853. 16s. 4d. compared with the corresponding period last year.

Dover.—The new municipal electric tramway service was inaugurated on Monday, the Hon. George Wyndham, M.P., driving the first car. The rails are laid on sleepers.

London County Council.—A public meeting, presided over by the Mayor of Bermondsey, decided to call upon the local M.P.'s to support the County Council's embankment scheme.

West of Fife Trams.—The promoters of this scheme desire certain modifications in the County Council's requirements as to permanent way. The matter has been referred to committee.

Wilmslow.—The proposed scheme for a tramway between Wilmslow and Cheadle was under the consideration of the Wilmslow Council on Monday night. Finally, a resolution approving of the scheme was lost.

Dartford.—In reply to a public deputation, which urged that the laying of the tramways through the centre of the town should be commenced forthwith, the Mayor stated that steps were being taken to expedite matters as much as possible.

Berlin.—The Great Berlin Tramway Co. has unanimously sanctioned a proposal for the concession of the service into an underground system in certain streets where the traffic is particularly heavy. The cost of the change is estimated at £3,000 000.

Ramsgate.—The Board of Trade has fixed Friday, the 13th inst., as the date of the adjourned inquiry into the Ramsgate tramway accident of Aug. 3, when a tram went over the East Cliff. The inquiry was adjourned for the evidence of the driver, who was too severely injured to be available.

Motor 'Buses.—The London and District Motor 'Bus Co. are beginning their first service this week, and all the company's conductors and drivers will be dressed in uniform. The first service will be between Charing Cross and Putney, *viâ* Leicester-square, Piccadilly-circus, Hyde Park-corner, Knightsbridge, Brompton-road, and Fulham-road.

Potteries Electric Traction Co.—At the meeting of the Stoke Town Council last week it was decided to take immediate steps against the Potteries Electric Traction Co. to compel them to carry out their obligations with reference to the alterations to the roadway in Church-street, and as to the making-up of the highway at the Trent Vale light railway extension.

Leeds.—The Corporation have substituted half-mile for two-thirds of a mile stages in connection with ½d. fares, the longer distance being unprofitable. Having regard to the low fares charged over the system, the Corporation consider transfer tickets inadvisable. The Morley Town Council are understood to be negotiating with Leeds for an extension of the latter's system.

Barcelona Tramways.—The company notify that notarial transfers of their concessions have been executed, and that the instalment of £245,000 has been paid to the company. The company have given notice to redeem the 4½ per cent. debenture stock, and have set aside £50,000 to meet the 5 per cent. debentures (1888). Proceedings will in due course be taken for voluntary liquidation.

Lancs and Yorks Railway.—Steam trains will shortly disappear from the Liverpool-Southport section. An electric battery station has just been erected at Hall-road. There are four of the station buildings between Liverpool and Southport, two of which, situated at Hall-road and St. Luke's, are in operation, while others, at Great Howard-street and Freshfield, are nearing completion.

Bournemouth.—The proposal to institute a Sunday service appears to have aroused considerable opposition, and a committee has been appointed, pledged "in the interests and welfare of the borough, to the maintenance of its best asset, a quiet Sunday, earnestly to support at the forthcoming municipal election those candidates who promise to maintain the present six days' service in the borough."

Wednesbury and Darlaston.—After being closed for nearly two years the tramway between Wednesbury and Darlaston was reopened last week for passenger traffic, and the appearance of the electric cars in place of the old steam trams evidently gave general satisfaction. A through service is in operation between Darlaston and Handsworth. Arrangements to reopen the Dudley section are being proceeded with.

South Shields.—At the meeting of the Tramways Committee the town clerk reported that replies had been received from 37 tramway undertakers, of whom 24 have appointed an independent official as tramways manager, and 13 combine the managership with the office of electrical engineer. The committee, after a long debate, decided by a majority of seven to five to adhere to their former decision to recommend the Corporation to combine the two offices.

Heywood.—The work of reconstructing the tram track is now proceeding steadily towards the centre of the town. From Heap Bridge to Boohole Farm the track is practically completed, but there is a break from the farm to the Towler Inn, where the new lines require laying. From the Towler Inn to the Brunswick Hotel the old track has been lifted and the new lines laid, and the paving has been finished up to the neighbourhood of Wrigley Brook.

Wemyss.—At a meeting of the Kirkcaldy District Committee a letter was submitted from Mr. Sellon, the engineer, suggesting that a meeting should be arranged with him for the purpose of agreeing to certain details, including accommodation for road scrapings, in connection with the Wemyss tramway scheme. Councillor Prentice thought the Roads Committee should send their suggestions to Mr. Sellon, and if he could not agree to them they could meet him and discuss the matter. This was agreed to.

Newcastle.—The total revenue of the Corporation tramways in the past year amounted to £197 493, and after meeting working expenses the gross profits are £71.155. The net balance, after providing for various charges, is £9 954. The number of car miles run is 4 326 152, and the passengers numbered 43 069 934. The Sunday traffic realised £18,910, an average of £356 per day. The weekday traffic was pretty uniform, but the average receipts on Saturdays were £838. The Newburn Urban District Council have decided to approach the Corporation with a view to the Scotswood line being extended.

Fatality.—At a coroner's enquiry held on Monday into the circumstances attending the death of a child named Selina Phillips, who was knocked down by a tramcar and killed, a witness stated that the car struck her down, and he saw her on the lifeguard. He ran alongside and tried to get her by the foot, but she rolled off and under the lifeguard. His opinion was that the driver could not possibly have seen her approach, as she was on the blind side of the car. It was a pure accident, and the driver did all he could to avert it. The jury returned a verdict of "Accidental death," and added a rider that no blame was attributable to anyone.

Mitcham Light Railways.—Committees of the Croydon Rural District Council and the Carshalton Urban District Council have decided, as the result of a joint conference, to recommend that the British Electric Traction Co. be required to provide a wood-paved track throughout the route in the two districts; that in all cases where the width of the carriageway between the outer rail and the kerb was less than 9ft. 6in. the company should be required to wood pave the whole width of such carriageway; and that the cable or feeders should be laid under track. Also that the two authorities should consult together before approving the designs of standards and other details connected with the construction of the lines.

Belfast.—Terms have been arranged for the widening of Shore-road in connection with the reconstruction of the trams. The advertising contract has been let for five years at £2,500 per annum. The overhead equipment is almost complete, but it will be a little time before the power-house is ready. Probably the system will be in operation by the middle of next month. In regard to the delay in the work of reconstruction, the contractors, Messrs J. G. White and Co., state that if the contract is completed within the specified nine months it will constitute a record considering the size of the undertaking, but they have been handicapped by material not being ready. They intimate that they will be prepared to treat any claim arising through the delay in an equitable spirit.

Cost of Tramway Accidents.—A special report just issued compares Sheffield, Leeds, Manchester, Bradford, and Glasgow in regard to accidents. At Sheffield it was found that in the year 1904 1,722 accidents of all kinds happened with a car mileage of 5 997,063, 315 claims were made, and £470 was paid for compensation. In Bradford for the year ended March 31, 1905 1,739 accidents occurred 238 claims were made, and £4,600 was paid in compensation, with a car mileage of 5 053,392. In Leeds £2 000 was paid on a car mileage of 7,044 745 during the same 12 months. At Glasgow £18 000 per annum is paid in insurance against third-party risks; and in Manchester £11.000 was paid for the last 12 months as claims with a car mileage of 13,759,071.

Hanley.—At the meeting of the Town Council the following report of the Works Committee was submitted: "The extension of the Providence-square tramway along Chell-street has been completed, and there only remains to be put in a passing place loop at the junction of Leonard-road. The work of doubling the Broad-street tramway between Victoria-square and Shelton Church has made good progress. The section between Queen-street and Victoria-square will next be taken in hand, and the few objections that have been made will be met by adjusting the kerbs a few inches in the short length between Oxford-street and Sun-street. Objections have been lodged with respect to the narrow part of Snow-hill, but hopes are entertained that terms will be made satisfactory to the owners."

Tipton.—It is gratifying to learn that the Town Council and the South Staffordshire Tramways (Lessee) Co. have now finally agreed upon terms which are as follows: The company undertake within three months from the sealing of the agreement to electrify the line between Dudley and the Bulls Head Inn, Princes End, and within the same period to reconstruct and electrify the tramway from Wednesbury boundary to the Oaker Hill railway station. The intermediate portion where the mining subsidences are now taking place was to be electrified and reconstructed within 18 months from the sealing of the agreement, unless the Council, in their wisdom, see fit to extend that time. In addition, the company undertake to pay to the Council £150 for the watering of the track up to April 3 next, the sum to be paid in advance. The company also agree to pay the sum of £110 per annum, which sum was to be paid in April.

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Bradford.—After an inquiry into the general administration of the tramways department lasting over six months, the special committee of the Tramways Committee have now issued their report. The inquiry was instituted at the express wish of the manager (Mr. C. J. Spencer) himself, in consequence of certain criticisms which had been levelled at his management. The result is a complete vindication of Mr. Spencer's administration, for the committee, after a careful and detailed investigation, and a comparison with other large tramways, unanimously report that the Bradford tramways compare favourably, both as regards working and organisation, with any other large system in the country. The accounts, both as regards income and expenditure, they find are satisfactory when compared with the accounts of similar systems and taking the local circumstances into consideration.

Falkirk.—At the meeting of the Town Council on Monday the dispute between the Council and the Scottish Central Electric Lighting Co. as to the supply of power for the trams about to be opened in the burgh, was discussed. This has now been settled by agreement, under which the electric power company pay the Council the sum of £100 towards their legal and other expenses, and the sum of £30 per annum. The tramway system will be inaugurated within the next few days. The company are at present restricting the cars to 18. Of that number 15 have already been completed. The cars, which have been made in France, are of the double-decked type, and have a holding capacity for 50 passengers. The high-tension supply of 3 000 volts is transmitted to the sub-station, where it is converted to a pressure of 500 volts, which is the line voltage. The contractors for the entire undertaking are Messrs. Bruce Peebles and Co.

Collision.—At the Hyde Borough Police Court last week Thomas Edwards, a car driver, of Stalybridge, was charged with not bringing his tramcar to a standstill to avoid impending danger in Mottram road. A witness stated that he was riding a horse up Mottram-road, towards the arches; he had a halter on the horse, and the rope was in its mouth. He was proceeding up the centre of the road and saw a tramcar coming in the opposite direction. He tried to take his horse out of the tram track, but there was some water on the roadside and the horse would not face it. Witness then shouted two or three times to the car driver to pull up, but he did not do so. The car dashed into witness's horse, and witness was thrown through the front window of the car. His horse died shortly after the accident. Witness's head was badly cut, and he was not able to follow his work properly yet. The car was coming at a furious speed. He shouted first time when the car was about 50 yards away. For the defence it was contended that the occurrence was quite accidental, and it was stated that defendant bore a good character. Finally, the Bench imposed a fine of 5s.

Torquay.—At the meeting of the Town Council on Tuesday, the town clerk reported having written to the Dolter Electric Traction Co conveying the resolution of the last meeting of the Council that they would only approve of the suggested alterations of tramway routes provided the company relieved the Council of their obligation under their agreement in the event of the Council failing to obtain the consent of the Local Government Board to the proposed loan enabling them to supply the current for working the trams. In their reply, the company stated that the resolution could not be entertained. "The directors," the letter proceeded, "had gone considerably out of their way to assist the Council in the very awkward position in which they had been placed in regard to their proposed new electricity works. It was quite clear under the Act that the Council had to supply the current, but where they supplied the current from was of no moment to the company." The company would now act strictly in accordance with the terms of the Act. After some discussion the matter was referred to committee. The Council have rejected the company's application for leave to lay a line along the sea-front, æsthetic considerations being the reason.

Preston.—The Corporation's official booklet describing the history of the tramway system contains some interesting information. The actual reconstruction of the tramways for electric traction, with standard gauge instead of the 5ft. 6in. gauge used with the horse trams, was commenced on the expiration of the lease to Messrs. Harding and Co., at the end of 1903. Two routes were opened for service in the following June, and in January of this year an extension to the Bowling green Inn was completed. The extent of the system is 10 54 route miles, partly double and partly single track, this work and the overhead equipment being carried out by Messrs. Dick, Kerr, and Co. The Corporation's generating station takes a supply of steam from the refuse destructor. Two Lancashire boilers are at present installed in the boiler-house, and the engine-room contains two 300 kw. Dick-Kerr compound-wound generators, while there is accommodation for another 500 kw. set. The engines are of the horizontal cross-compound type, built by Messrs. Cole, Marchent, and Morley, of Bradford. Each generating set is specially designed to run for two hours on a 25 per cent. overload, and a momentary overload of 50 per cent. above the normal. Official tests of the plant showed the consumption to be 12 25lb. steam per indicated horse-power, and 19 5 lb. steam per kilowatt-hour measured at the terminals of the generators, the combined efficiency of the engine and generator being 85 per cent. The cars were built by the Electric Railway and Tramway Carriage Works, of Preston, and 26 of them are mounted on Brill single trucks with 30 in. steel-tyred wheels, the wheel base being 5ft. For the overhead equipment, span and side bracket construction was adopted. Altogether Mr. W. H. Tittensor, the engineer and manager, has charge of an excellent system.

New American Electric Railway.—A Pittsburg correspondent of the *Times* writes that the Spokane and Iceland Railroad, which runs for 150 miles through a fairly well-developed part of the State of Washington, is to be exclusively equipped for that length with electric power for traction purposes. Steam is to be barred out from any portion of the line, though for the ordinary interchange of passenger and goods traffic the line will be operated to connect with other steam railways. The step is regarded as notable in that the railroad mentioned is the first to decide upon electricity as the sole tractive power. In the construction of the line, however, there appears at first to have been no leaning towards electrical equipment, steam services being contemplated, until a difficulty arose in the high cost of coal in the part of Washington through which the line is to run. Thereupon a standard electric railway with standard equipment throughout was determined on, and the Westinghouse Electric and Manufacturing Co. has been awarded the contract. The single-phase alternating-current system is to be adopted, it being regarded as the most economical for long-distance transmission of power and as dispensing with sub-power stations, while energy is to be generated from a large water-power plant near Spokane. The trolley system is to be used for operating the locomotives, and the one power-house only which the single-phase system of current renders possible will suffice for general traction and shunting purposes, for the lighting and heating of the trains and stations, and for supplying power to the company's works. The initial cost of the work is named at £100,000. The correspondent remarks that the contract is significant in view of the tenacious clinging to steam power by the ordinary American railways and the consequent retarded efforts of electricity to obtain any real footing hitherto.

Croydon.—In reference to our note last week, the following is the text of the terms offered by the British Electric Traction Co. for a renewal of the lease: (1) An increased yearly payment of ½ per cent. on the expenditure for the time being by the Corporation in connection with the tramways—*i.e.*, a yearly payment at the rate of 7 per cent. in place of 6½ per cent. as provided in the present lease. As the expenditure by the Corporation as at Dec 31 last amounted to £237 512. 8s. 10d., the increased percentage represents an additional yearly payment of £1.187. 11s. 4d. (2) An increased yearly payment in respect to road repairs of £100 per mile where the road is paved with wood, and £50 per mile where the road is paved with any other material, for each mile of single track, and of £200 per mile where the road is paved with wood, and £125 per mile where the road is paved with any other material, for each mile of double track. The scale fixed in the present lease is £100 per annum per mile of route, and the yearly payment amounts to £1,076. 19s. 6d. The increased scale represents an additional yearly payment of £1,732. 9s. (3) A farther yearly sum equal to 25 per cent. of the net profit realised from the working of the leased lines, such profit to be arrived at after charging 7 per cent. on the capital employed in the working of the lines, other than that provided by the Corporation, such as the cost of the additional cars provided by us. (4) Electrical energy to be supplied by the Corporation for the working of the leased lines, and for lighting purposes at the price fixed in the present lease—viz., 2d. per Board of Trade unit. (5) Tramway No 20, which is to be constructed by the Corporation under the provisions of the Act of 1902, and the further extensions of the Corporation's tramways for which the Corporation have recently obtained the sanction of Parliament, if and when the Corporation construct the same, to be leased on the same terms and conditions as the existing tramways, and the lease to be coterminous. (6) The Corporation to be entitled to inspect the books and accounts of the working of the leased tramways for the purpose of ascertaining the amount of any payment to be made to the Corporation under paragraph 3 hereof. (7) The new lease to be for the term of 21 years from June 1, 1906, determinable at the end of seven or 14 years by six months' previous notice in writing to be given by either side. The company allude to the fact that they have obtained powers for constructing a system in Mitcham, and point out the advantages to be derived from working the connected lines under one management.

LIGHTING AND GENERAL.

Leek.—Mr. Kenneth Faulkner has been admitted as pupil to the electrical engineer.

Sutton Coldfield.—Sanction has been received to the borrowing of £8.000 for electricity purposes.

Eastbourne.—The Corporation are about to lay cables for the electric lighting of Hampden Park and Willingdon.

Dundee Telephonists.—The Women's Trade Union League have recently formed a local branch of telephone operators.

Eastern Extension Telegraph Co.—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share.

Gloucester.—Sanction has been received to borrow £11.610 for the purposes of the electricity undertaking (extension of buildings and plant).

Stirling.—After investigation, the recent breakdown has been found to be due to an injury to the armoured cable caused by a blow from a pickaxe.

Reuter's Telegram Co.—The directors have declared an interim dividend at the rate of 5 per cent. per annum for the half-year ended June 30 last.

Award.—The jury at the Liége Exhibition has give the Grand Prix to Marconi's Wireless Telegraph Co. for their exhibit of wireless telegraph apparatus.

Edison and Swan United Electric Light Co.—The directors recommend a dividend for the year ended June 30 last of 2½ per cent. on the "A" shares.

Kettering.—The Kettering Working Men's Club is now lighted by electricity. Messrs. Thompson and Co. were the contractors, and the cost was about £105.

Agency.—The British Johns-Manville Co. have been appointed sole agents for the McGillivray system of emergency lighting for cars, trains, and public buildings.

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Accrington.—The units delivered for week ending Sept. 16 were 7,241, as compared with 4,200 units for corresponding week last year, an increase of 3 041 units, or 72 per cent.

Carrickfergus.—The Lighting Committee have been instructed to make inquiries as to the best means of lighting the town, and find out the cost of an electric plant or new gas plant.

Portsmouth.—The Horndean Light Railway Company have decided to generate their own current and to run a 20 minutes' service from Cosham to Horndean during the winter months.

Salford.—The Council have agreed to allow power consumers (from Jan. 1) to use 15 per cent. of their consumption of electric current for lighting purposes at the power rate.

Direct United States Cable Co.—The directors have resolved upon the payment of an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ended Sept. 30, 1905

Competition.—A competition of electric lighting and heating apparatus is being opened in connection with an exhibition to be held between Oct. 15 and Nov. 15 under the auspices of *Le Batiment*, a Paris journal.

Islington.—An estimate of £80, the cost of providing and laying the necessary length of low-tension distributing main, to meet an application for a supply of electricity for power purposes, has been approved.

Worksop.—Sanction has been received to a loan of £3 000 for electric light purposes (without an inquiry). The period of 16 years has been fixed for repayment, and an extension to 25 years is being asked for.

South Metropolitan Electric Light and Power Co.—The warrants for the payment of the interest on the 4½ per cent. first mortgage debenture stock of this company, payable on Oct. 1, have been posted.

Kensington.—The Brompton and Kensington Electricity Supply Co. are distributing circulars among their customers in Kensington stating that for the purpose of power, heating, and cooking electricity can now be obtained at the rate of 1d. per unit.

Gomersal.—An application of the Yorkshire Electrical Distribution for the Council's assent to their application for a provisional order authorising them to supply electrical energy at Gomersal will come before a special meeting of the Council shortly.

Dunfermline.—The Corporation and the Fife Electric Power Co. are still negotiating, but the Town Council Committee at present decline to agree to guarantee a maximum quantity of 50,000 units being taken for the first year at the rate of 1⅞d. per unit.

Hammersmith.—The premises of 18 additional consumers, representing a maximum of 378 8-c.p. lamps, have been connected to the mains, and seven consumers have been disconnected, the present number of consumers taking current from the mains being 1,661.

Spanish Cables.—As it is considered impossible to further repair the Canaries cable the Minister of the Interior will propose to the Chamber of Deputies the laying of a new cable. He will likewise propose the laying of a new cable between Spain and North Africa.

Cardiff.—With regard to telephones, tell-tales, fire-alarms, and electric bells at the new asylum at Whitchurch, it has been decided that firms named by the architects with any others suggested by the borough electrical engineer should be asked to tender for the work.

New Address.—The offices of the Midland Electric Corporation for Power Distribution, Limited (J. Hardie McLean, M.I.E.E., general manager and engineer), have been removed from 73, Lichfield-street Wolverhampton, to Colmore House, Waterloo-street, Birmingham.

Falkirk.—The Council have decided to reduce the price of electricity for power purposes to 2d. per unit for the first hour per day of maximum demand, 1½d. for the next two hours, and 1d. per unit thereafter, but with a minimum charge of 40s. per annum. The new rates come into force with the January term.

Bruce Peebles and Co.—An interim dividend has been paid on the original issue of the preference shares at the rate of 6 per cent. per annum for the half year to June 30, 1905, and on the recent new issue of preference shares at the rate of 6 per cent. per annum for the period ending June 30, 1905.

Maidenhead.—Mains are to be laid to Upper Taplow. The following prices have been agreed to in connection with a prospective consumer—namely: for the first 10,000 units per annum, 2d. per unit; for the second 10 000 units per annum, 1½d. per unit; and any further consumption at 1¼d. per unit.

Whitby.—An electrical exhibition is being held with the object of popularising the light and promoting the use of electricity in all its branches in the town. The arrangements were made by Mr. L. H. King, electrical engineer to the Whitby Urban District Council, assisted by Mr. J. Hawes, the Council's assistant electrical engineer.

Brighton.—The ratepayers' association have passed a resolution to the effect that, in view of the action taken by the Postmaster-General and the inconvenience caused to traders by a dual system of telephones, the ratepayers' federation should urge upon the Council the necessity of commencing negotiations for the disposal of the municipal undertaking.

Hull.—The Electric Lighting Committee have decided to lay the mains in Victoria-avenue at an estimated cost of £140. The electrical engineer, Mr. Bell, has been asked to report upon the advisability of laying a cable to St. Andrew's Dock. The agreement which had been prepared for the hiring of electric motors from the Corporation has been approved.

London Gazette.—The partnership between Edwin C. Wallace and E. H. Watson, electrical engineers, 36, Trinity-street, Leeds, has been dissolved by mutual consent. The last day for receiving proofs in the estate of Alexander Holland, electrical engineer, trading as the Electrical and Mechanical Engineering Co. at 13, Bridgwater-street, Farnworth, Lancs., is Oct. 14.

New Firms.—Mr. H. S. Meyer, M.I.E.E., who for the last five years has been the British Thomson-Houston Co.'s chief designing and consulting engineer for alternating-current work, has resigned his position to open an office in London as electrical expert and advising engineer. Mr. John E. Raworth has opened an office at the Queen Anne's-chambers, Westminster, as a patent agent.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 11 special settling day for Babcock and Wilcox's further issue of 270 000 ordinary shares of £1 each, Nos. 530,001 to 800,000, and have ordered the said securities to be quoted in the official list. The committee have also been asked to allow the Indian Electric Supply and Traction Co.'s £125 000 6 per cent. construction debenture stock to be quoted in the official list.

New Atlantic Cable.—A Reuter telegram says the cable steamer "Colonia," which left Canso on Sept. 23 paying out the Commercial Cable Co.'s new Atlantic cable, arrived at 6 p.m. on Tuesday at the point 187 miles from the Irish coast, where she has to make her final splice between her ocean cable and the cable laid westward from Ireland by the steamer "Cambria" in June last. This makes the fifth Atlantic cable laid by the Commercial Co.

King's Norton.—A special meeting of the Council will be held to consider the Electric Lighting Committee's recommendation that they should be authorised to continue the negotiations with Callender's Cable and Construction Co., Belliss and Morcom, and the Electric Construction Co. as to the proposed establishment of an undertaking under the electric lighting order, 1898, and to settle with them the terms of the agreements to be entered into by the Council with the proposed new company.

York.—A scheme for lighting Gillygate, Castlegate, Fishergate, and Fulford-road (as far as the barracks) with electricity in place of gas will come before the next meeting of the Lighting Committee. The electric mains for this scheme have already been laid, and it is proposed to use enclosed arc lamps. A scheme for converting the gas lamps in Scarcroft-road and Bishopthorpe-road (as far as main extends) into incandescent electric of the same candle-power as the present gas lamps is also under consideration.

Derby.—The Electric Lighting Committee in their last report recommend a further reduction in the sliding scale of charges for the supply of electricity by ¼d. on each item, as follows: not exceeding 2 000 units per quarter, 4½d.; over 2,000 units and not exceeding 3,000, 4¼d.; over 3,000 and not exceeding 4,000, 4d.; all quantities over 4,000 units per quarter, 3¾d.; and to reduce the charges on the maximum demand system from 6d. for the first hour and 3d. afterwards to 6d. for the first hour and 2½d. afterwards.

St. Marylebone.—It is anticipated that the whole of the 6,000 consumers in the St. Marylebone district will have been transferred from the system of the Metropolitan Electric Supply Co. to that of the Borough Council's by the beginning of 1906. The whole of the district at the present time is being supplied with both continuous and alternating current at pressures varying from 50 to 240 volts. The whole of the consumers' installations have been overhauled, and the conversion of the pressure to 240 volts continuous current is being proceeded with as rapidly as possible.

Buncrana.—The Buncrana Electric Supply Co.'s undertaking was opened yesterday. The station engineer-in-charge is Mr. John K. Swan. In connection with the carrying out of the contract the following were contractors: engineers—hydraulic and power, Mr. James F. Maryon, C.E., London; electrical, Mr. Lewis J. Lawless, A.I.E.E., Dublin; engines, turbines and steel-pipe line supplied by James Gordon and Co., London; dynamos, motor and balancer set by Crompton and Co., Chelmsford; switchboard and resistances by General Electric Co., Witton; power-house buildings erected by Mr. Humphrey Campbell, Buncrana. The engine-room contains two direct-current Leffel water-turbines and continuous-current shunt-wound generators. The turbines are designed to develop 65 b.h.p. on the coupling when working under a head of about 60 ft., the water being conveyed from the upper level by means of riveted steel piping of 28in. internal diameter. The dynamos are of Messrs. Crompton's four-pole type, having self-oiling ring bearings and carbon brushes. The sets run at a speed of 780 r.p.m., and one of these duplicate sets will be sufficient for dealing with the present lighting requirements, the second being held in reserve for immediate use in the event of anything going wrong with the other turbine or generator. The equipment also comprises a gas-engine capable of working up to 75 b.h.p., and a third electric generator arranged for belt driving from the gas-engine or mill turbine. The engine is by Messrs. Grice, of Birmingham, arranged to work with suction gas supplied from a special producer plant contained in a compartment adjoining the engine-room. The distribution of the electric energy for the public and private lighting is by means of bare copper cables, carried overhead on poles spaced about 130ft. apart. The service is carried out on the three-wire system at 235 volts between either mains and the neutral conductor, the maximum voltage between the outside wires being 470. An independent service is provided for the street lamps controlled directly from the power-house. There are five arc lamps, besides a large number of smaller lamps, varying in power from 80 to 50 candles each, for the less important positions. The street lamps are in all cases enclosed in watertight lanterns, mounted on brackets fixed to the poles carrying the overhead cables, and each lamp will be protected by a fuse to cut out the fitting in case of any fault in the lamp sockets or connections. House connections are made by means of overhead service lines leading directly from the nearest connecting point to insulators fixed on the consumers' premises, and connection inside each house is carried out by means of special cable connecting the source of supply with the wiring contractor's cables.

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Handsworth.—The formal opening of the electric lighting station in Piers-road will take place on Monday, when Sir A. B. W. Kennedy, the consulting engineer of the works, will give an account of the undertaking. Dr. A. T. Holdsworth, chairman of the Council, will unveil a bronze tablet fixed to the front of the building recording the date of opening. Afterwards Councillor Fred Tibbitts, chairman of the Parliamentary and Electric Supply Committee, will unlock the door of the principal entrance and declare the building open, and Mrs. Tibbitts will set the machinery in motion.

Dudley.—The electrical undertaking has now been running about five years. It provides current for the tramways, for several factories, and for the lighting of the main thoroughfares of the town and of many private residences and shops. The works and distributing plant has cost nearly £80,000. After provision had been made for principal and interest, there has remained every year a profit of a few hundreds of pounds, which have been placed to a reserve fund. An inquiry has been held into the application of the Town Council for sanction to borrow £21,000 for purposes of their electrical undertaking.

Southwark.—The Electric Light Committee reported at the last meeting of the Borough Council on a communication from the Electric Contractors' Association on the powers sought to be given borough councils to wire and fit consumers' premises for the use of electrical energy. As our readers are aware, the clause giving such powers was struck out of the County Council (General Powers) Bill last session by the House of Lords Committee after having passed the House of Commons. The Council adopted a recommendation that the County Council be urged to insert the clause in their next General Powers Bill.

Aston.—The second anniversary of the opening of the electric power station was celebrated last week. At a dinner the Chairman of the Electricity Committee (Councillor A. E. Godrich) said that whilst the number of units sold in August, 1904, was 78,432, it had grown to 118,616 units in August of the present year. The price they charged for lighting purposes was lower than any other place in the country. They charged for lighting purposes a maximum of 3¾d. per unit, and a minimum of 2½d. per unit, less 5 per cent. if the amount was paid promptly. Subject to the approval of both Councils, they had arranged to supply electrical energy to Erdington.

Elstead.—The Hambledon Rural District Council have been discussing a proposal under which the highways would be lighted by lamps affixed to the telegraph poles. The suggestion comes from Mr. A. Allen, who contends that the authorities by placing very large timbers as poles for the telegraph and telephone services were shutting out the light of the roads, and he thought both the main and the district roads should be lighted, and that the authorities that were erecting the poles should be asked to light, if not every second pole, every third one. He thought that the County Council, who derived great revenue from motorists and vehicular traffic, and the postal authorities might help them in the matter.

Fochabers.—The water power to generate the electric light for Gordon Castle and Fochabers was turned on on Tuesday by the Duke of Richmond and Gordon. Mr. Morgan, the Glasgow manager of Messrs. Gorham and Drake, the electrical engineering firm who have the contract; Mr. Miles, the resident manager for the firm; Mr. Ritchie (of Messrs Carrick and Ritchie, Edinburgh, who have had the building up of the turbines) attended. The sluice gates are at the head of a canal which is a mile long, and leads to the power-house. After the sluices were shut and those conveying the water on to the turbines raised, the Duke turned the lever in the power-house, which let the water on to the turbine, the dynamo instantly revolving.

Guernsey.—Sir Henry Giffard, President of the States, on Tuesday inaugurated the new multiple switchboard, forming a principal part of the extensive improvements of the central exchange of the municipal telephone department, and carried out at a cost of £2 600. Major-General Mainguy (chairman of the States Telephone Council), Colonel Bird, and others attended. The new switchboard was built by the International Electric Co. to the special design of Mr. A. R. Bennett. It enables each operator alone to connect any two subscribers. The Guernsey municipal telephone now numbers nearly 1,100 subscribers, being in proportion of one telephone to every 28 inhabitants against one in 70 in London, and one in 40 in Glasgow. Although the charges are low the department has made an annual profit since its formation over and above the amount required for interest on capital, provision of sinking fund, etc.

Lamp Testing.—The Westminster Electrical Testing Laboratory (the Electrical Testing Laboratories, Limited), York-mansion, York-street, Westminster, have published a new scale of fees. This is prefaced with some general remarks, in the course of which it is stated that incandescent lamps on life test are run on a circuit taking current from the Westminster Electric Supply Co.'s mains. The voltage is kept almost absolutely constant at 200 volts by means of a specially designed automatic regulator. The recording voltmeter, which is maintained always on the circuit, shows that the voltage never rises more than 1 per cent. above 200, and this amount only for a minute or so at a time whilst the regulator is coming into action. An excess pressure cut out which can act quickly is connected to the circuit, to act as a safeguard to the lamp in the event of a very sudden rise of voltage occurring, against which the automatic regulator might not act sufficiently quickly. For lamps taking more than 200 volts, cells are added to the circuit to make up to the voltage required. 100-volt lamps are arranged in two banks in series, and are connected to balancing cells, which are capable of maintaining the balance of the voltage should a lamp fail.

Venezuelan Cable.—The *Globe's* New York correspondent wires on Oct. 3 that the fact that the French ambassador and President Roosevelt had a 20 minutes' talk that day appears to be the only foundation for the announcement that Franco-American action of a drastic character is about to be taken against Venezuela. It is asserted now on behalf of President Castro that if the company and the Government had been allowed quietly to arrange matters the price to be paid for the company's land lines would have been settled by mutual concessions weeks ago, and then the Government would spontaneously have allowed the company two more coast stations, and an office in the capital. But according to President Castro, the good diplomats stepped in and spoiled everything. This display of benevolence seems, however, to be overdone. The company concession was granted in 1887, the first cable was landed the following year, and there have been constant troubles ever since, including a period of three years during which the Venezuelan Government prevented the company from doing any business whatsoever. A dispatch from Caracas of Monday's date says the French Cable Company, pending the arrival of its commissioners from France, has consented to the closing of its offices at Caracas and on the coast. Mr. Calhoun, the special United States commissioner to Venezuela, has sailed for home.

Hanley.—The Coventry Town Council are endeavouring, in conjunction with the local chamber of commerce, to seek increased facilities in the public telegraph service, particularly in respect of the provision of a continuous day and night and Sunday service, both for the receipt and delivery of telegrams, being of opinion that such a service should be established in all towns with a population exceeding 50,000. A resolution in favour of a continuous day and night and Sunday telegraph service being established in all county boroughs has been confirmed. The Board of Trade have approved of the Council as undertakers of the Hanley Electric Lighting Order, 1891, connecting the inter-conductor of their high-pressure mains with earth and the connection with earth of the intermediate conductor of the three-wire system at the new post office, their approval to be revoked or varied at any time. The Board also approved the supply of power up to 150 kw. in underground sub-stations of street boxes. An application for an electric motor of 7½ h.p. on the hire-purchase terms has been agreed to, the terms of payment aggregating £33. 10s., spread over two years, and a motor will be ordered for the purpose from Messrs. Brooks, of Huddersfield. Further applications were received which will probably be dealt with from stock. The Electric Lighting Committee are considering a report in which the electrical engineer stated that he had carried out some experiments on street-lighting, and that, with a view to improving the effect of the lamps in Etruria road and Victoria-road, he recommended that silvered glass reflectors be fitted to such lamps as a charge on the lighting rate, in consideration of the electricity department providing two lamps instead of one, maintaining same and supplying the extra electricity required without change in the current prices paid per post for the public incandescent lamps.

Tunbridge Wells.—The Town Council on Wednesday considered a proposal made by Councillor Woollan for the sale of the municipal electric light undertaking to a company. The reasons advanced for this course were that the concern never had paid, and was never likely to do so. It was pointed out by the proposer of the resolution that the general body of ratepayers, whose credit was pledged for £80,000, were not likely to gain a single farthing by the working of the concern, and there was always the possibility of it becoming a charge upon the rates. In his opinion it had reached the limit of its profit earning capacity, and whilst consumers were grumbling at the high rates charged, there was no way by which the prices could be reduced without entailing a call upon the rates. If the concern were sold to a company, it would be developed in a way that the Corporation could not do, and consumers would benefit by getting a better light at a cheaper rate, and the ratepayers would be better off because a larger staff of men would be employed than was the case at the present time. Municipal trading was bad, and the want of success in regard to the Tunbridge Wells electric light was a clear proof of this. Although the accounts showed that a small profit had been made, the arrangements for the repayment of the loan were open to question, and there was no depreciation fund at all. Judged from an ordinary business standpoint, there would be a loss of £2,000 a year instead of a profit of £700. Several members spoke strongly against the proposed sale, and pointed out that the undertaking had made satisfactory progress from the first. It had paid £16,000 off the loans account, contributed £3,000 to the rates, and had a reserve fund of £4 000. It had not cost the rates a single farthing, and was never likely to. In it the town possessed a valuable monopoly, which it would be folly to part with. Alderman Robb, the chairman of the Lighting Committee, said, although convinced that municipal trading was a curse to the country, he would be lacking in his duty to the ratepayers if he did not tell them that they had a very valuable undertaking. It had progressed every year, but it might have done more if the Council had been more sympathetic towards the recommendations of the Lighting Committee. If it was worth keeping at all, it ought to be pushed for all it was worth. He strongly opposed any sale at the present time. On a vote being taken, the Council decided by 17 votes to 7 not to sell the undertaking.

Wireless Telegraphy.—The Gesellschaft für drahtlose Telegraphie, Berlin, report the following work at present being executed by them. Holland: The Dutch military authorities are at the present time making manœuvre trials with transportable stations, and, if satisfactory, a number of military stations will be ordered for their colonies. Several stations of 180 km. range have been ordered. The place of erection is at present unknown; presumably they are required for warships in the Dutch East Indies. Norway: Two stations have been installed on the Lofoten Islands. Turkey: The two large stations—viz., Rhodos, in Asia Minor, and Derna, in North Africa—are nearing their completion, and will most likely be taken into operation in a few weeks, although somewhat great difficulty has been experienced on account of a lack of a sufficiently experienced staff. Peru: Three engineers who have been on the way with the two stations to be installed in the interior of Peru since Feb. 6, have only just arrived in Masisea and Puerto Bermudez, after having met with great difficulties in the transport of the machines

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and iron towers. This transport, on account of the low level of the water and the many cataracts, had to be effected principally in open boats, the main difficulties being now, however, overcome. The erection of the stations will, therefore, be taken in hand in the course of the present month. Brazil: In August of the present year the Brazilian training-ship "The Benjamin Constan" arrived in Cherbourg, on which occasion complete Tel-funken apparatus were installed. Germany: The "Reichspost" (Government postal service) has, as is well known, been engaged for some time with experiments in wireless telegraphy. Two experimental stations "system Telefunken" having been erected in Berlin, and the results obtained by the same having proved that our system fulfils the high requirements of the Imperial Post, the official stations between Borkum Rift lightship and the lighthouse at Borkum were installed. The establishment of a connection between the Borkum lightship and the naval station at Heligoland was also carried out. The erection of a large station which it had been intended for a long time to build for the purpose of controlling the whole of the North Sea, was also taken in hand. This station is now being installed at Norddeich, near Emden, the preliminary work—viz, the foundations for the towers, the erection of the station house—having already so far progressed that the building of the four iron lattice towers of 60m. to 70m. high, and the putting down of the machines, can now be commenced. Switzerland: The Swiss War Department are installing at the present time two wireless telegraphic stations—system "Telefunken"—for the intercommunication of the fortresses of Rigi-Scheidegg and St. Gotthardt. This department has also purchased from the Gesellschaft für drahtlose Telegraphie m. b. H., Berlin, several portable stations, which are regarded as especially practical for mountainous country.

PROVISIONAL PATENTS, 1905.

SEPT. 25.

19342. Improved magnetic apparatus for advertising purposes. Gustaf Charles Lundberg, 477, Liverpool-street, London.

19345. Improvements in holders and connections for electric incandescent lamps. John Robert Quain, 6, Waterford-road, London.

19355. Improved means for automatically operating gas or other valves or electric switches at predetermined times. Arnold Hare, 111, Hatton-garden, London.

19368. Improvements in brush-holders for dynamo-electric machinery. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, London. (Complete specification.)

19372. Electrically-operated electromagnetic valves. Walter Clifford Northcott, Eyre, Coote Townsend, and Egmont Charles Hoegerstaldt, 5, Great Winchester-street, London. (Complete specification.)

19379. Process for the production of incandescent filaments for electric incandescence lamps. The Deutsche Gasglühlicht Akt.-Ges. [Auer Ges.] 322, High Holborn, London. (Date applied for under Patents Act, 1901. Jan. 17, 1905, being date of application in Germany.) (Complete specification.)

SEPT. 26.

19425. Improvements in and relating to electro-capillary apparatus. Ernest Oldenbourg, 61, Chancery-lane, London.

19447. A new or improved connectors for electric conductors. Edward Wilmer Hill, Norfolk House, Norfolk-street, London.

19483. Improvements in hydraulic lifts electrically operated. Edmond Meyer Tudor Boddam, 23, Savernake-road, London.

SEPT. 27.

19495. Improvements in electric radiators or heaters. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

19504. Improvements in trolley pole controllers. Andrew Lafayette Prentise, 18, Southampton-buildings, Chancery-lane, London.

19545. Improvements in and connected with electric meters. John Mesny Tourtel, 33, Cannon-street, London.

19551. Improvements in electrical time switches. Edward Du Bois, Norfolk House, Norfolk-street, London.

19553. Improvements relating to telephones especially adapted for the use of partially deaf persons. Cecil Nathan and John James Leyland, 322, High Holborn, London.

19554. Improvements in indicating or checking devices for use in connection with telephones. Henry Brown Sheldon and Frank Morris Elliott, 6, Lord-street, Liverpool.

19561 Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

SEPT. 28.

19568. Improvements in electrically-controlled semaphore signals for railways. Frank Bartholomew Holt and Arthur Wallis, Telegraph Department, Midland Railway, Derby.

19603. Improvements in and relating to automatic electrical circuit breakers. Crompton and Co., Limited, and Robert Charles Harris, 55, Chancery-lane, London.

19616. Improvements in electric batteries. Georges Schauli, 173, Fleet-street, London.

19631. Improvements in primary electric batteries. Majs Christensen, 40, Chancery-lane, London.

19633. Improvements relating to sockets for holding electric lamps and the like. Frederick Millington, 322, High Holborn, London.

19638. Process for the electrolytic production of copper. Johannes Albert Wilhelm Borchers, Franz Emil Güsher, and Paul Rudolf Frankf, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 4, 1904, being date of application in Germany.) (Complete specification.)

SEPT. 29.

19657. Electric transformer controller. George Tilden Hanchett, De Witt Clinton Conkling, and John Edward Winn, 57, Barton-arcade, Manchester. (Complete specification.)

19680. An improved form and method for holding and insulating flexible cords and wires in connection with electric lampholders and other electric appliances. Frank MacCallum, 61, Piccadilly, Manchester.

19684. Improved means of attaching and detaching the reflectors of electric lights. Walter Bell, 4, St. Ann's-square, Manchester.

19698. Improvements in electric lighting apparatus for shop-window lighting and the like. Henry Langdon Vickery, 5 Budge-row, London.

19706. Improved replacement action for intercommunication telephones. William John Roach, 5, Palmer-street, Westminster, London.

19712. Improvements in or relating to electric arc lamps. André E. Blondel, 111, Hatton-garden, London. (Complete specification.)

19719. Improvements in reflectors for electric arc lamps. Milton Victor Ely and Edwin Rudolph Grote, Worple-road, Wimbledon, Surrey. (Complete specification.)

19746. Improvements in or connected with trolley heads for electric tramcars or the like. Frank Hewer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

SEPT. 30.

19752. Improvements in road vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.) (Complete specification.)

19753. Improvements in insulated belts for electric tramway systems and the like. James Haydock and Thomas Smith Jones, Penny Bank-chambers, Halifax. (Complete specification.)

19816. Improvements in or relating to electrical fuse or cut-out boxes. Robert Rumney and Henry Hepher Bishop, Birkbeck Bank-chambers Chancery-lane, London.

19819. Improved device for strengthening telephone currents. Franz Oprendek, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19823. Improvements in or connected with means for supporting and insulating overhead conductors for electric tramways or railways. Frank Hewer, 221, Birkbeck Bank-chambers, Southampton-buildings, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 19.

1904.

20877. Magnetic separators. Goodwin and Hollidge.

21962. Dynamo-electric machines. British Thomson-Houston Company, Limited, and Clinker.

23097. Electrical measuring instruments. Fricker.

23109. Electro-capillary apparatus. Armstrong and Orling.

23816 Electric control systems particularly applicable to electrically heated and propelled vehicles. British Thomson-Houston Company, Limited. (General Electric Company.)

23971. Electric device adapted for circuit closing, indicating, power transmitting, and other purposes. Anders and Byng.

24030 Electric time switch or contactor. Jones.

24432 Electro-mechanical synchronisation apparatus. Bonniksen.

24960. Electric brakes or interruptors and means for operating the same. Davis.

25276. Vapour electric lamps, rectifiers, and the like. British Thomson-Houston Company, Limited. (General Electric Company.)

25524. Electric lighting of railway carriages and the like. Imray. (Denham.)

25630. Syatems of control for electrically-operated doors. British Thomson-Houston Company, Limited. (General Electric Company.)

25634. Seals for vacuum tubes. British Thomson-Houston Company, Limited. (General Electric Company.)

25705. Electric projecting lamps chiefly for enlarging and projecting lanterns. Kamm.

25730. Dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

28889. Electric fire-alarm and like circuits. Abrahamson.

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25963. Apparatus for the distribution of electric current. Atkinson.

1905.

424. Working of single lines of railway on the electric staff or other electric systems. Jacobs.

1281. Devices for use in controlling polyphase and monophase alternating-current motors. Siemens Bros. and Co., Limited, and Berry.

2190. Starting switches for electric motors. Clatworthy, Holmes, Holmes, Holmes, and Holmes.

10647. Electric cables. Smith and Granville.

10804. Single-phase alternating-current meters. Allmänna Svenska Elektriska Aktiebolaget. (Date applied for under International Convention, Sept. 15, 1904.)

10553. Electric arc lamps. Weedon. (Date applied for under International Convention, May 20, 1904.)

11169. Carbon-holders for arc lamps. Siemens Bros. and Co., Limited. (Schuckertwerke, G. m. b. H.)

11329. Device for lowering the vacuum of X-ray and other vacuum tubes. Cressor.

11361. Secondary battery plates Hubbell.

13381. Electrodes for electric arc lamps British Thomson-Houston Company, Limited. (General Electric Company.)

13679. Aerials for the transmission and receipt of electromagnetic wave energy. Fessenden.

15658. Telephone attachments Damico.

15673. Electric lamp bulb and method of and apparatus for finishing same. McDonald. (Date applied for under International Convention, Nov 2, 1904.)

16075. Means for supplying and cutting off currents of high potential to and from conducting lines. Siemens Schuckertwerke, G. m. b. H. (Date applied for under International Convention, Feb. 23, 1905.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-1
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	98-100
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275,001-375,000	5 ..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	91-94
—— 4½ per cent. 2nd Debenture Stock	100 ..	78-81
Callender's Cable, Debentures	100 ..	109-111
—— Ordinary	5 ..	10½-11½
—— 5 per cent. Pref.	5 ..	5⅛-5¼
Crompton and Co.	3 ..	1⅜-1¼
—— 5 per cent. Debentures	100 ..	95-100 p.c
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1⅜-1⅝
—— "A" Shares, 01-017,139	5 ..	2-2½
—— 5 per cent. Debentures	100 ..	90 95 xd
—— 4 per cent. Deb Stock, Red.	100 ..	83 88
Electric Construction, Nos. 1 to 112,100	9 ..	⅛-1¼
—— 7 per cent. Cumulative Pref.	2 ..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	96-98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
General Electric Company (1900), 5 per cent Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-100 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	12 13
—— 4½ per cent. Preference	5 ..	⅛-⅜
—— 4½ per cent. Debentures	100 ..	09 111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	99-102 xd
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	34 36
—— 5 per cent. Bonds	100 ..	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	12 12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red	100 ..	106 108
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅝ xd
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	104-107
Brompton and Kensington, Ordinary	5 ..	9½-10¼
—— 7 per cent. Preference	5 ..	9⅝ 10⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9¼ 9⅜
—— Nos. 60,001-80,000	5 ..	9 9¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13.
Central Electric Supply, 4 per cent. Guar. Deb Stock	100 ..	103-106
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	6⅜-7¼
—— 4½ per cent Cum. Pref., 1-80,000	5 ..	4¼-5⅛
—— 4 per cent. Debenture Stock, Red.	100 ..	103 105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5 ..	4⅜-5
—— ditto (1903) 40,001-80,000	5 ..	4⅜-5⅛
Chelsea Electricity Supply	5 ..	5⅜ 6⅛
—— 4½ per cent Debentures	100 ..	109 111
City of London, Ordinary	10 ..	11-11½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	104 106
County of London Electric Supply, Ordinary	10 ..	8¾-9¼
—— 6 per cent. Cum. Pref	10 ..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent 2nd Debentures Prov. Certs	100 ..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100 ..	108-110
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5½ 5¾ xd
—— 4½ per cent First Deb. Stock, Red.	100 ..	99 102
Havana Electricity, 1-15,000	10 ..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5 ..	8-8½
Isle of Wight Elec Lt and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1,150,000	1 ..	15/16-1 1/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	12 12¾
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent Pref	5 ..	4¼-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 00,001-30,000	5 ..	10½ 11
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109 113
—— 4½ per cent. Cum. Pref.	5 ..	5⅜ 5¾
—— 3½ per cent. Mortgage Debenture, Red	100 ..	100 102
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	100-102 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5 ..	7¼ 8¼
—— do., 57,0 0-75,0 0	5 ..	7¾-8¼
—— 5 per cent. Pref., 1-57,00	5 ..	6¼ 6¾
—— do., 57,0 0-75,0 0	5 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	14 15
—— 4 per cent. First Mort. Debs. Nos. 1-5.0 (Reg.)	100 ..	98 100 xd
Oxford Electric, Ordinary, 1-95 and 40-14,510	5 ..	6¼-7
4 per cent. Debenture Stock	100 ..	100 102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-103 x i
Smithfield Markets Electric Supply, Ord 1-12,000	5 ..	2¼ 21
—— 4 per cent. Debenture Stock	100 ..	76-80
South London, Ordinary	5 ..	3-4
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16- 5/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb	100 ..	105-108 xd
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 10,-20,080	5 ..	14 15
—— 7 per cent. Pref	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	88 100
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅜-4¾ xd
—— 5 per cent. Cumulative Preference, 50,00.-80,000	5 ..	5-5¼ xd
Westminster, Ordinary	5 ..	12¾ 13¼
—— 5 per cent. Cum. Pref., 10,1 1-138 251	5 ..	6¼-6⅜
Electric Tramways.		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5 ..	5⅝-6¼
—— Ord.	5 ..	8 5/16-8 9/16
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	104-106
Barcelona Tramways, Ord., 1-20,000	10 ..	13¾-14¼
—— 5 per cent. Cum Pref. Shares, 1-10,000	10 ..	9.-10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101
—— 4½ per cent. Red Deb. Stock	100 ..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,605	1 ..	27/32-31/32
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13¾ 13⅞
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1-1½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	96-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	123-126
—— Ord. Pref.	100 ..	104-107
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	103-106
—— 4 per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c
—— 4, per cent. Vancouver Power Deb.	100 ..	9 -102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9-9¼
—— 6 per cent. Cm Pf., 30,001-60,000	10 ..	10¼-11
—— 5 per cent. Perpetual Debenture Stock	100 ..	122-124 xd
—— 4½ per cent. 2nd Deb Stock	100 ..	99-101
Buenos Ayres and Belgrano Trams	5 ..	3¼-4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5¾-6
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb Stock, Red.	100 ..	105-107
—— Prov. Cert., all paid	100 ..	102 105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	98-100
Calcutta Tramways, 1-102,268	5 ..	9¼-10
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-109
Cape Electric Tramways, Nos. 1-480,000	1 ..	1¼-1½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	3¼ 4¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14½
—— 6 per cent. Cum Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,0 0	10 ..	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4 per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref. Nos. 30,001-60,000	5 ..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8 8¼
London United Trys. (1901) 5 per cent. Cum Pref.	10 ..	9¼-10¼
4 per cent. 1st Mt. Db Stock, Red.	100 ..	100-103
Madras Elec. Trams (1904), 5 per cent. Deb. Stk., Rd.	100 ..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	7/32-3/32
—— 5 per cent. Cum. Pref., 500,001-1,000 000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	104-108
Montreal Street Rail., Sterling 5 per cent (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104
New General Traction, 6 per cent. Cum Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent Cum Pref	10 ..	9¾-9¾
Perth Elec. Tramways (W.A.), 5 per cent 1 Mrt. Deb Sk.	100 ..	106-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9-9.
—— 4½ per cent Debenture Stock	100 ..	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,1 2 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 —	91-93
—— 4 per cent. Pref	100 ..	101-103
—— " " deferred	100 ..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	110-112

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Name.	Amount paid. £	Last price. £
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— ,, ,, ,, '85	100	117-120
—— ,, ,, ,, '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3½-4½
—— 4 per cent. Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99½-100½
Waterloo and City, Ordinary	100	89-91

Name.	Amount paid. £	Last price. £
Telephones.—		
National Telephone, Preferred	100	112-113
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref	10	13½-14½
—— 6 per cent Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5½
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock Red.	100	104½-106½
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week. Ending	1905. £	1904. £	Increase or decrease. Week. £	Current year. £	Miles of single track open. 1905.	1904.	Accounts for past year. Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d
Aberdeen Corporation	Sep. 30	1,626	1,642	− 116	− h	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	—	—	—	—	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Oct. 1	1,039	1,078	+ 11	− 503	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	Sep. 30	330	342	+ 48	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 27	910	1,003	− 63	+ 685	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 28	1,475	1,515	− 35	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 30	815	734	+ 81	− 820	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	Oct. 1	1,812	1 814	− 12	—	40	38	March 31	95 765	20,205.196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	Sep 27	1,490	1,135	+ 354	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 30	4,387	4,888	− 500	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 24	1,058	1,052	− 3	+ 823	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 29	4,814	5,017	− 203	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 30	1,139	1,125	+ 41	—	10 60	10·60	March 31	—	—	—	—	—	—	
Burton Corporation	Oct. 1	266	344	− 78	− 1,091	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	Sep. 30	1,946	2,065	− 119	+ 233	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 23	187	202	− 15	− 702	8·5	8·5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 30	6,363	6,474	− 111	− 1,885	6	6	,, 31	347,588	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway.	Oct. 1	2,535	2,515	+ 20	− 538	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	Sep. 28	555	512	+ 43	+ 812	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	,, 1	250	251	− 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	,, 31	11,250	2,853,200	284,343	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 29	132	125	+ 7	+ 464	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 29	3,845	3,927	− 82	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 29	932	924	+ 8											
Dundee City Tramways	,, 27	1,043	893	+ 160	+ 464	22	23	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 30	835	698	+ 137	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 30	17,375	15,776	+1,599	+15,559h	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	,, 20	1,803	1,618	+ 185	+ 1,781	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 30	1,640	1,552	+ 88	+ 895	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 30	2,136	2,131	+ 5	+ 515	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 27	113	148	− 35	− 702	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 30	5,843	5,856	− 13	—	89	89	March 25	298,233	64,223,646	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	—	—	—	—	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 23	10,688	10,684	+ 4	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	Oct. 1	1,433	1,538	− 105	− 744h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	Sep. 16	15,278	13,907	+1,371	+58,332	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 28	135	165	− 29	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 30	12 815	12,585	+ 230	+14,831	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,299	6·99
Metropolitan District Railway	Oct. 1	7,465	7,009	+ 458	− 3,036	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 1	17,271	17,119	+ 152	+ 222	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	Sep. 30	130	122	+ 8	+ 330	—	2½	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 3	3,731	4,020	− 229	+ 3,213	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 11	1 511	1,142	+ 369	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 30	1,737	1,934	− 197	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	—	—	—	—	—	6½	4½	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	—	—	—	—	—	9½	7½	,, 31	23,569	5,251,472	593,054	1·07	9·53	2,612	7·49
Salford Corporation	Oct. 2	4,461	4,115	+ 346	—	70½	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 1	5,007	4,691	+ 316	+ 6,159	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	Sep 20	1,024	1,054	− 30	− 541	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 29	816	549	+ 267	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	Oct. 1	1,236	1,216	+ 20	+ 959	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	Sep 29	193	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	•
Wallasey U.D C.	,, 30	750	744	+ 6	+ 647	11·85	10·5	,, 31	38,768	7,412.881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 28	2,035	1,115	+ 920	+19,104	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	•
Wolverhampton Corporation	,, 27	795	711	+ 82	—	—	7½	,, 31	—	—	—	—			

* Including steam trains. † And 98 miles of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures.

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NOTES.

The British Association.—The first party of the members who recently toured South Africa, including Sir William Preece, arrived at Southampton last Saturday and entrained for London. Their impressions regarding the tour are stated to vary somewhat, but in general it appears to be voted an excellent success.

London's Electricity Supply.—With the new session just opened the committees of the London County Council are stated to be again considering the question of a municipal central electricity supply for the Metropolis. We have previously expressed our views on this subject, but await with interest the new measure projected by the Council.

Institution of Mechanical Engineers. — The ensuing session of this institution will be inaugurated on Friday, Oct. 20, at 8 p.m., when a paper by Colonel L. Cubillo on "The Manufacture of Cartridge Cases for Quick-Firing Guns" will be presented. Subsequent general meetings will be held on Nov. 17, Dec. 15, Jan. 19, Feb. 16 (annual general meeting), March 16, and April 27.

Electro-Harmonic Society.—The nineteenth season of this society will be inaugurated on Friday evening, Oct. 20, at 8 p.m., under the chairmanship of Mr. W. Worby Beaumont, in the King's Hall, Holborn Restaurant. Vocal music will be rendered by Messrs. F. Norcup and H. Dearth, while the instrumentalists will be Messrs. T. E. Gatehouse and A. E. Izard. Some capital variety items will be contributed by Messrs. Chas. Capper, W. Edwards, N. H. Owen, and Harrison Hill, and the hon. secretary, Mr. W. E. Lane, hopes to see a good assembly of members.

Machine Coal-Cutting in India.—The report of the Chief Inspector of Mines of India for 1904 states that at present coal-cutting machines are used at only two collieries in India. Nearly all the coal is won by the "bord-and-pillar" system—*i.e.*, cutting the seams into pillars by driving galleries. The pillars are seldom extracted. The cheapness of Indian labour, compared with European and American, has probably prevented enterprise in the use of machines being shown in India. There should, however, be a good opening for machinery, as the native miners do not exhibit any great aptitude, though they have shown themselves capable of managing the machines. If any doubt remains as to a reduction in the cost of machine-cut coal, there can be no question in regard to the great economy in time. With those now in use, a gallery could be driven at least twice as far in a given time as by hand.

Glasgow Technical College Scientific Society.—The opening meeting of the fourteenth session will be held on Saturday evening, Oct. 21, when Mr. Henry Dyer will deliver a lecture upon "The Training and Work of Engineers in some of their wider aspects." The complete syllabus for the session is as follows: Nov. 4—"Electric Power Plant Design," by Mr. Philip D. Ionides; Nov. 18—"The Commercial Efficiency of Prime Movers," by Mr. A. Marshall Downie; Dec. 2—"Metallography," by Mr. James Muir; Dec. 9—fourteenth anniversary dinner; Dec. 16—"The Economy of Power Production—Relative Merits of Gas and Steam Engines for Various Purposes," by Mr. William D. Hamilton; Jan. 20, 1906—"Deep Mine Pumping," by Mr. John Hogg; Jan. 27—"Cylinder Ratios," by Mr. James Andrews; Feb. 3—"Notes on Tool-Room Organisation and Practice," by Mr. George Blair; Feb. 17—"The Inglis Patent Boiler," by Mr. Gardiner Inglis; March 3—"Portable Electric Tools and their Application to Industrial Purposes," by Mr. Andrew Stewart; March 17—"Metals Used for Bearings of Shafting and Lubrication of Same," by Mr. James Murdoch; March 31—annual general meeting.

South Africa.—Since the immediate effects of the war were overcome electricity has made great strides in South Africa both for lighting and traction, and its general adoption for mining purposes is coming in for greater attention. Our contemporary the *British South African Export Gazette* estimates the value of the electrical plant now being installed in that part of the world at over half a million per annum, apart from such materials as boilers and engines. Of this amount about two-thirds is in respect of electrical machinery, another £100,000 goes in telegraph and telephone material, the remainder being spent on fittings and miscellaneous apparatus. Now that the country is settling down there is a good prospect of steady development. Already electricity has been adopted even by the minor towns for lighting, and practically all the large towns have their electric tramway system. It is gratifying to see that, though the United States is asserting itself in South Africa in the matter of electrical machinery, English makers hold the field with regard to fittings and accessories. In this branch the United Kingdom supplied over 70 per cent. of the total last year, Germany and the United States, who were second and third respectively, showing quite modest results. We trust that British manufacturers will see to it that they maintain this field in our South African Colonies, and not only so, but make a strong bid for a larger share of the orders for electrical machinery.

London County Council Tenders.—In general it has been the policy of the London County Council to purchase in the cheapest market, with the result that, whether it be the home manufacturers' fault or not, contracts have gone abroad. Where a number of firms tender to the same specification it is rather difficult to induce a committee to exercise discrimination upon other considerations than that of price; hence such matters as quality of work are apt to be overlooked. The Highways Committee of the London County Council, however, have lately shown a considerable degree of broad-mindedness in this respect. Two or three months ago it was decided to purchase an additional 150 cars, and of the tenders received for the car bodies that of the Hungarian Railway Carriage and Machine Works, Limited—viz., £388 per car—was the lowest. This company, however, were not prepared to accept the Council's conditions of labour, so it was decided to accept Messrs. Hurst, Nelson, and Co.'s offer of £423. 10s. per car—this being the lowest home tender. In regard to the trucks the committee carefully examined the designs submitted by the different firms, as, in view of the increased weight due to top covers, this is a matter of great importance. As the result of their investigations the committee decided to accept the tender of Messrs. Mountain and Gibson, Limited, which stood at £120 per car, against the £92 of the Hungarian Company and the £96 of the lowest home tender. Taken altogether, our Æediles are to be complimented upon such exercise of discrimination.

The American Institute. — The volume dated September of the *Proceedings* of the American Institute contains the discussions on "High Power Surges in Electric Distribution Systems of Great Magnitude"; "An Experimental Study of the Rise of Potential on Commercial Transmission Lines due to Static Disturbances, such as Switching, Grounding, etc."; "The Constant-Current Mercury-Arc Rectifier"; "Data Relating to Electrical Conductors and Cables"; "Methods of Measurement of High Electrical Pressures"; "Some Comments on Remarks

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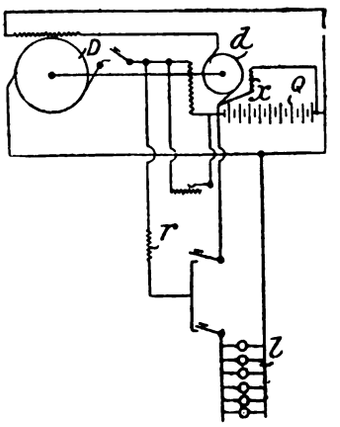
made by Colonel R. E. B. Crompton before the International Electrical Congress at St. Louis"; "Three-Phase Traction"; "Heavy Electric Freight Traction"; "Weight Distribution on Electric Locomotives as affected by Motor Suspension and Drawbar Pull"; "Choice of Motors in Steam and Electric Practice"; "Electrical Features of Block Signalling"; "Limits of Injurious Sparking in Direct-Current Commutation"; "A Study in the Design of Induction Motors"; "Limitations in Direct-Current Machine Design"; "A New Instrument for Measuring Alternating Currents"; "Synchronous Converters and Motor-Generators"; "Water Powers of the South-Eastern Appalachian System"; "A New Induction Generator"; "The Development of the Ontario Power Company"; and "A New Carbon Filament." There are also papers on "Standardisation of Enclosed Fuses," by H. A. Lacount and "Air-Gap Flux in Induction Motors," by A. S. Langsdorf.

Milan Exhibition.—This exhibition will be opened on April 15 next, under the patronage of the King of Italy. The exhibition will be divided into nine international and one national section. France, Germany, Austria, the United States, and other leading countries have decided to participate, and a British commission has been formed, under the auspices of the Government, which has made a grant of £10,000 for the creation of a British section. In spite of the shortness of time at its disposal the commission has been fortunate enough to secure in the various buildings space which, both in regard to area and position, will place this conntry upon an equality with the various other foreign nations who will participate. The importance of this country taking a prominent part in the exhibition will be evident to manufacturers who have watched the gradual decrease of their trade relations with Italy and the corresponding growth of German and French imports. In a circular letter from the Anglo-Italian Chamber of Commerce British manufacturers are assured that goods from this country of the best quality are still preferred in Italy to any others. The opportunity afforded by this exhibition of comparison with the manufactures, and sometimes imitations, of other countries should not be lost. There is in particular a splendid field for machinery of the latest type, Italy having entered on a period of great prosperity and her purchasing power having largely increased. Space in the British section is available at 2s. per square foot, and it is to be hoped that electrical manufacturers will utilise this opportunity of demonstrating their latest improvements.

Cooking by Electricity.—The possibilities of electrical cooking were exemplified at Olympia on Monday evening, when the committee of the Electrical Exhibition gave a dinner, cooked entirely by electricity, to a number of Press representatives and others. The dinner was held in the lecture hall, and the courses were prepared in view of the guests by Mrs. Deane on the usual kitchen appliances which serve for her daily demonstrations. It was a remarkable testimony to the advantages of electrical cooking that no odour or fumes from the ovens and other apparatus could be detected. Mr. E Cunliffe-Owen, the chairman, said that was the first occasion in this country when such a large dinner, all cooked by electricity in the dining-room, had been held. If it had been prepared by any other method, he thought the guests would have lost their appetites before they began. There were 65 present and 56 units had been consumed, so that the whole cost of cooking at 1d. a unit was 4s. 8d. The supply companies had met the question of electrical cooking in a liberal spirit, and it remained for manufacturers to follow their example. At present some of their apparatus was dear, but they would be able to produce cheaper articles with the growing impetus towards this method of cooking. It had been looked on hitherto as a costly fad, but that dinner served to show that it was the best and cheapest form of cooking. He believed that the present exhibition would do for cooking what the exhibition at the Crystal Palace in 1892 did for electric lighting. Radiators were already supplying heat at 1d. per hour, and it was evident that there was a very large future for electric heating and cooking.

Regulation of Variable-Speed Dynamos.—A patent has been obtained in this country by the Compagnie Générale d'Electricité de Creil, Paris, for a method of obtaining a constant potential from a variable-speed dynamo for charging accumulators, train-lighting, etc. The system is designed as an improvement upon that for which the company had previously lodged a specification, the object being attained in that instance by arranging a small auxiliary generator in the field circuit to control the



excitation. In the present arrangement an additional exciting coil, x, is arranged on the field of the auxiliary generator, d, and is in shunt with the accumulators, Q. Means are also provided in the case of train-lighting for supplying the lamps direct from the dynamo. In the arrangement shown the lamp circuit, l, is connected through a resistance, r, with the dynamo circuit, switches being provided for connecting the lamps either with the dynamo or the battery.

Electric Tramways in Germany.—The statistics concerning German electric road lines show that during the 12 months ending Oct. 1, 1904, the towns provided with such services increased by four. The length of route increased by about 60 miles, representing a total of 2,375 miles. The total output of the generating plant has increased only by about 1½ per cent., while the total output of accumulators on traction load shows a somewhat greater increase, the total accumulator capacity installed amounting to 39,809 kw. In explanation of the small increase in generator output, it may be mentioned that the plant of the Hanover tramways has been reduced from 10,063 kw. to 4,555 kw. It appears that there is a strong tendency to abandon the conduit and accumulator systems in favour of the overhead, which, on account of its economy, promises to become general practice. It has also been found in Germany that the conduit system is less reliable than the overhead. Mixed working by trolley and accumulator cars is retained only in Dresden, while trolley working in conjunction with sections of conduit line exists in Berlin, Dresden, and Düsseldorf. Entire accumulator traction is retained only on a short section of line in Bremerhaven, which will shortly be converted to the overhead system. In this connection it is interesting to note that on railways the accumulator system has not only maintained its standing, but has even been extended.

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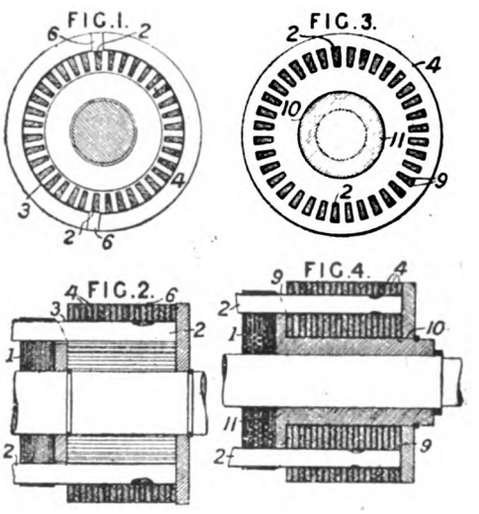
Single-phase alternating-current continues to gain ground. Owing to the successful trials on the main-line section between Niederschöneweide-Spindlersfeld, this system has been adopted for the Hamburg-Altona Railway, and it has been substituted for three-phase on the Murnau-Oberammergau line. Trackless cars are stated to give satisfaction and to promise commercial success, though definite figures are not yet available. Six routes are worked on this system, the cars being used chiefly for goods.

Magnetic Survey of the North Pacific Ocean.—The Department of International Research in Terrestrial Magnetism of the Carnegie Institution of Washington is about to make a magnetic survey of the North Pacific Ocean, and the *Scientific American* contains some interesting particulars relative to the expedition. The brig "Galilee," a wooden sailing vessel, has been fitted out at San Francisco for the expedition. The purpose of the expedition is to get exact data of the distribution of magnetic forces over the ocean, the present magnetic charts used by navigators of the North Pacific depending chiefly upon observations made on islands and along the coasts. Observations of this kind are subject to disturbance by local conditions, so that the charts now in use are not trustworthy. It is thought that the work can be accomplished in three years, and the sum of £4,000 has been allotted for the expenses of the first year. The "Galilee" will first cruise from San Francisco to San Diego, thence to Honolulu and back to San Francisco. Then a circuit will be made from the west coast of America to the Galapagos Islands, and thence to the Philippine Islands and Japan, returning by way of the Aleutian Islands and closing the circuit at San Francisco. The observations will be continued over a series of areas bounded by parallels of latitude and meridians of longitude each 5deg. apart, lying next on the mid-ocean side of the circuit last made, proceeding gradually and by successive circuits into the central region of the North Pacific Ocean. The whole length of the course proposed is 70,000 knots. The work is directed by Dr. L. A. Bauer, who is in charge of the magnetic work of the U.S. Coast and Geodetic Survey. He will accompany the expedition to San Diego. The scientific head and commander is Mr. J. F. Pratt, of the U.S. Coast and Geodetic Survey, who has had 30 years' experience in geodetic, astronomical, hydrographic, and magnetic work.

Moral Qualifications of Engineers.—In the editorial columns of the September issue of the *Club Journal* (Philadelphia) Mr. Charles F. Scott quotes an engineer of wide experience as saying that in selecting young engineers for specific work he found a greater number were lacking in moral qualifications than in technical ability. He did not restrict the term "moral" to mean simple, common honesty, but used it in a broader sense to include courage, judgment, backbone, moral strength, and all those things which make up the complex called character. Commenting on this, Mr. Scott remarks: "College courses are apt to give 99 per cent. to technical subjects and 1 per cent. to culture studies. Were the divisions 85 per cent. and 15 per cent., one would be decreased by only a seventh, while the other would be increased fifteen-fold. When older men talk about the value to an engineering student of a debating society, of familiarity with parliamentary practice, of fluency in composition, of culture studies, of the training in effective co-operation which may be secured through student organisations, of education as a means of forming right habits and developing the faculties as well as acquiring technical knowledge, the student in engineering does not seem to understand what they mean. The development of this broader side of life must be, after all, a matter of individual choice and effort. Others may counsel and may inspire. The result depends upon the man himself, upon what he chooses to bring within the range of his experience and upon the success with which he assimilates that experience in his growth. No one who has caught the spirit of the modern engineer will think that this applies to school days only. The principle of progress is to keep on. The idea is not static but kinetic, as well for the individual as in society and science and engineering." One can appreciate Mr. Scott's observation that purely technical knowledge should be supplemented by other accomplishments in order to evolve the perfectly competent engineer; but, considering the disparity he names in the amount of attention paid to the two branches in college courses, his compatriots must be congratulated upon their engineering achievements. At the same time it is gratifying to recall that "culture" is one of the subjects in which, according to the report of the Mosely Commission, the British engineer scores.

Field Magnets.—A patent has been granted to Mr. M. Walker, of Manchester, relating to ring-end connectors on the revolving parts of dynamos intended to be rotated at a very high speed. Dynamically-balanced ring connectors, marked 4 in Figs. 1 and 2, which we reproduce from the



Official Patents Journal, are shrunk or pressed over the hard insulating bush, 3, or strips of hard insulation, which cover the ends of the conductors, 2, which project beyond the laminated core, 1. The rings are insulated from one another, and each electrically connected to two or more of the conductors, 2, by soldering or by means of flexible strips, 6, of sheet copper. In the modification shown in Figs. 3 and 4, the conductors, 2, pass through slots punched in the rings, 4, which are mounted on an insulating bush, 10, surrounding either the shaft or a cylinder, 11, attached to the shaft, each of the conductors being covered with hard insulation, 9. The hard insulation may consist of mica or other good material for resisting compressive stress. The provisional specification also states that the connectors may take the form of straight bars at right angles to, and having their middle points in, the axis of rotation, or of a combination of a ring with two or more bars.

Imperial Consolidation by Telegraphy.—Mr. Charles Bright, F.R.S.E., contributes to the *Monthly Review* an article on this subject, in which he urges the importance, on political as well as on strategic grounds, of the outlying portions of the Empire being brought into direct telegraphic communication free from the prospect of "eavesdropping." The author points out that the

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Pacific Cable, though all-British, is open to interruption in the event of war, as the connecting links are by means of submarine cables and land wires, besides which the terminal rates in Australia are out of all proportion to what they should be. At the same time he emphasises the contention that the all-British Pacific line was only justified (*a*) as a political and strategic necessity, and (*b*) because the companies would not undertake it themselves. Thus, while advocating all steps which will render the route strictly all-British, the author deprecates any proposal that would involve the expropriation of the existing cable companies. Such a step he considers would almost certainly prove a false step, as the companies, whose functions are essentially different from those of the proprietors of inland telegraphs, have to act somewhat in the position of diplomats in regard to their cables landing on foreign territory; and if once the Government took over all the cables belonging to the companies, Mr. Bright predicts a deadlock in regard to English cable developments with foreign countries. Apart from this the author is averse to the State acquisition of the companies' cables on commercial and economic grounds, and he also alludes to the unfairness of expropriation, as the shareholders risked their money at a time when such investments were hazardous. While contending that it would be unwise as well as unfair for the Government to step in as general traders in the matter of submarine telegraphy, the author expresses the hope that the companies will see their way to lowering their tariffs, and that no agreements will be entered into by the State in future without such being provided for on a sliding scale. The author ventures to think that such reductions will in the long run benefit the companies as well as the public. Although, as stated, Mr. Bright is opposed to the State taking over the existing cable service as a commercial business, he considers that there are overwhelming arguments in favour of a single trunk system of cables all connecting up the more important points of the British Empire under direct control (by ownership) of the State. The all-British Pacific cable was but the first step in this project for girdling the entire Empire. It is the author's view that a comprehensive system of this character, designed especially for Government service rather than as a competitive commercial concern, is a political and strategic necessity of the age.

The Specific Resistance of Electrolytes.—At the recent meeting of the American Electro-Chemical Society a paper by Mr. R. Threlfall, entitled "A Standard Method of Determining the Specific Resistance of Electrolytes," was presented, an abstract of same appearing in the *Electrical Review* of New York. The author's experience has convinced him that no method hitherto proposed affords so direct and accurate a means of comparing the specific resistance of an electrolyte with that of mercury as by the use of the potentiometer. His measurements have been made with a potentiometer the accuracy of whose coils was guaranteed to two parts in 10,000. The essential part of the apparatus consists of a glass tube 98·6cm. long, and with a mean diameter of 0·9254cm., as ascertained from two careful weighings of mercury. The tube was slightly conical, and was assumed to be so regularly. Two reference marks were made near the two ends of the tube by coating it with wax and holding the edge of a sharp chisel against it as it revolved slowly on a lathe. The fine circular lines were etched by hydrofluoric acid, and were found to be 87·155cm. apart. This tube contained the electrolyte under investigation, and fitted into two glass T-pieces, one at each end. The vertical branches of the T's gave access to the platinised electrodes, while the horizontal branches were used to fix the position of the testing electrodes of the glass tube drawn down to long, fine points. The testing electrodes were merely held in position by rubber bungs, strongly compressed, and were adjusted so that the free ends lay exactly in the same cross-section as the reference rings. The testing electrodes were connected in the usual way through two beakers containing respectively the solution under examination and the liquid used in the Oswald normal electrode. By turning glass cocks the siphons could be put out of action, and diffusion stopped. The tube containing the electrolyte was immersed in a large bath containing heavy mineral oil, and provided with a heating coil running the whole length, and a shaft with screw paddles also running the whole length of the trough. As comparison resistances, standards certified by the Reichsanstalt at Charlottenburg were employed, and, of course, care was taken to have the resistance of the standards and electrolyte so adjusted that about the same voltage was operative over each part. By substituting mercury for the electrolytes a comparison is easily made. The development of an accurate and easy method of determining the resistance of electrolytes suggests the possibility of making electrolyte standards of resistances. Prof. C. F. Burgess described a simple method for making quick and approximate measurements of the resistance of electrolytes. A long tube is filled with the material, and attached to this tube at points whose distance apart is accurately known are two tubes, into which are inserted Ostwald normal elements. A thermometer is placed in the electrolyte itself; this is an important feature. No polarisation takes place, so that readings may be taken instantaneously. Mr. Carl Hering expressed gratification at the return to direct currents for measuring the resistance of electrolytes. He suggested the use of gold electrodes, as these do not polarise.

Load Factor.—At the twenty-fourth annual convention of the American Street Railway Association the effect of load factor upon the cost of operation was the subject of an interesting paper by Mr. L. P. Crecelius, of which an abstract appears in the *Electrical World* of New York. Evidence is given to show the advantage of interconnecting several stations by means of 'bus bars and shutting down certain ones completely during periods of light load. The author first discusses the character of the load on railway systems. In urban railway systems the load curve is double peaked, having the characteristic morning and evening peaks of city travel when the people go to and from work; the breadth, magnitude, and duration of these peaks depending, of course, upon local conditions, such as the size and lay-out of a town, and upon its sociology. In a manufacturing centre the peaks are often remarkably symmetrical, and are little affected by climatic conditions, as the people usually go to work at about the same time in the morning and leave to go home at nearly the same time in the evening. In the larger cities, where it becomes necessary to transport a mixed community consisting of factory employés, merchants, clerks, shoppers, theatregoers, etc., the peaks lose their symmetry, the morning peak becoming lower and not so sharp as the evening peak. The writer describes the system of the United Railways of St. Louis, which has in operation four power stations. Two of the larger stations, one of 13,950 kw. and one of 7,000 kw. capacity are kept in operation continuously, and constitute the main central stations. The two smaller stations are operated on swing watches on weekdays—that is, operated during the peak hours only. 'Bus wires have been run from the larger stations to both of the smaller ones, and there connected through circuit breakers and double-throw

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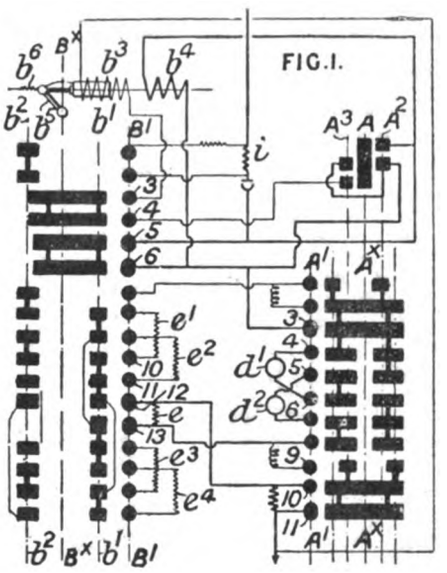
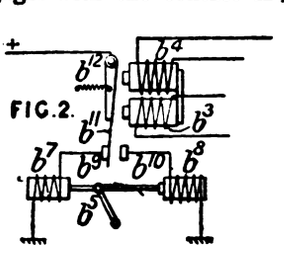
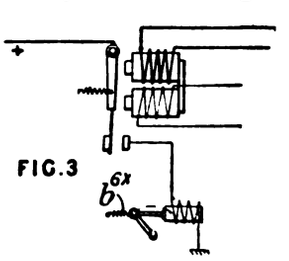
switches to either one of the two feeder 'buses, with which the smaller stations have been supplied. Installing double-throw switches the feeder sections can be connected. During the rush hours the 'bus wires are connected to the same 'bus on which the stations are operated, thereby becoming equaliser wires. The amount of copper in the 'bus wires is just sufficient to carry the load of the smaller stations during the lighter part of the day, allowing a reasonable drop in potential. The resulting economy of operation in this case more than justifies the expenditure of a good many dollars in the 'bus wires, and also the resulting increase in the cost per kilowatt-hour of the power generated under this arrangement in the smaller stations. Thus it is found that in bringing up the load factor of the main stations from 50·23 per cent. in the first case to 57·7 per cent. in the second, that a saving of ·0002875d. per kilowatt-hour has been made on the total power cost. And on a basis of 310,000 kilowatt-hours per day, which is about the average output of the stations of this system during the summer months, this would represent a saving of £36 per day when operating under these conditions. It has been found that since the installation of a storage battery, which is located in the business district of the city where the traffic is very congested, the character of the service has been improved to a marked degree during the rush hours. Also a large reduction in the amount of copper required to handle the sections located in this district from the four stations has been effected. This, together with the fact that a battery can always be called upon in cases of emergency to take hold of the load, points to the advantages to be derived in using storage batteries to smooth up the load curve when conditions warrant their use. In discussing his own paper, Mr. Crecelius stated that no difficulty is experienced in arranging for the operating force of the two small stations to report for duty twice per day during the morning and evening rush hours. Mr. H. Le H. Smith called attention to some of the more important items that depend upon the load factor. These include the electrical losses, the radiation losses from the stack, and the inability of automatic stokers to respond readily to rapidly fluctuating loads or to be adjusted for a great range of load. He thought a better definition of load factor than the ratio of average to maximum load could be found in the ratio of the actual energy developed to the maximum possible output of the station. The latter definition is the one accepted generally in this country.

Motor Control.—A patent has been granted to the Johnson-Lundell Electric Traction Company for a method of regulating motors, which is described in the *Official Patents Journal*. It is particularly applicable to the system patented by the grantees two years ago, in which the motors are connected up as series motors while propelling and accelerating the vehicle, and as compound-wound generators while braking the vehicle. The handle of the controller, A×, is provided with a contact, A, and is capable of a certain amount of free movement in either direction independently of the controlling cylinder, so that the contact A may be brought into engagement with either of the contacts, A^2, A^3, carried by the controller, the handle being held by springs in its normal position between the contacts A^2, A^3. With the contact b^1 of the field-change cylinder, B×, in engagement with the fixed contacts, B^1, the motors are in their series condition, while the regenerative condition is obtained by rotating the cylinder, B×, so that the contacts b^2 engage with the contacts B^1. The device by which the field-change cylinder, B×, is actuated consists of a solenoid provided with a shunt coil, b^3, and a series coil, b^4, the core being connected to a crank-lever, b^5, connected with the cylinder, B×, and to a spring, b^6, or to a weight. When the motors are in their series condition, as represented by Fig. 1, the current from the trolley passes through the resistance, *i*, contacts 5, 6 of the row B^1–B^1, contacts 3, 4 of the row A^1–A^1, armatures d^1, d^2 to contact 13, thence in parallel through the fields e^1, e^2, e^3, e^4, *e* to contact 12, and finally to ground through contacts 10, 11 of row A^1–A^1. If, now, the handle of the controller be moved so that the contact A engages with the contact A^3, the controller cylinder remaining stationary, the circuit through the shunt coil, b^3, is completed. The field-change



cylinder, B×, is thereby turned into the position in which the contacts b^2 engage with the contacts B^1, thus converting the motors into their regenerative condition, at the same time breaking connection between the contacts 5, 6, and thus compelling the generated current from the motors to pass through the series coil, b^4, and also breaking the circuit of the shunt coil, b^3, between the contacts 3, 4. If, now, the current generated by the motors falls below a predetermined value, the spring b^6 returns the cylinder, B×, to the position b^1–b^1, in which the motors are in the series condition. Should the motor man turn the handle in a forward direction when the motors are in their compound condition, the contact A× engages with the contact A^2, thereby short-circuiting the





coil b^4, and thus allowing the cylinder, B×, to return to the position b^1–b^1. The cylinder, B×, also returns to the position b^1–b^1 should the connection between the motors and the source of supply become broken, for in such a case the coil b^4 is immediately de-energised. Figs. 2 and 3 represent modifications of the device for actuating the cylinder, B×. A tongue, b^{11} (Fig. 2), is held in its normal position against a contact, b^9, by a spring, b^{12}, or by a weight, the coil b^7 being energised by the main current. When either of the circuits of the coils b^3 b^4 is closed and the current is above a predetermined value, the tongue, b^{11}, is attracted, thereby engaging with the contact b^{10} and completing the circuit of the coil b^8. The coil b^7 may be replaced by a spring, b^6× (Fig. 3). An electric motor may be substituted for the coils b^3 b^4.

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THE LANCASHIRE ELECTRIC POWER COMPANY.

It is not long since we announced the inaugration of a supply of electricity from the Thornhill generating station of the Yorkshire Electric Power Company, and now we have to chronicle the opening of the power station which has been erected by the Lancashire Electric Power Company at Radcliffe. Thus events in connection with the supply of power over wide areas are moving apace, and the near future will show how far the promoters' sanguine expectations are capable of realisation. Meanwhile the prospects are sufficiently encouraging to warrant confidence in the ultimate success of their schemes.

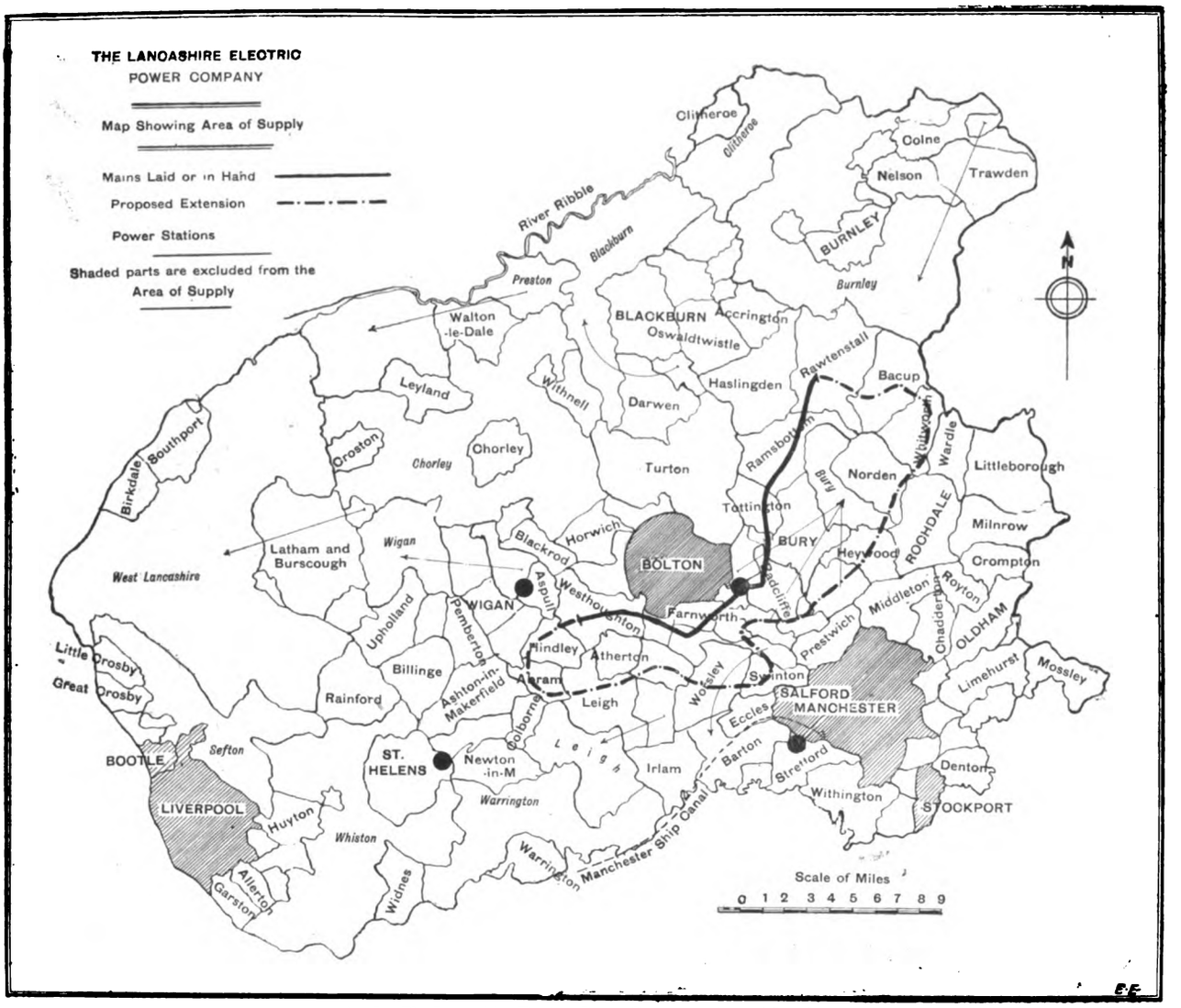

FIG. 1.—The Lancashire Electric Power Company's Area of Supply.

In its essential features the Radcliffe power station closely resembles the Thornhill model, but as this type is a strictly modern development we need not apologise for entering once more into fairly full detail. Accompanying is a map (Fig. 1) of the area within which the Lancashire Company have powers to supply, showing the present development of the 10,000-volt distribution from the Radcliffe centre, and the return lines of mains contemplated. In one direction the mains extend to a distance of some 15 miles. They are all run overhead from the power station to points at different radii, where they dip underground, in some cases to emerge for conveyance overhead by direct routes across country, and then dip again. We shall have more to say later on about this interesting feature of the scheme.

The selection of the site for the power station is a matter that has received very careful consideration, and the one chosen may well be considered ideal. The plot, which is 20 acres in area, and has been taken on long lease from the Earl of Derby, is situated on the left bank of the River Irwell, and is contiguous on the other side to the Lancashire and Yorkshire Railway. It adjoins the Outwood coal pit of Messrs. Thos. Fletcher and Co., Limited. Abundant condensing water and coal supply is thus assured. Another feature which renders this site particularly advantageous is the fact that the railway is some 50ft. above that part of the land on which the power station is built. This enables the coal to be taken from the truck to the grate entirely

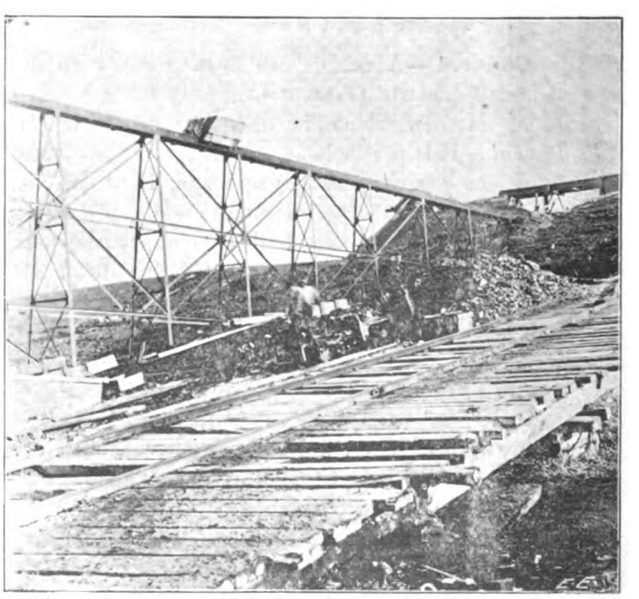

FIG. 2.—Radcliffe Power Station—Railway to Coal Bunkers.

by gravity, which force, costing nothing, tends to economy. Suitable sidings have been put down by the company,

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parallel with the railway, and at the back of the boiler-house. Coal is conveyed from the pit mouth in trucks, and shunted on the power company's siding by an electric locomotive, to which is also fitted a 10-ton jib crane for tipping purposes. At the end of and under the siding a containing hopper is fitted, into which the coal trucks are emptied. Under this hopper, again, is a small railway running down an incline (Fig. 2) at right angles to the siding, and on this inclined railway is a small truck, into which the coal is weighed in one-ton lots from the hopper. Gravity then comes into play and takes the truck down the inclined railway into the top of the boiler-house and over the bunkers. Here a toggle on the truck engages with a trip set at the bunker it is required to fill, the sides of the bogie fall open, and it is emptied practically instantaneously, the empty truck being returned to its original position under the siding hopper by a falling weight, which had previously been lifted by the truck on its downward journey.

The power-house buildings (Fig. 3), consisting of boiler and turbine houses, are of steelwork construction, filled in with brick, built on a foundation slab of concrete 3ft. thick, stiffened by a grillage of steel girders (Fig. 4). This slab forms the floor of the basements. The turbine-house and boiler house floors are some 9ft. above this, and are composed of steel girders with concrete on corrugated iron formers.

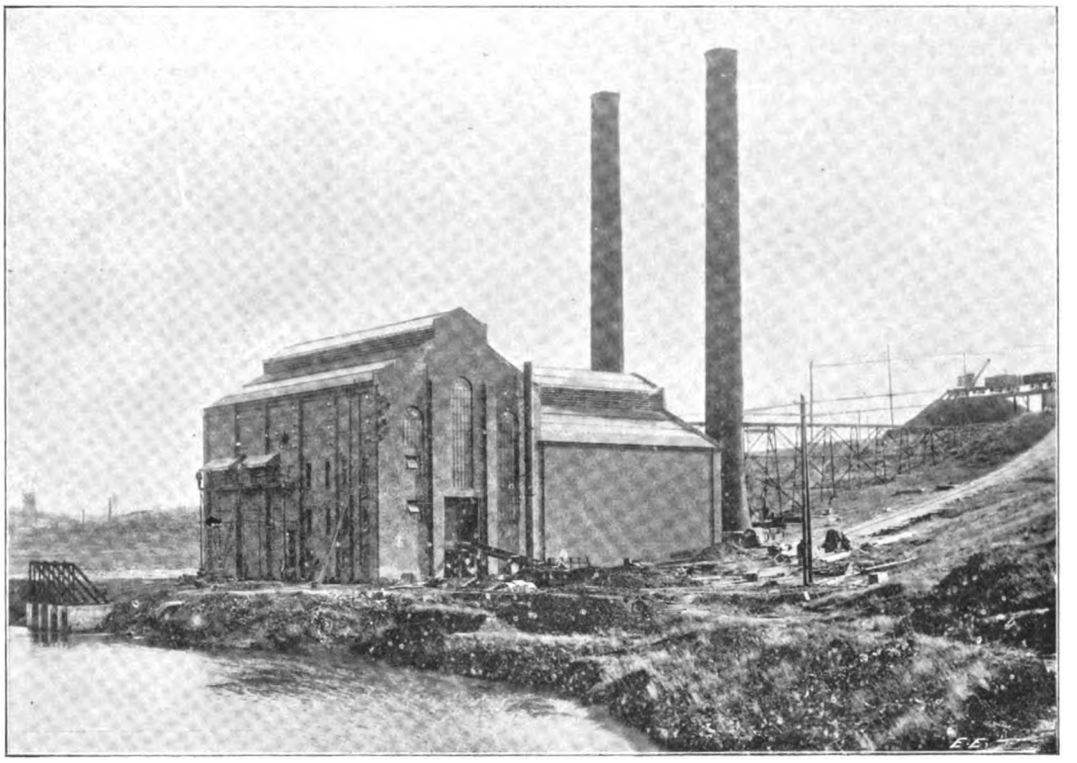

FIG. 3.—Radcliffe Power Station—Exterior View.

The dimensions of the boiler-house are 70ft. by 80ft., and of the turbine-house 100ft. by 50ft. These dimensions are remarkable, inasmuch as 8,000 kw. of generating plant is contained in the buildings. The coal is fed from the bunkers by shoots on to the grates. These are of the chain type, driven by electric motors. The boilers, of which there are six, are of the watertube type, with superheaters, made by Messrs. Babcock and Wilcox. Each is capable of evaporating 20,000lb. of water per hour from 60deg. F., to steam at 160lb. per square inch pressure, and 150deg. F. superheat. The heating surface of each is 5,730 square feet, and the grate area 100 square feet. They are arranged in two banks of three, one bank on each side of the boiler-house, as shown in Fig. 5. Each bank has

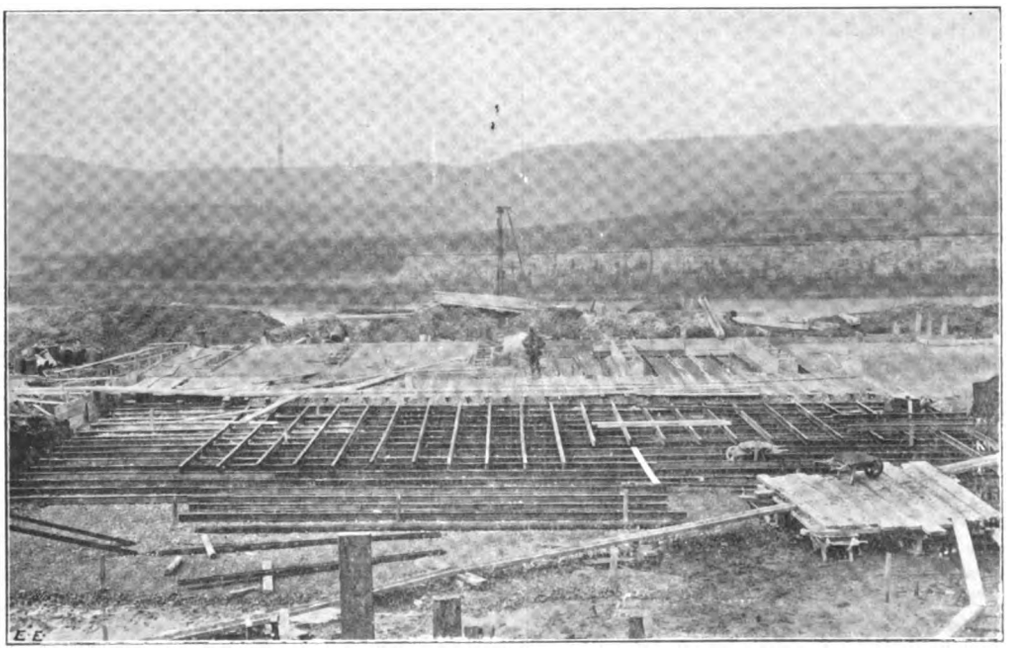

FIG. 4.—Radcliffe Power Station—Foundation in course of Construction.

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its own flue beneath the boilers, which is led out to its own brick-lined steel chimney, 150ft. high and 10ft. diameter. The ashes and clinkers fall from the back

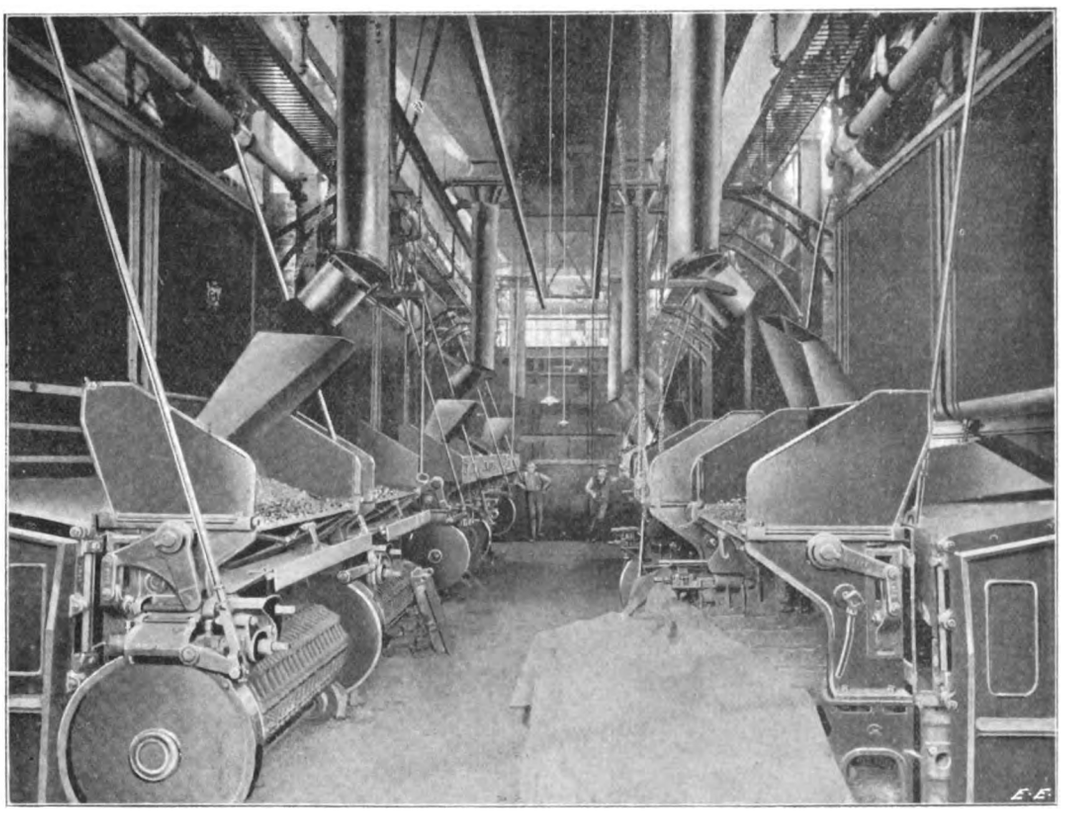

FIG. 5.—Radcliffe Power Station—Boiler House.

of the chain grates into the basement, from which they are taken away in trucks on an industrial railway. The hot-wells are in duplicate at the turbine-house end of the basement. There are no economisers, the feed water being heated by the exhaust from the exciter sets. The make-up water is taken from the mains of the Bury and District Joint Water Board. The steam from each boiler is fed into a ring of piping, so that in case of mishap the steam can be fed either way round the ring to the turbines, etc. The steam is brought through the wall dividing the engine-room from the boiler-house, each turbine being fed direct from the steam ring in the boiler-house. A branch is also brought through for feeding the exciter sets.

The main plant (Fig. 6) in the turbine-house consists of four Curtis turbo-generators, made by the British Thomson-Houston Company, each having a capacity of 2,000 kw., running at 1,000 r.p.m., generating three-phase current at 10,000 volts and 50 cycles. Each set consists of a vertical steam-turbine and an alternator, the spindle which is driven in the turbine being in the same line, and directly coupled to the driven spindle in the alternator. For the benefit of those who are not already familiar with the Curtis turbine* it may be explained here that steam is admitted continuously, being brought to a series of nozzles on the casing of the machine, where it expands, and in doing this loses pressure, of course, but gains speed. After passing these nozzles it impinges on the rotating element, which consists of a series of diaphragms keyed on to the spindle and with buckets cut on the periphery. These buckets are shaped like the crescent moon in section, being some 2in. to 5in. deep, while their axis lies in the line of rotation, and not (as in other turbines) at a slant. A motion is thus transmitted to the moving part, the steam passes to somewhat similar buckets fixed in the case, then through four such sets of diaphragms, increasing in size as the pressure is reduced, and, finally, on to the condenser in the ordinary manner. The regulation is both mechanical and electrical, the nozzles are controlled by electrically-operated valves, the governor lifting up contact fingers on a controller allowing a greater or less number of nozzles to be open. The final regulation is obtained by the actual adjustment of the last valve. By this means a speed of remarkable constancy is attained, the variation being as small as one-tenth of one per cent. The constancy of the angular velocity and the small speed variation are quite remarkable and phenomenal. This steadiness it is hoped will prove of great utility to the manufacturers of the county.

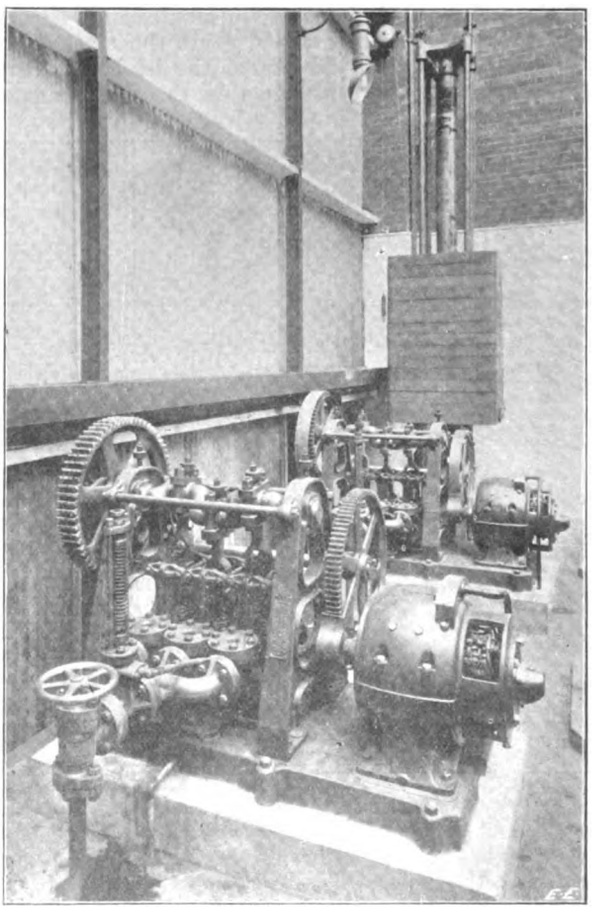

FIG. 7.—Radcliffe Power Station—Water Accumulator.

The turbines being vertical, the whole of the weight of both the turbine diaphragms and also of the rotating

* For a full description of the Curtis turbine, see *Electrical Engineer*, vol. xxxv., p. 690.

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element of the alternator is borne by the vertical spindle. The step bearing on which this rotates is of a very special construction. The bottom end of the spindle is finished flat, and rests in a cup-shaped bottom block, which is capable of being raised or lowered by means of a suitable screw. Through the centre of this block is bored a hole, and this is fed with water at a pressure of 400lb. to the square inch. This raises the spindle from the block, and the water comes out in a constant film, about one-thousandth of an inch thick, escaping round the top of the cup. Practically frictionless bearing is thus obtained. Water at the requisite pressure is provided by two force pumps, one capable of dealing with all the turbines and one a spare. These are three-throw pumps, and electrically driven. As it is of utmost importance that the water should not fail, there is a water accumulator (Fig. 7), which consists of a hydraulic ram provided with heavy weights, and is so arranged that, if the pump fails, the accumulator gives the supply, at the same time ringing an alarm bell, giving ample time for the attendants to start up the spare plant. The condensers are placed right against the turbines, and the air-pumps are directly beyond; the whole making very compact units. These condensers are of vertical type with very ample surface, so as to obtain a high degree of vacuum; they are by the Mirlees-Watson Company, while the air-pumps are Edwards's three-throw type, and driven direct by motors.

The excitation for the turbines, as well as the current for all the auxiliary plant, is obtained from three reciprocating high-speed engines by Allen, of Bedford, direct coupled to B.T.-H. dynamos. They each have an output of 150 kw., and run non-condensing, the exhaust heating the feed water as mentioned in the foregoing. In the turbine-house is also a dry-air pump; this keeps the water part of the condensers free from air, and keeps the circulation good by maintaining a syphonic action in the circulating system. This pump also is used to prime the circulating pumps. There is a 25-ton electric crane, which travels the length of the turbine-house.

(To be continued.)

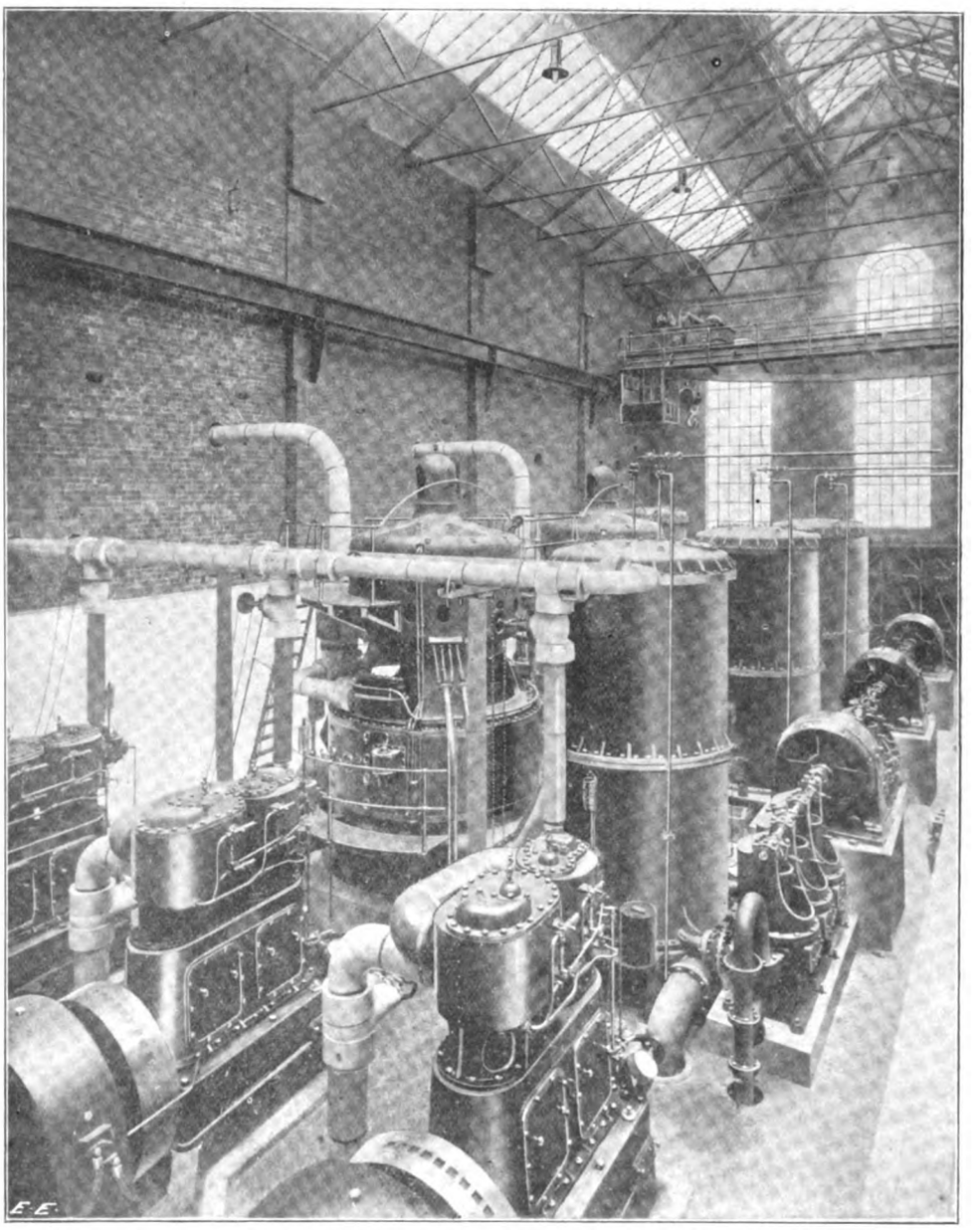

FIG. 6.—Radcliffe Power Station—Main Plant in Turbine House.

THE HASTINGS ELECTRIC TRAMWAYS.

On Tuesday last, through the courtesy of the contractors (Messrs. Dick, Kerr, and Co.), we were privileged to inspect the electric tramway system which they have constructed in the Hastings district. The company owning the system is the Hastings and District Tramways Company, and they have secured from time to time extensive powers for the construction of lines. Owing to the opposition which was brought against the schemes in Parliament, the construction of the same has had to be carried out in what may be termed the least economical manner. Thus it is along the sea-front that there is the greatest need for tramway facilities, and the construction of this line has to be delayed until the whole of the rest of the system is completed and working. The long circular route is now completed, and the line to Bexhill is under course of construction.

The company will shortly have this line to Bexhill com

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pleted, but will be unable to get cars from one portion of its system to the other. We need hardly say that, while the company will be inconvenienced, the public will suffer to a considerably larger extent. The other feature in connection with the sea-front tramway is that under the Act it must not be constructed on the overhead trolley system. The actual system to be adopted has to have the approval of the Corporation, or, failing agreement, the approval of the Board of Trade, but under the Act the trolley system is barred. This leaves a choice between accumulator traction, the conduit system, and one of the many surface contact systems now on the market. Those who know the sea-front at Hastings will appreciate how unsuitable it is for the working of either of the latter alternatives. At high tides the sea frequently comes over into the road, bringing with it large quantities of beach and sand. In our opinion, the reasons for objecting to the overhead trolley system for the front are nothing like so strong as those which can be brought against any alternative proposal. We should not be surprised to hear that after the rest of the lines have been worked the Corporation will find their objections to the overhead wires disappear. In that case we trust they will assist the company in making the whole of the system uniform.

The circular route above referred to goes through Ore and the old London road to the Harrow, returning down the Saddlescombe-road, Silver-hill, and Bohemia. It is remarkable from many points of view. The grades and curves on it are such that they can be only dealt with by electric traction. The line at the highest part traverses a ridge commanding a splendid sea view in one direction and an extensive range of country in the other. The first parts of the route proceeding from the Memorial in either direction serve well-populated districts, which will provide a regular traffic throughout the year. Quite apart from this traffic, the scenery commanded by the route will make it a most popular one for visitors.

We propose to commence our description of the system at the power-house, which is situated at Ore. The area served is so large that high-tension transmission to sub-stations is absolutely necessary. In consequence of this the consulting engineers (Messrs. Kincaid, Waller, Manville, and Dawson) have installed a composite plant, which can deliver high-tension, three-phase current at 6,600 volts for supplying the distant part of the line, and direct-current plant to feed the lines near the power station. The three-phase current is transformed into direct current at the sub-stations placed on the outlying portions of the line.

The power station adjoins the Ore Station of the South-Eastern Railway, and a siding has been constructed between the railway and coal store to facilitate the supply of coal. The steam plant consists of three Babcock and Wilcox patent marine water-tube boilers, with a working pressure of 180lb. per square inch, each boiler being provided with a steam superheater fitted with all the usual accessories. Each boiler (*Fig.* 1) is capable of evaporating 14,000lb. of water into high-pressure superheated steam with natural draught. The superheaters—also of Babcock and Wilcox make—are so proportioned that an increased temperature of 120deg. F. can be maintained. The gases and products of combustion are carried through a main horizontal steel flue, constructed above and behind the boilers, into a self-supporting chimney, also of steel, 8ft. in diameter and 175ft. high, which has been erected quite clear of the building. The area of both flue and chimney is so proportioned as to admit of necessary extensions in boiler plant, which, judging by the appearances of traffic, will soon become necessary. The

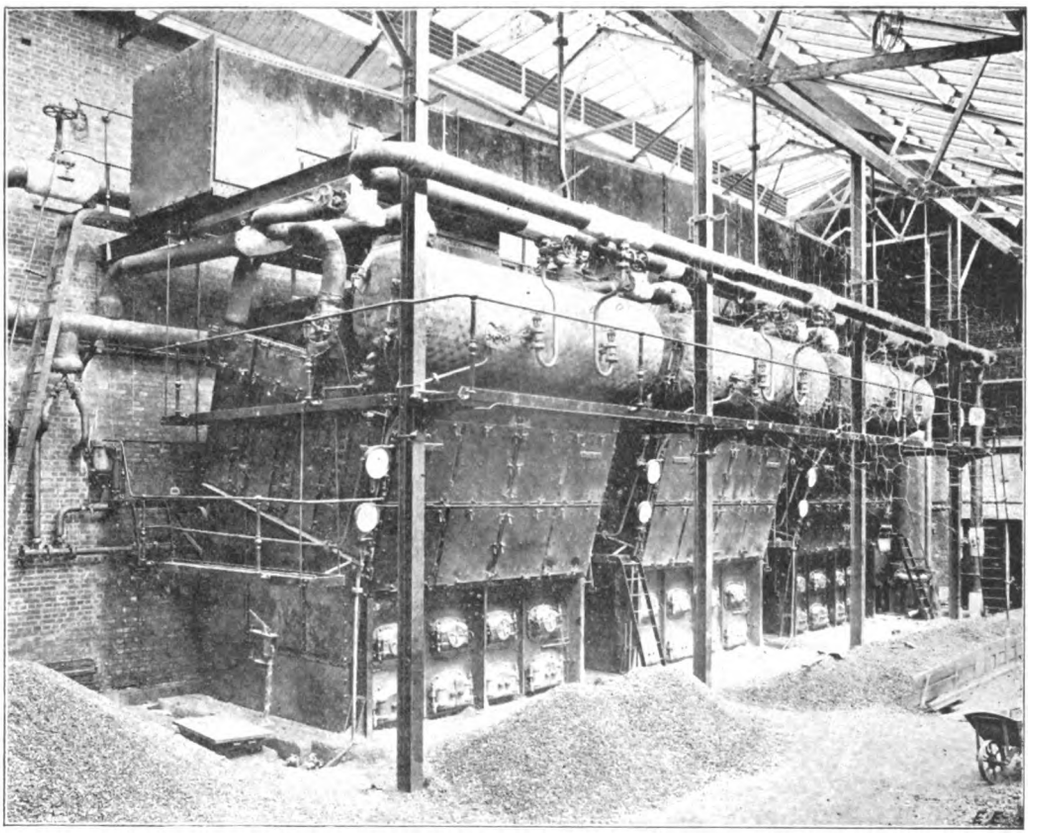

FIG. 1.—The Babcock-Wilcox Marine type Boilers in the Hastings Tramway Power Station.

feed-water supply is provided for by the erection of two of Messrs. J. P. Hall and Co.'s direct-acting, differential steam-pumps, which are housed in an annexe or pump-room, opening conveniently out of the boiler-room, and as each pump is capable under normal circumstances of dealing with from 30,000lb. to 40,000lb. of water hourly, there is ample provision for supply and reserve.

The pipe arrangement has been designed to give security against accident at the same time that alternative directions of supply are provided. The main steam-pipe is of solid drawn mild steel, 8in internal diameter, arranged on the "ring" system, the "ring" being divided up into a suitable number of sections by means of through-way valves, and one half of it is arranged vertically above the other the whole "ring" being suspended upon the boiler-house side of the wall which divides the power-house in two. Each of the boilers is connected by means of a 5in. pipe to the lower half of the main steam range, while each of the four steam-engines, already installed, derives its supply from the upper half of the ring main by means of branch pipes of the same bore as the engine steam inlet. The drainage of the ring has been amply provided for, as each section has its own particular draining pocket, in

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addition to which a separate pocket is provided at each end of the ring to intercept any water which might be carried over on its way to the engines. It is hardly necessary to add that all these pockets are fitted with automatic apparatus for the instant clearance of such water as may reach them. We may add that automatic isolating valves are fitted into each separate boiler supply pipe, in order that security may be given against the far-away possibility of any local accident to a boiler.

handiness, and general utility as in the design of the hardly more important main range. We may add that the branch pipes to the auxiliaries from the secondary ring are all of copper, solid drawn, and having flanges of gunmetal brazed on. The bodies and covers are of Siemens-Martin acid-process cast steel, and those on the main ring are provided with by-pass valves to facilitate operation. Special attention has been paid to the design and construction of these valves because of the fact that they are required to work

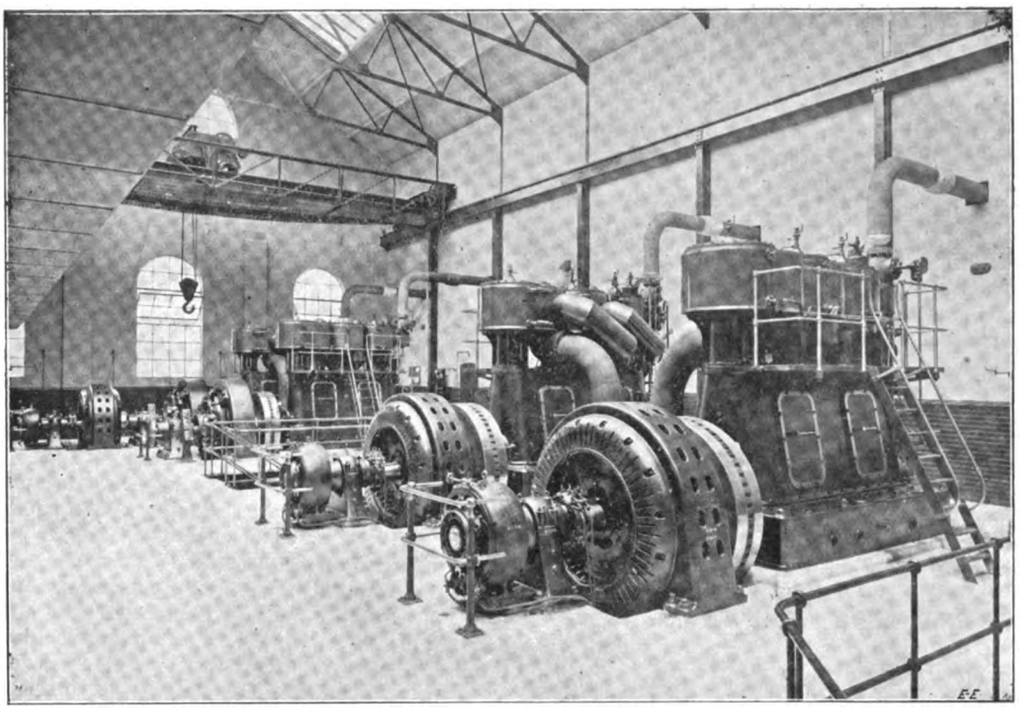

FIG. 2.—The Engine Room, showing the Belliss-Dick-Kerr Generators.

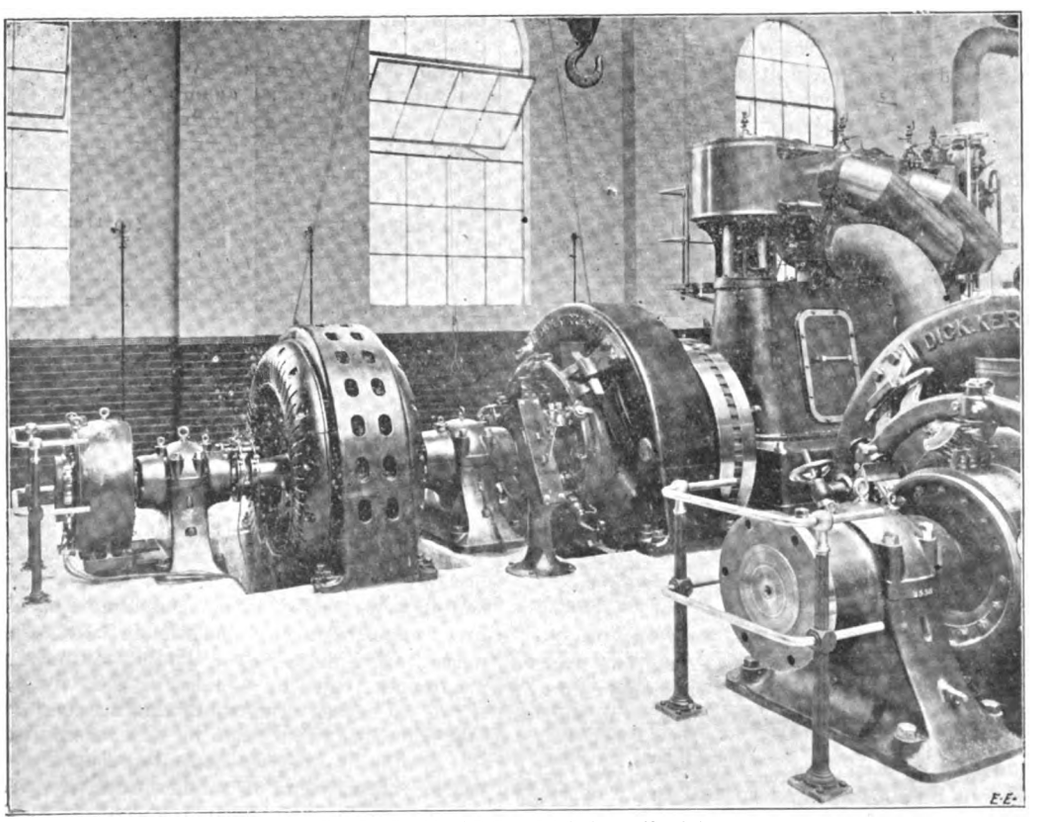

FIG. 3.—Combined D.C. and A.C. Generating Set.

Beside the main steam ring, a second of smaller diameter has been erected, through which steam is supplied to the feed-pump engines, the condensing engines, and other auxiliaries, and the small ring is a miniature of the main ring, its features being in all respects similar, and the same care has been devoted to considerations of safety, upon a pressure of 180lb. steam, superheated 120deg. F. The pipes are all covered with a composition containing 85 per cent. of magnesia, which is wired every foot, the whole being covered with plastic material, over which strong canvas has been neatly sewn and suitably painted. The feed suction and delivery and the whole of the pipe

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cistern in connection with the condensers have been designed with the same care and the same considerations which were devoted to the steam system.

The steam, upon leaving the engines, is dealt with by a surface-condensing plant which has been supplied by Messrs. W. H. Allen and Co., and which has been erected in the basement of the engine-room. Its pumps are driven by means of a vertical, compound, enclosed high-speed steam-engine, the circulating pump being coupled direct, while the air-pumps are driven through a single-reduction system of gearing. The condenser is designed for dealing with about 30,000lb. of steam per hour and producing a vacuum to within about 4in. of the barometric pressure. The air-pumps are of the two-throw, vertical, single-acting "Edwards" pattern, and are worked from a pair of cranks upon a shaft, which is connected to the engine shaft through a raw-hide pinion gearing into a spur wheel. The circulating pump is of centrifugal type, and is capable of providing the requisite circulating water and delivering it to the distributing troughs of the feeding trays inside the cooling tower, which is of the Klein Company's usual standard construction. The pump casing and disc are of cast iron, the latter being carried on a steel shaft coupled direct to the engine, which runs, if necessary, at a speed of 425 r.p.m. The discharged water from the air-pumps is taken by means of a small pump driven by the same engine, and is delivered into the cleaning apparatus, from whence, freed from oil and other deleterious matter, it is taken once more by the feed pumps to recommence its cycle of operations.

The cleaning apparatus to which reference has just been made, and which is capable of dealing with the maximum amount of feed water required, is constructed upon the Davis-Perrett system, which combines an electrical treatment of water with a filter of the Wilson automatic self-cleaning type, as supplied and made by Messrs. Masson, Scott, and Co. In this process the condensed water is received in wooden treating tanks, divided by metallic electrodes which are so arranged as to cause the water to circulate from inlet to outlet, and in its passage it is subjected to the action of electric current, with the result that the emulsive character of the oily water is destroyed, the oil forming a flocculent precipitate with the oxides of the metal, which can be easily removed by a simple filter. A continuous current at a pressure of about 500 volts is used, the tanks being supported upon insulators carried upon an overhead platform within the boiler-room, and just above the pump annexe. A galvanised wrought-iron tank having a capacity of 1,000 gallons is installed for the reception of the clean water from the filter, and this tank acts as a hot-well from which the feed pumps' suction is taken, and into this tank such small make-up as is necessary is supplied from the feed tank.

The engines, of which there are four in number, are of the well-known Belliss three-crank, triple-expansion type, with forced lubrication. Each engine (Fig. 2) is capable of giving a normal output of 540 b.h.p. when running at a speed of 375 r.p.m. condensing or non-condensing, with a steam pressure of 175lb. per square inch at the stop valve.

The electrical plant consists of three of Dick-Kerr's standard alternators and two of the same firm's standard direct-current generators, all machines being designed for coupling to high-speed engines. Two alternators and one direct-current generator are each direct coupled separately to a Belliss engine, the fourth engine (Fig. 3) driving an alternator and generator coupled together so as to form a reserve in case of the breakdown of either an alternating-current or a direct-current unit. The alternators generate three-phase current at 6,600 volts, 25 cycles, each machine being provided with a direct-driven exciter. They are designed for a continuous output of 300 kw., and to sustain an overload of 25 per cent. for one hour with a moderate rise in temperature. The three alternators are designed to run in parallel with each other, means being provided for raising their voltage up to 6,600 when running at a constant speed to compensate for loss in the mains. The rotor spider is made of high-quality cast iron of a very strong design, the hub being provided with flange for bolting to engine flywheel, and is pressed on to the shaft by hydraulic pressure, and key seated.

The pole-pieces are made of laminated steel, and are held together between two cast-steel end plates of strong construction. The upper part is of a T-shape construction for holding the field coils in position; the lower part of the pole-pieces is dovetailed for fixing on the rim of the rotor and held in position by means of keys. The removal of the field coils is effected by sliding the pole-piece from the dovetailed groove parallel to the shaft without disturbing any other part of the machine. The design and shape of the pole-pieces gives a distribution of lines of forces in the air-gap to produce an approximately sinusoidal-shaped wave of E.M.F. The exciter is mounted on the extension of the alternator shaft. The stator frame is built in two halves, securely bolted by means of finished bolts. The frame is made of cast iron, and is designed to allow complete ventilation of the laminations and at the same time to secure rigidity of the frame. The coils are former-wound and are embedded in rectangular slots, being held in position by wooden wedges, and are easily and quickly replaced; they are protected outside the laminations by means of a cast-iron shield, cast in sections, bolted to the frame, and easily removable. This shield is of a perforated design, and does not in any way interfere with the ventilation.

The direct-current machines are designed to give an output of 300 kw. when running at 375 r.p.m. at a pressure of 500-550 volts. The generators are in every respect in accordance with the standard practice of Dick, Kerr, and Co., Limited. The magnet frame is of cast iron, the pole-pieces being built of laminated steel and cast into the magnet frame. The commutation is sparkless at all loads, and the field windings are so arranged as to give a 10 per cent. rise in the E.M.F. from no load to full load.

The switchboard was built by Dick, Kerr, and Co., Limited, and consists of 20 marble panels, each supported independently on an iron frame. The board consists of three alternating-current generator panels, one alternating-current spare generator panel, one alternating-current total output panel, four alternating-current outgoing feeder panels, two direct-current generator feeder panels, one direct-current total output panel, one Board of Trade panel, one negative booster panel, six direct-current feeder panels.

The whole of the extra high-tension oil switches are contained in a special chamber beneath the main switchboard gallery, each switch being isolated in a separate cell, the front of which is closed by a sheet-iron door. The switches are operated from the main gallery by wooden rods and levers, and the panels on the gallery contain no instruments or switches carrying current at high pressure.

(*To be continued.*)

PRIME MOVERS AND AUXILIARY PLANT AT OLYMPIA.

BY E G BEAUMONT, A.M.I.C.E.

(*Continued from page 481.*)

The external appearance of one of the 12-b.h.p. high-speed Wade and Jones oil-engines may be gathered from the photo reproduction (Fig. 6). It is there shown coupled to a two-pole 7-kw. Parker dynamo having an output of 50 amperes at 140 volts. A simple form of universal coupling is used between the engine and dynamo, which gives some freedom of movement in all directions without necessitating the use of a flexible coupling. The cylinders are opposed, and the connecting rods work on to a single-throw balanced crankshaft having one long crank-pin. One connecting rod has a big end bearing the full length of the crank-pin, and the second rod is forked and takes a bearing at each side of the first rod and over its bearing sleeve. With this arrangement of cylinders and with a single-throw crankshaft two useful working strokes in succession are followed by two idle strokes. With a two-cylinder engine of this type an almost perfect balance of the reciprocating and rotating parts may be obtained if a two-throw crankshaft is used with the crank-pins opposite each other or at 180deg. Greater regularity of turning effort may also be in this way obtained, the working and idle strokes occurring alternately. The cam shaft inside

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the closed chamber at one side of the engine is hollow, and there are fixed upon it the exhaust-valve cams, a centrifugal governor, and the eccentric which drives the valveless pump

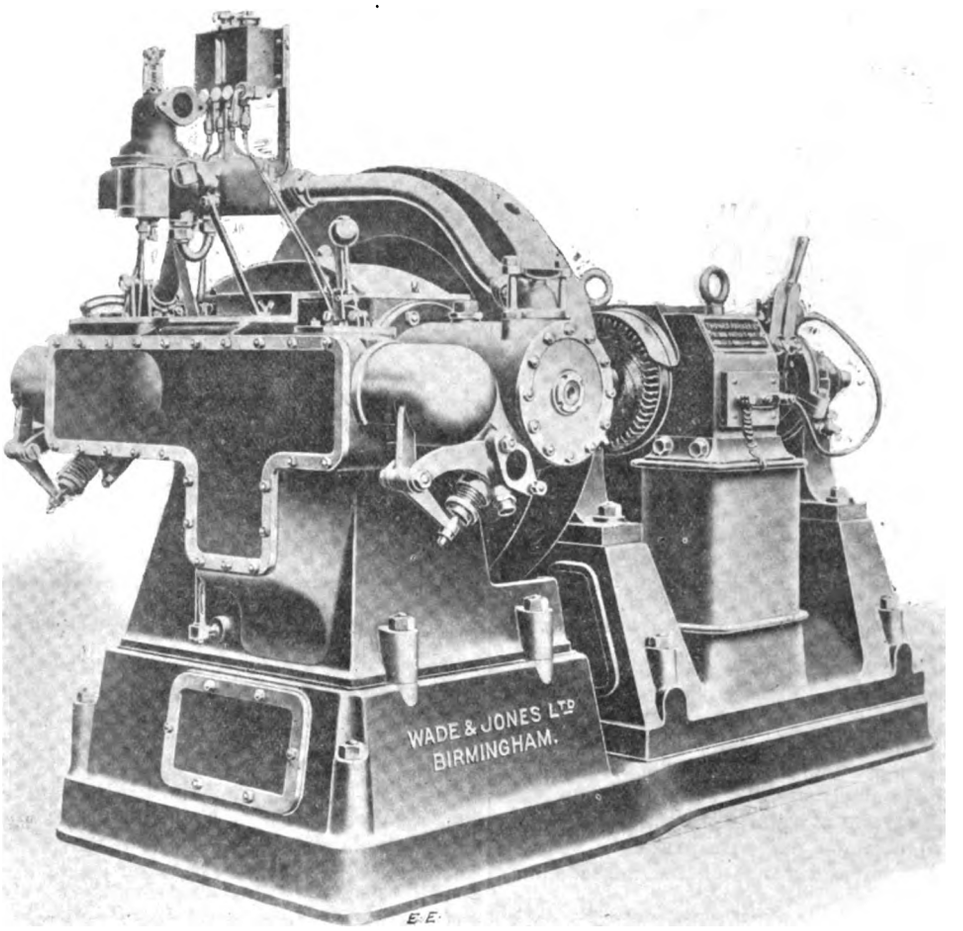

FIG. 6.—View of a 12-b.h.p. Wade and Jones Oil Engine.

for the forced lubrication system. Compression relief cams, with projections which may be caused to overlap the exhaust-valve cams when they are moved into position by a rod

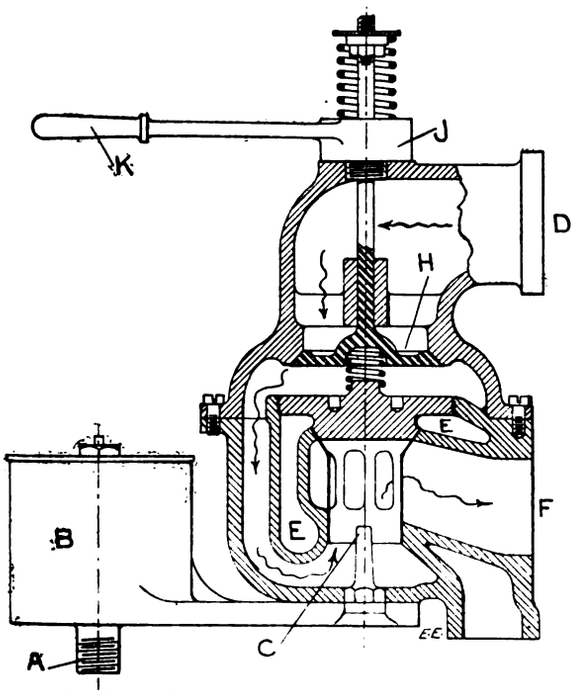

FIG. 7.—The Carburettor of the Wade and Jones Engine.

sliding within the hollow cam shaft, facilitate starting the engine. Movement is given to this rod, and so to the sliding cams, by a forked lever, the ball-ended top of which may be seen towards the right-hand end of the cam-shaft casing. The exhaust-valve boxes are arranged diagonally below the cylinders, and, with the bell-crank valve operating levers, may be seen in Fig. 6. These valve boxes are readily removable complete with the valves and operating levers, and are separately water-jacketed in order to avoid difficulties with water joints at the cylinder facings. The valve stems are cooled, and the possibility of sluggish working of the valves is reduced. The inlet valves at the top of the cylinders are accessible for examination, and are connected by lagged pipes, one of which is visible, with the vaporiser extension of the carburettor.

The sectional view of the paraffin carburettor (Fig. 7) differs in small details from that shown in Fig. 6, but it correctly shows the internal arrangement. Through a two-way cock petrol or paraffin fuel is supplied at A to the constant level float chamber, B, and thence to the large-bore spraying nipple, C, and at about the level of the top of the jet piece. The air inlet is at D, and the course taken by the air is indicated by arrows. The flow of air by suction from the engine around and past the nipple C induces a flow of petrol or paraffin in the form of a spray. The air, heated during its passage through the carburettor by contact with the hot outer and inner walls of the exhaust gas jacket or chamber, E, readily absorbs or takes up the sprayed fuel, partly by surface evaporation on the oil-wetted internal surfaces of the carburettor, and carburation of the air is also assisted by the continued rush of the mixture through the hot exhaust jacketed throttle valve and vaporiser chamber connected at F. The induction pipes between the vaporiser and the inlet valves are, as already stated, lagged to prevent chilling of the mixture and condensation of what is, without doubt, not so much a vapour or gas as an air oil mist. By reference to Fig. 7 it will be seen that the air on its way to the carburettor mixing chamber has to open, and pass through, the spring-closed valve, H. The designers attach considerable importance to the adjustment of the spring pressure on this valve, but this is a maker's adjustment, and the use of the internally threaded collar, J,

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with the handle, K, is only intended to be a further means of slight variation of the spring pressure to suit extreme conditions of atmosphere or temperature. Petrol is first supplied to the carburettor, and the engine may be started and got under way with no heating of the vaporiser or the delay caused by the preliminary heating required with the usual types of stationary oil-engines. The change from petrol to paraffin may be made as soon as the engine has

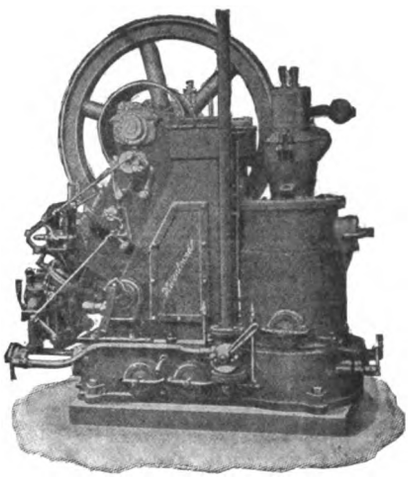

FIG. 8.—The Hillenbrand 5-b.h.p. Suction Producer Plant and Engine.

warmed up its carburettor and vaporiser chambers, and while it is running on load.

These engines are not made in larger powers at present than 25 h.p., but for small electric light installation work, and for the many purposes where auxiliary plant is required, they should prove extremely useful. It has already been mentioned that the system of electrical ignition employed is precisely that in common use with many automobile petrol engines, and involves the use of accumulators and induction coils with sparking plugs in the cylinder heads. As this is the only system of ignition fitted to the engines, it may be assumed that the problem of running a stationary oil-engine with paraffin fuel and with automatic fuel supply through a carburettor has been successfully dealt with, for if combustion is imperfect, and the engine becomes dirty internally, ignition by the use of sparking plugs would be impracticable.

Of the three engines exhibited by Messrs. A. P. Wright and Co., two are shown coupled to continuous-current dynamos, and the third to a Sturtevant ventilating or drying fan to deal with 12,000 cubic feet of air per minute against a water-gauge resistance of 1·5in. The cylinders of these engines are 6·5in. diameter, the stroke is 7in., and the normal speed is 700 r.p.m. Other interesting details not here referred to, such as the completeness of the lubricating system, and the nature of the construction and workmanship, may be judged by examination of the engines at Olympia.

The small Hillenbrand suction gas-engine exhibited by Messrs. G. Braulik on Stand No. 209 may now be included among the few working exhibits. From Fig. 8 some idea of the appearance of the complete producer plant and

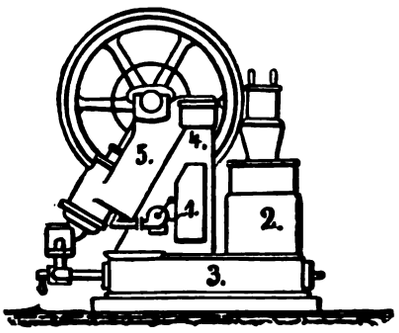

FIG. 9.—Outline Diagram of Hillenbrand Engine.

engine may be gained, and some description of its working may be given with reference to the outline diagram (Fig. 9). Although the engine may under some circumstances be direct coupled to the dynamo or other machinery to be driven, it is shown at the exhibition belted to a Silvertown continuous-current dynamo having an output of 12·5 amperes at 220 volts. An interesting feature is the utilisation of some of the waste heat in the exhaust gases and of the heat absorbed in the cylinder jacket to warm the air in its passage to the producer, and to warm the air entering the cylinder with the gas to form the explosive mixture. The air warmed during its passage through the cylinder jacket passes over the surface of the cooling water, and the vapour thus formed is further heated during its passage through the exhaust silencer contained in the bed, 3, of the engine (Fig. 9). The heated vapour then passes up through the producer grate and through the incandescent fuel for the formation of producer gas from the anthracite fuel in the usual manner. The gas leaves the producer, 2,

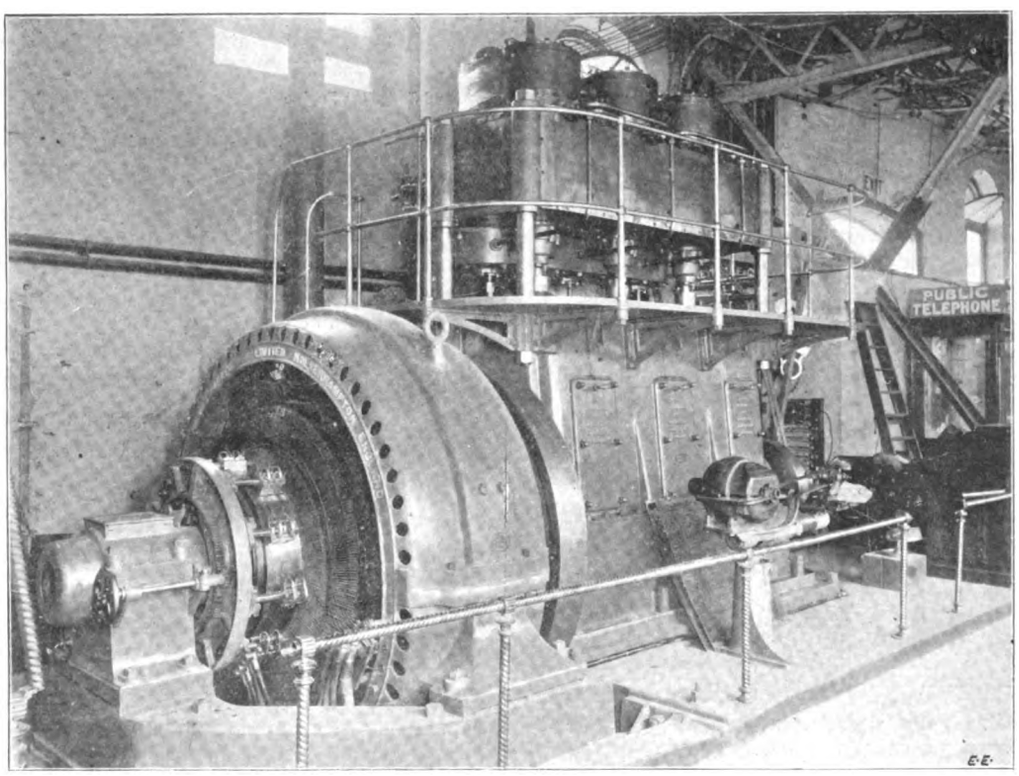

FIG. 10.—A Peache-Parker Generator at Olympia.

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and then follows an upward and downward course through the scrubber contained in the chamber, 4, and thence to an expansion chamber in the engine bed. The mixture of gas and air is controlled by a mixing cock before entry to the inlet valve box, the air required for combustion in the cylinder being previously heated to a higher temperature than that of the gas with which it is mixed by its flow around the crankshaft bearings, and through a system of pipes in the cylinder cooling water. It is claimed that by this attention to regulation of temperature no deposition of tarry matter occurs on the engine valves or in the cylinder, and the appearance of the valves when examined at the exhibition after a stated run equivalent to several months' continuous working seems to confirm this claim. Without doubt economy may be expected to result both of fuel and of water from the peculiar heat interchanges obtained in this design of engine. The engine illustrated develops 5 b.h.p., and the floor space occupied is only 6ft. by 3ft. It is, therefore, a very compact design, but it is obviously not of a type intended to be made in large sizes. The engine, working on the Otto cycle, is arranged diagonally on the cast frame with the valves set vertically in their boxes at the base of the cylinder, and low-tension magneto ignition is employed. The illustration here given (Fig. 8) necessarily does not show features of design and construction, which can only be appreciated by inspection of the engine at the exhibition.

Fig. 10 shows the Peache single-acting high-speed steam-engine and 10-pole continuous-current generator conjointly exhibited by Messrs. Davey, Paxman, and Co., Limited, and Messrs. Thomas Parker. As already stated, this set is supplying power and light for the purposes of the exhibition, supplied with steam from the marine-type Babcock and Wilcox water-tube boiler to be seen in the exhibition yard. The design of the engine is now well known and proved, and, as may be seen from Fig. 10, is of the three-crank, six-cylinder, tandem, compound type, with the piston valves at the back of the cylinders operated by an interesting form of valve gear, which takes up no room lengthways and permits the use of long and ample crankshaft journals and bearings. The high and low pressure cylinder diameters are respectively 11in. and 22in., with a stroke of 12in., and at a speed of 325 r.p.m. the engine is capable of developing 440 h.p. to 500 h.p. The rated dynamo output is 1,150 amperes at 250 volts. The engine and dynamo were erected at Olympia and there run for the first time, and by continuous running since the opening of the exhibition constitutes the only working example of a modern steam-driven central-station generating set.

The frequent and continued use of superheaters of various types for the supply of superheated steam to modern steam-engines has done much to disprove the adverse criticism made by many a few years ago, to the effect that the unsatisfactory experience obtained many years ago would be repeated. The early failure to use superheated steam has not been repeated, and the success achieved as regards the durability or useful life of the exposed parts of the superheaters is to be largely attributed to the good use made of the excellent steels now available. Messrs. McPhail and Simpson's exhibit of superheaters and parts should be seen by those interested in the use of superheated steam, and in improving the economy of their steam plant. The tubes shown on their stand, which have been in service for nine years in a superheater connected with a Babcock and Wilcox boiler, should particularly be examined. The temperature of the steam in these tubes is stated to have been 700deg. F., but there is little evidence of deterioration other than the comparatively slight pitting or irregular wasting of the external surface. In any case the use of these tubes under high temperature and over a period of nine years demonstrates that the life of superheater tubes may be greater than that of the tubes used in a multi-tubular steam-boiler, and removes any uncertainty there may have been as to their durability.

No further reference has been made to the Diesel oil-engine, but at a future date some particulars may be given. It may, however, be said that in essential details there is little change from the 20-h.p. horizontal engine which many readers will remember was shown at the Glasgow Exhibition in 1901. Such changes as have been made are mainly those affecting constructional detail and the rearrangement of parts in the vertical type of engine.

The small internal-combustion motors will not now be described, for they have many features common to the types already illustrated. They are, however, instructive examples of the reduction of weight, space occupied, and first cost made possible with high speeds of rotation. A typical exhibit is the 18-h.p. to 24-h.p. Blake petrol engine, coupled to a Siemens four-pole 7-kw. dynamo, shown on the Electrical Power Storage Company's stand (No. 98), and introduced by the Windsor Electrical Installation Company. The over-all dimensions of this set are 5ft. 4in. by 2ft. 3in. by 3ft. 9in. high. With the decreased difference of cost of paraffin and petrol, the use of the rather more expensive fuel may be of little importance with these small engines for country house lighting.

There are other exhibits of purely auxiliary plant to be seen, and amongst these may be mentioned the collection of pumps of various types, some of them electrically driven, shown by Messrs. Frank Pearn on Stand No. 211, and electrically-driven air-compressors, among other machinery, on Messrs. George Richard and Co.'s stand (No. 68).

A final reference may be made to the exhibit in the Loan Section of the portable generating plant used by the Electrical Engineers (R.E.) Volunteers to such good purpose during the South African war. The completeness of the design of this petrol-electrical combination must be seen, and seen by engineers, to be appreciated.

CALCULATION OF ALTERNATE-CURRENT TRANSFORMERS FOR MINIMUM COST.

BY DR. R. POHL AND H. BOHLE, BRADFORD.

(*Concluded from page 449.*)

We may now proceed in two ways to obtain the maximum possible, $S \times B$, and the corresponding values of d, d_1, and h

(a) We substitute the value of d_1 in equation (17) and find

$$S\,B = \frac{\beta}{2\,\frac{\gamma}{a}\,d^4} - \frac{a}{4\,\frac{\gamma^2}{a^2}\,d^6 - 4\,\frac{\gamma}{a}\,d^5}$$

Differentiating, we obtain

$$\frac{\delta\,S\,B}{\delta\,d} = -\frac{4\,\beta}{2\,\frac{\gamma}{a}\,d^5} + \frac{24\,\frac{\gamma^2}{a}\,d^5 - 20\,\gamma\,d^4}{\left(4\,\frac{\gamma^2}{a^2}\,d^6 - 4\,\frac{\gamma}{a}\,d^5\right)^2}$$

By simplifying, arranging, and placing the differential coefficient equal to zero, we find

$$8\,\beta\,\frac{\gamma}{a}\,d^2\left(\frac{\gamma}{a}\,d - 2\right) + (8\,\beta - 6\,\gamma)\,d + 5\,a = 0 \qquad (19)$$

This is an equation of the third degree and may easily be solved graphically. It is even possible to solve it directly, but the proceedings are less simple. By means of equations (16), (17), (18), (12), (13), (2), and (4), we find d_1, S B, h, G_c, G_i, S, and B respectively.

(b) We assume several values of d and calculate—after having found d_1, by means of equation (16)—the corresponding values of S B. The latter we plot now as function of d, and we obtain in this way a curve (see Fig. 9) from which the maximum possible value of S B and the corresponding value of d may be taken. The subsequent calculation is the same as under (a).

It will be found that the method depicted under (b) is the simpler one of the two. From the curve we see that two values of d correspond to every value of S B. In other words, we may build two transformers—the one short and thick, and the other long and thin, but which have the same efficiency, distribution of the losses, densities, and weights.

After having settled the principal dimensions of the transformer, the calculation of the flux, the number of primary and secondary turns, the radiating surface, the no-load current, and the drop is a simple matter. If it is found that the radiating surface is insufficient, we must

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either increase the efficiency or employ a suitable method for cooling the transformer.

For a series of standard designs we may simplify the calculation considerably. The frequencies usually employed are 50, 40, and 25. For a standard shape of core cross-section, the space factor, f_i, will be nearly constant. For constant primary and secondary pressures, f_c will increase

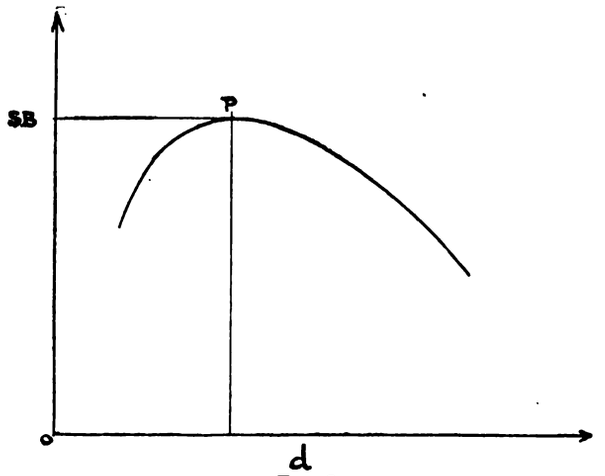

FIG. 9.

slightly with increasing output, but this increase is only small, so that no great error is made if f_c is assumed to be constant. Let, for instance, $f_i = \cdot 67$ and $f_c = \cdot 35$, then α may be plotted as function of the output. This has been done in Fig. 10 for frequencies of 50, 40, and 25. Similarly, we may plot the quantities β and γ as functions of the total loss, W_v, if we assume that $\sqrt{K_2}$ is constant. The error thus introduced will be very small, as may be seen for Curve II. of Fig. 6. For Figs. 11 and 12, $p_c = p_i = \cdot 5$. $K_1 = 2 \cdot 6$; $K_2 = 4 \cdot 15 \times 10^{-8}$, and $K_3 = \frac{S_c}{S_i} = 3$.

The course of the calculation is now as follows: In the

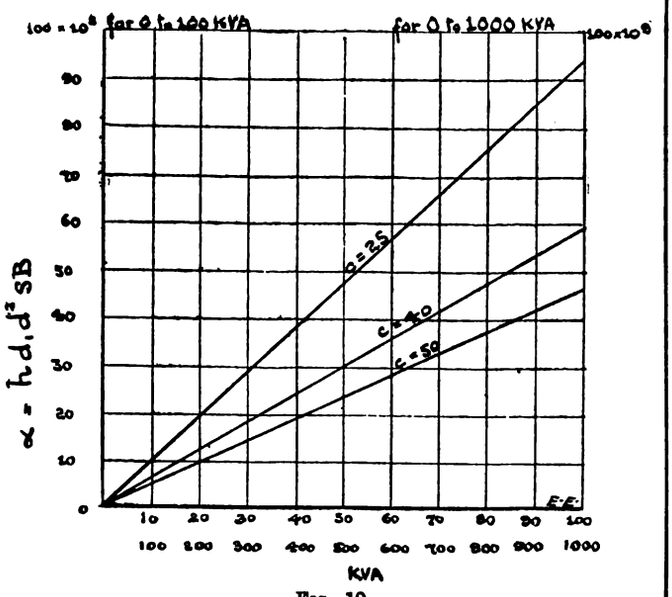

FIG. 10.

first place, we determine the conditions under which the transformer has to work. Next, we distribute the losses, decide upon the space factors, f_i and f_c, and calculate by means of the equations (9), (14), and (15) the quantities α β, and γ. When this has been done, we assume various values of d, and calculate the corresponding values of S B, which are then plotted as functions of d. In this way we obtain a curve from which the peak values of d and S B may be taken. Equations (16), (18), (12), (13), (2), and (4) determine, then, d_1, h, G_c, G_i, S and B respectively. An example will further illustrate the method.

A transformer of 50 kilovolt-ampere capacity has to be designed for a full-load efficiency of 97·5 per cent. The transformer is to be used for power purposes only, and is consequently nearly always fully loaded. The frequency of the network is 50 periods per second. The cost of the transformer must be a minimum. The price per kilogramme of copper is thrice that per kilogramme of iron, so that $\frac{S_c}{S_i} = K_3 = 3$. We distribute the losses, $W_v = 1{,}250$, evenly, so that $p_c = p_i = \cdot 5$, and $W_c = W_i = 625$. For a mean temperature rise of 40deg. C. and a supplementary loss of 15 per cent., the constant $K_1 = 2 \cdot 6$. Let, further, the space

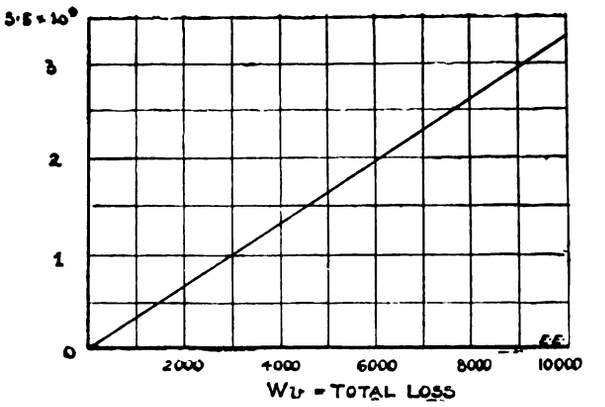

FIG. 11.

factors, f_i and f_c, be equal to ·67 and ·35 respectively, and $K_2 = 4 \cdot 15 \times 10^{-8}$. We have now

$$\alpha = \frac{5 \cdot 7 \times 10^8 \times \text{K V.A.}}{C \times f_i \times f_c} = \frac{5 \cdot 7 \times 10^8 \times 50}{50 \times \cdot 67 \times \cdot 35} = 24 \cdot 25 \times 10^8.$$

(See also Fig. 10.)

In a similar manner we find β and γ.

$$\beta = \frac{K_3 W_v}{\cdot 012 \times f_i} \times \sqrt{\frac{p_c \times p_i}{K_1 K_2 K_3}} = \frac{3 \times 1{,}250}{\cdot 012 \times \cdot 67} \times \sqrt{\frac{\cdot 25 \times 10^8}{2 \cdot 6 \times 4 \cdot 15 \times 3}} = 4 \cdot 1 \times 10^8;$$

and

$$\gamma = \frac{W_v}{\cdot 028 \times f_c} \times \sqrt{\frac{p_c \times p_i}{K_1 K_2 K_3}} = \frac{1{,}250}{\cdot 028 \times \cdot 35} \times \sqrt{\frac{\cdot 25 \times 10^8}{2 \cdot 6 \times 4 \cdot 15 \times 3}} = 1 \cdot 12 \times 10^8.$$

(See Figs. 11 and 12.)

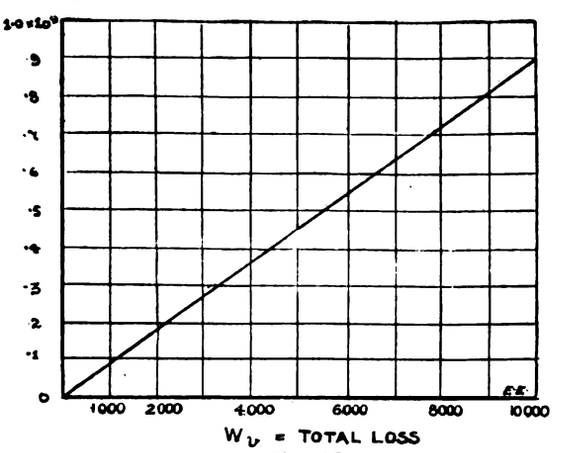

FIG. 12.

Next we assume various values of d, and determine the corresponding ones of d_1 and S B.

Let $d = 25$,	then $d_1 =$	7 5,	and S B =	2,380.
26	,,	10 4	,,	4,150.
27	,,	13	,,	4,500.
28	,,	16·2	,,	4,500.
29	,,	19·2	,,	4,300.
30	,,	22 8	,,	4,000.

In Fig. 13 the values of S B have been plotted as functions of d (see Curve I. of Fig. 13). The most economical values for d and S B are 27·5 cm. and 4,600 respectively, denoted by the peak, P, of Curve I. They form now the basis of the subsequent calculation. We find

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$$d_1 = 2d\left(\frac{\gamma}{a}d - 1\right) = 2 \times 27{\cdot}5\left(\frac{1{\cdot}12 \times 10^8}{24{\cdot}25 \times 10^8} \times 27{\cdot}5 - 1\right)$$
$$= 14{\cdot}6 \text{ cm.}$$

$$h = \frac{a}{S\,B\,d_1\,d^2} = \frac{24{\cdot}25 \times 10^8}{4{,}600 \times 14{\cdot}6 \times 27{\cdot}5^2} = 48 \text{ cm.}$$

$$G_c = \frac{W_v}{S\,B} \times \sqrt{\frac{p_c \times p_i}{K_1\,K_2\,K_3}} = 238 \text{ kg.}$$

$$G_i = 3 \times 238 = 714 \text{ kg.}$$

$$S = \sqrt{\frac{W_c}{K_1\,G_c}} = \sqrt{\frac{625}{2{\cdot}6 \times 238}} = 1.$$

$$B = \frac{S\,B}{S} = \frac{4{,}600}{1} = 4{,}600.$$

In this way we have settled all the main dimensions of the transformer. In order to find the primary and

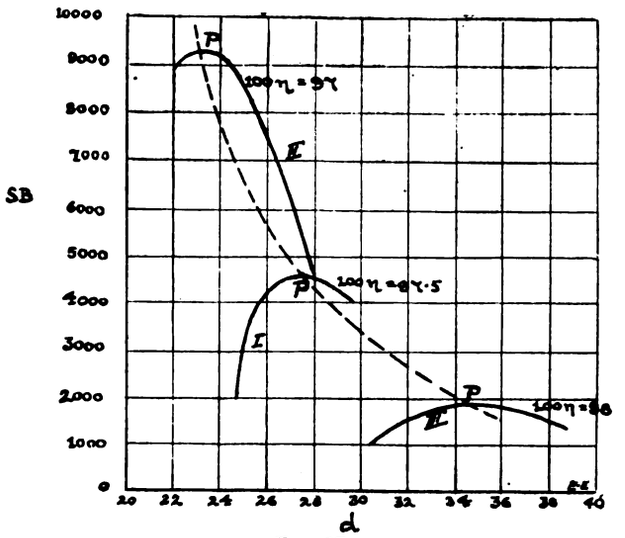

FIG. 13.

secondary turns, we must know the primary and secondary pressures. As, however, the subsequent calculation contains no new features, it will be left to the reader. He will then find that the radiating surface will be large enough for natural air cooling, and that the drop is also extremely small.

In order to show the relationship between the efficiency and the cost of the active material, the transformer has also

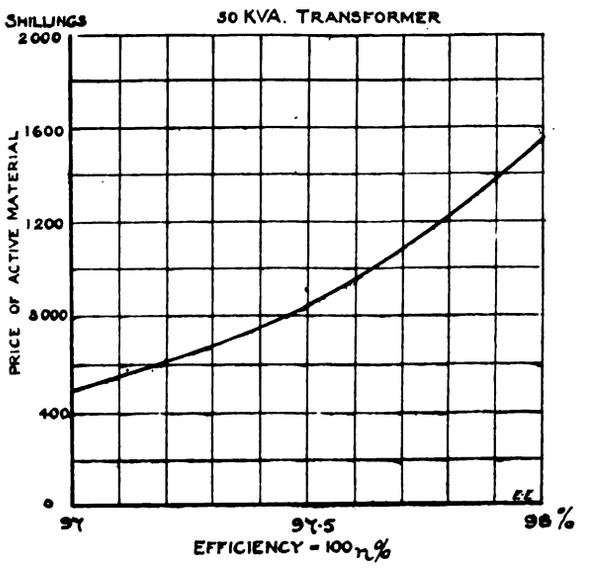

FIG. 14.

been calculated for efficiencies of 97 and 98 per cent. By connecting all the points, P—*i.e.*, the peaks of the three curves (see Fig. 13)—we obtain a fourth curve, which represents the weights—consequently, also the price—of the active material. The curve is shown separately in Fig. 14, in which the price of the active material has been plotted as function of the efficiency. We have reckoned here 21d. per kilogramme of insulated copper, and 7d. per kilogramme of stamped iron plates. We see that the price of the same transformer (active material) for an efficiency of 98 per cent. is nearly 3½ times higher than for an efficiency of 97 per cent. In the latter case, effective artificial cooling would be necessary.

By using our method of calculating transformers, it will be found that in many cases the cost of a transformer will be reduced by a not inconsiderable amount, and the time spent on the calculation is also greatly decreased. For three-phase core and single-phase shell transformers, a slight modification of one or two formulæ will be required, but which should offer no difficulties.

ELECTRICITY METERS.

The series of lectures at the Olympia Exhibition are attracting large audiences, and there was a substantial attendance again on Tuesday evening, when Mr. S. Z. de Ferranti delivered a popular address upon "Electricity Meters." Having described the mechanical principles of the gas-meter, he traced the evolution of the meter designed by himself, stating that 23 years ago he was favourably impressed by electro-chemical methods. He soon discovered, however, the superior qualities of the motor meter, which he believed would be the instrument of the future. He also discussed the depositing meter devised by Edison 25 years ago, and the instruments of Kelvin, Ayrton and Perry, John Hopkinson, and Aron, down to the Fricker prepayment meter. The audience seemed highly interested, though how far they understood the subject is problematical. If their knowledge was on a par with that of the average layman, the result was creditable to Mr. Ferranti's abilities as a lecturer.

MILAN INTERNATIONAL EXHIBITION, 1906.

We have been requested by Mr. Arthur Serena, hon. executive commissioner for Great Britain at the Milan Exhibition of 1906, to state that H.M. the King of Italy will offer prizes to the extent of £1,600 to exhibitors. This amount will be divided as follows: (1) a prize of £200 for automatic safety couplings for railway rolling-stock; (2) a prize of £200 for the best method of testing high-voltage electric currents without danger to the operator; (3) a prize of £400 for the best and most original exhibit of machinery or manufacturing process; (4) a prize of £200 for the best established method of distributing healthy and pure milk in centres of population: (5) a prize of £400 for the best type of popular dwelling adapted to the climate of Northern Italy; (6) a prize of £200 for motor boats.

In addition to the foregoing there will be given a national prize of £200 to the public institution or private society which, during the last 10 years, has been most successful in the work of reclaiming waste lands in mountainous districts, and in the improvements of pasturage. These special inducements to exhibiting will doubtless possess attraction for British manufacturers, inventors, and others, who should without loss of time address themselves for further particulars to the Hon. Executive Commissioner of the British Section, 1 and 2, Oxford-court, Cannon-street, London, E.C.

FORTHCOMING EVENTS.

SATURDAY, OCT. 14.

Birmingham Electric Club.—At 7.30 p.m., general meeting.

WEDNESDAY, OCT. 18.

Junior Institution of Engineers.—At 4 p.m., visit to the Olympia Exhibition.

THURSDAY, OCT. 19.

Rugby Engineering Society.—At 8 p.m., "Electric Switchgear," by Mr. J. Whitcher.

FRIDAY, OCT. 20.

Institution of Mechanical Engineers.—At 8 p.m., "The Manufacture of Cartridge Cases for Quick-Firing Guns," by Colonel Leandro Cubillo.

Electro-Harmonic Society.—At 8 p.m., first smoking concert of the season in the King's Hall, Holborn Restaurant.

Tramways and Light Railways Association.—Oct. 25, at 8 p.m., "Roller Bearings," by Mr. T. W. How.

Institution of Civil Engineers.—Nov. 7, at 8 p.m., inaugural address by Sir Alexander Binnie and presentation of awards.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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HISTORIC.

It is just as well to be reminded occasionally of the history of electrical developments. The latter half of the nineteenth century has much to answer for in this direction, yet many of those actively engaged in electrical enterprises do not really understand that the whole development is within the recollection of many an old man. Eighty years ago, and where was telegraphy? And old men of eighty are met with daily. Electro-deposition, again, is within that period, as is electric lighting and power transmission, while wireless telegraphy is still more recent, and within the memory of almost every schoolboy. Mr. Esson in his presidential address to the Civil and Mechanical Engineers selected, as was natural, for his text, "The Influence of Electricity on Power Engineering." In a way, electrical development can never have quite the same far-reaching effect as did the development of steam, but none of us can imagine the magnitude of change of the revolutionary epoch inaugurated really only some twenty-five years ago. The development of steam brought the ends of the world more closely together than were towns at the extremities of this island a hundred years ago. People who dogmatise about food supply and certain economic fictions have not yet learned that the latter are fictions, just because the cornfields of Manitoba and the grazing lands of New Zealand are nearer to the great centres of population in Europe than even the glens of the Highlands at the end of the eighteenth century. The ease of intercommunication has considerably altered the prevailing conditions of living, and if due consideration is not given to the results following the development of steam, the conclusions arrived at will be incorrect. The evolution of electrical engineering has been more rapid than in the case of steam, and the results obtained, added to the invisibility of the agent used, have so acted upon the imaginations of the masses that a glamour is thrown around the subject similar to that which exists in the minds of the younger generation when reading the wonderful feats recounted in the "Thousand and One Nights." Electricity (the unknown), utilised by apparatus devised by capable men, seems to give opportunities in every direction, and no one is surprised at the next suggestion for its use. Tentative attempts at electric lighting have been made since the later thirties, but, of course, the apparatus then at command—batteries, crude arcs, and still cruder incandescents—was not effective. The early fifties saw a result that Mr. Esson might just have referred to, though it hardly, perhaps, comes within the scope of his discourse. We refer to the work of Wilde and what arose out of it. Except, however, for a little lighthouse work, electric lighting really slept till the advent of Gramme and Jablochkoff. The French Exhibition of 1878 led the way, and opened the eyes of the world more than anything that had gone before to the possibilities of electrical work. Between 1878 and 1881 the strides were rapid, and the exhibition at Paris in the latter year revealed fully to an astonished world the dawn of the electrical era. Prior to that electrical engineering was not. Since then it has been, and has overshadowed all other branches of engineering, till in one direction alone—the harnessing of water power previously running to waste—the work has become gigantic. Here is what Mr. Esson says on this point: "Up to the present I have referred to hydro-electric plants only, and it is not easy to estimate the total of the water power which has been utilised all over the world by their erection. The tribute under which Niagara River has been laid for power supply has been already cited, and I believe I am well within the mark in placing the total

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capacity of the hydro-electric power-houses at work and under construction on the American continent alone at a million horse-power. In Italy, Lombardy alone accounts for 88,000 h.p. in hydro-electric power-houses at work and under construction, while Switzerland, the home of hydro-electrics, accounts for 220,000 h.p. Taking the whole world, the water power utilised in the hydro-electric stations must lie somewhere between a million and a half and two millions of horse-power—a vast force the greater part of which might have run to waste for all time had it not been for the invention of the dynamo." We do not know if the ordinary reader sees in development of this kind a total change of certain conditions previously existing; hence the certainty of further change of population and of manufactures. The moral is clear enough to those not blinded by political or other antipathies that great changes are going on, and must be faced. Take one direction—a million horse-power used. Unless the demand for horse-power increases in proportion to the supply, there must be a less demand for factors previously making the horse-power. Work will be shifted from one place to another, with the consequent troubles arising out of such shifting.

THE DYNAMICABLES.

It is understood that ordinarily the social gatherings of this unique society are to go unreported. There are exceptions to every rule, and the gathering at the exhibition on Wednesday evening is one of the exceptions. The notice given was necessarily very short, and the Press was invited to assist in giving it a wide publicity. The result must have been gratifying to the president of the evening—Sir W. H. Preece—and to the hon secretary, Mr. Sharp. The latter deserves the best thanks of all Dynamicables for the excellent arrangements he makes on all occasions. Nearly a hundred members and friends sat down to dinner, most of whom had previously spent some time in "doing the exhibition." The toasts, as usual, were few, being confined to the loyal toasts and "Success to the Exhibition." We are all in our own ways trying to make it a success. Messrs. Lyons catered excellently.

CORRESPONDENCE.

THE ALL-STEEL RAILWAY CARRIAGE.

SIR,—Your correspondent "Experience" must be an old gentleman with a wonderful memory to recall so vividly the terrible discomforts of steel railway carriages 50 years ago. Of the hundreds of thousands of people who have travelled on Mr. Cuningham's steel cars on the Central London Railway during the past two years, not one has complained of being frostbitten in winter or parboiled in summer. In fact, I do not suppose they even knew that the cars were steel.

I must confess that until I read "Experience's" letter I did not know that the manufacture of steel was so far advanced 50 years ago that railway cars could be made of it.

No doubt the Brush Company would be very much obliged to "Experience" if he would produce some record of the steel cars of 50 years ago; but, failing that, the company is not likely to be turned from its course in pushing the sale of rolling-stock which both English and American practice of the present day shows to be in demand.—Yours, etc., T. C. E.

IMPERIAL NOTES.

DUNEDIN, NEW ZEALAND.

The city of Dunedin (the old name for Edinburgh) is in the province of Otago, in the South Island of New Zealand, and is 230 miles by rail south from Christchurch. The city was founded on March 23, 1848, constituted a Town Board on Aug. 27, 1855, and incorporated on Aug. 1, 1865. It has this year extended its area by taking in the adjoining boroughs of South Dunedin and Caversham, and has now a population of 38.121 (or with suburbs, 53,294), 91 miles of streets, and 8,715 buildings. Its rateable value is £360,846, and the general rates are 1s. 3d. in the £, special rates 9d. in the £, and water rate 1s. in the £, or 3s. in all.

Gasworks.—The gasworks are the property of the Corporation except in the added borough of Caversham, where this undertaking is in the hands of a private company. The price charged for gas for lighting purposes is 6s. 3d. per 1.000 cubic feet net, and for cooking purposes 5s. per 1,000 feet. There are over 4,000 gas consumers within the boundary of the old city, and 160 gas-engines. Gas was first lighted in Dunedin on March 9, 1863 On this undertaking the Corporation has borrowed £100,000.

Electric Tramways.—The tramway system is owned by the City Corporation, and the works of construction were commenced on Feb. 26, 1903. The total length of route is 14 miles 19 chains, and of this length 5 miles and 46 chains is double track. At the present time 15 miles and 57 chains of single track are being worked. On the city portion of the double track centre poles are used, and these are spaced at distances of from 120ft. to 130ft. apart. The gauge of the track is the standard 4ft. 8½in., and the sharpest curve has a radius of 52ft. 6in. The rails are of the grooved girder type, 6½in. in depth and 6½in. wide on the base, and weigh 94lb. per lineal yard. They are laid on Australian hardwood sleepers spaced 2ft. 6in. apart centre to centre. The surface of the track is made up with a layer of 1½in. tarred macadam and 1½in. tarred screenings, and finished with tar and sharp sand. The rails are protected by stone setts laid alternately longitudinally and transversely.

Power-House.—The power-house plant consists of three Westinghouse units, each 200 kw., direct-coupled to Belliss engines. Three boilers of the Babcock and Wilcox type are installed, but this installation is only of a temporary character until such time as the Waipori water-power scheme shall be completed. A storage buffer battery is used in conjunction with the power plant in order to carry the peaks to the load. The system is not yet quite complete, as several of the streets are to be widened before the tracks can be laid down. Portions of the system, however, have been running for some considerable time, and up to May 3 the number of passengers carried was 9,999,907, the revenue earned was £44,980. 18s. 5d., and the number of car miles run was 812,373. This gives a revenue return of 13·28d. per car mile.

Car-Sheds.—These are of the most modern type, provided with all necessary workshops, stores, etc., and all mechanical appliances for making the requisite repairs to the rolling-stock. The car-sheds are situated near to the centre of the system.

Rolling-Stock.—The rolling-stock consists of 50 cars, and includes 14 of the closed type (18ft. body with vestibule ends), 14 combination type (14ft. body and open compartments at each end), 15 10-bench open cars, six trailers, and one watering car. All cars are single-deckers with single trucks having a wheel base of 6ft. 6in. The motor equipments are of the Westinghouse type No. 80, with No. 210 controllers. All cars are fitted with Westinghouse magnetic brakes, which are used for all service stops.

Waipori Power Transmission Scheme.—The City Council has undertaken the installation of an electric power transmission plant at the Waipori Falls, which are situated about 35 miles from Dunedin. At these falls there is a head of water of 670ft., from which it is estimated that 5,000 h.p. will be obtained. It is proposed to shut down the steam plant and provide power for the tramways, street-lighting, and for light and motive purposes to private consumers. The first plant, which is now being installed, consists of two 1,000-kw. units direct coupled to Pelton wheels, and the power will be transmitted at a pressure of 35,000 volts (three-phase). It is anticipated that this power will be available in Dunedin by April of next year. Arc lamps are fixed on some of the central trolley poles, and it is intended to complete the lighting of several of the principal streets in this manner.

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SOME NEW DESIGNS IN ELECTRIC LIGHT FITTINGS AT OLYMPIA.

[BY OUR SPECIAL ARTIST.]

(Continued from page 478.)

At the stands of the Edison and Swan United Electric Light Company, Limited, are to be seen some extremely tastefnl fittings; but owing to the amount of space taken up by their other exhibits, customers would do well to visit the showrooms in Queen-street, E.C. The special exhibition edition of their catalogue, Section VI, bound in a cover of marble and gold, is also well worth possessing for those who wish to make a selection of fittings. A few designs are illustrated herewith. Fig. 1 shows a very refined hall lantern in oxidised silver. The dome and hand-beaten straps form a pretty combination, and the satin-finished glass gives a subdued effect to the light. A neat two-light rise and fall pendant for bedrooms is shown in Fig. 2, the metal work being of polished brass, and the shades of a type known as obscured threaded Irene. The price of this fitting is very moderate.

FIG. 1.

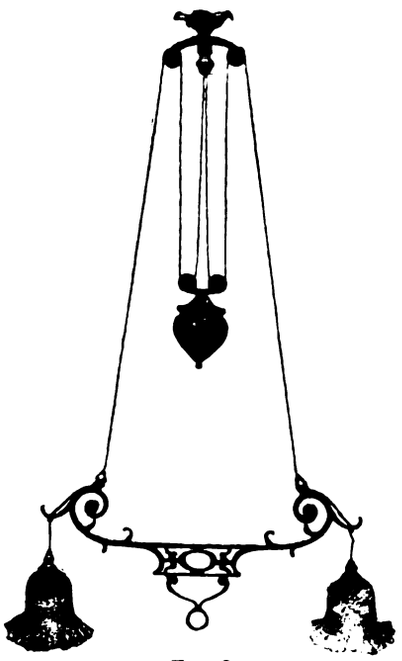

FIG. 2.

FIG. 3.

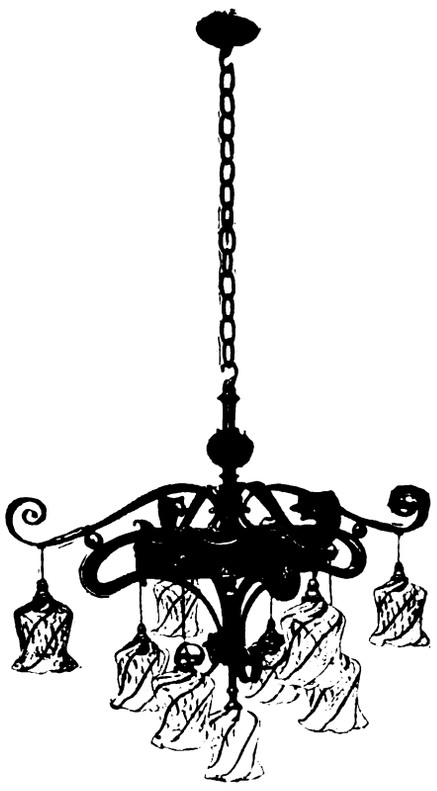

FIG. 4.

FIG. 7.

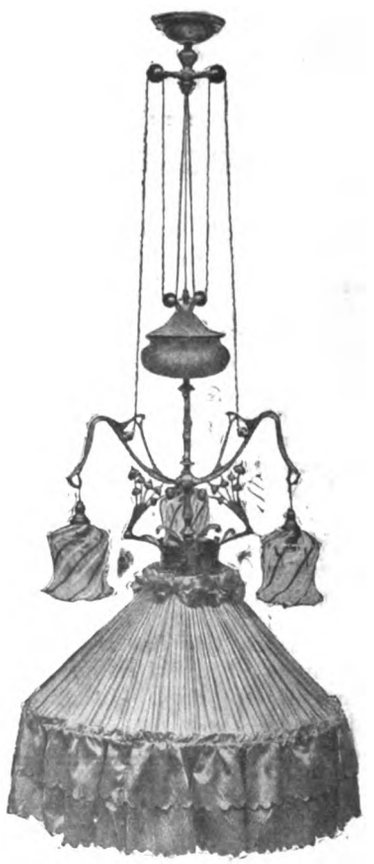

FIG. 6.

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Nothing could be more chaste and simple than the crown fitting shown in Fig. 3. This is of polished brass with chain and 5in. back-plate, and having a spread of 18in. The three amber-tinted shades give a tone which suits the fitting particularly to smoke-rooms and studies. Fig. 4 illustrates a new electrolier with nine lights, suitable for board-rooms, restaurants, etc. This is finished in polished brass, and provided with opal and green striped flint shade. The graceful curves of the arms will be specially noted. A dining-room pendant in oxidised silver and three similar flint shades is shown in Fig. 5. There are three lights under the shade, and the top lights can be omitted if necessary. Fig. 6 shows a handsome "Georgian" bracket in polished brass, also with a flint shade, as above; whilst Fig. 7 is a graceful design of Adams brackets for two lights, with "Hunterlite" candles. The length of this is 19in. and the spread 12in. Figs. 8 and 9 show two plain and inexpensive table standards. The former, for office use, is of polished brass, with green opal shade and cardboard curtain shade for screening the light from the eyes. This fitting can also be supplied in copper bronze for a slight extra. The standard shown in Fig. 9 is of Florentine bronze, and stands 12in. high. As a simple desk fitting for study or boudoir it cannot be excelled.

FIG. 8.

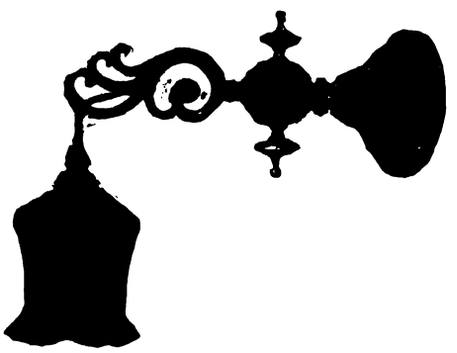

FIG. 6.

FIG. 9.

Amongst certain useful accessories in connection with fittings at Olympia there are the patent illuminating table cloth and connection shown at the stand of N. Burt and Co., and noticed by us in a recent issue; also a novel candle lamp made by Pope's Electric Lamp Company, for which special advantages are claimed. The General Electric Company, Limited, also have a new patent chain for suspending their electroliers, which is of great mechanical strength and as simple in design as the ordinary oval link chain.

DOMESTIC ELECTRIC LIGHTING.

BY JAMES SWINBURNE, M I E E.

On Friday, Oct. 6, Mr. James Swinburne delivered an interesting lecture at the Electrical Exhibition, Olympia, on the "Lighting of Houses by Electricity," of which the following is a *résumé*. The lecturer mainly confined himself to a description of the various types of electric lamp and the advantages of the use of electric light in comparison with other methods of illumination.

After mentioning the early work of Sawyer and Mann, Edison, Maxim, and Swan, the lecturer pointed out that the carbon incandescent lamp is to-day practically identical with the lamp suggested in 1836 and successfully made in 1880. The improvements made in these lamps are really improvements in detail of manufacture and standardising, which have fortunately rendered lamps much cheaper. Important improvements have been made in the method of blowing the bulbs of the lamps. In the early days bulbs were blown by hand; since then, however, the Germans have invented a method of blowing lamps by machinery, in a manner practically identical with that used in making bottles. The exhaustion of the lamps is now generally performed by the aid of a mechanical pump, although the vacuum obtained in this manner is not so good as that found in the earlier lamps. The method of "flashing" filaments invented by Maxim, but generally ascribed to Sawyer, has rendered it possible to obtain lamps which are practically uniform.

Before proceeding to describe the more modern form of electric incandescent lamps, Mr. Swinburne gave an interesting discussion on the relative cheapness of electric light and gas light. In the early days, when the luminous gas flame was used, electricity supplied at the cost of 3d. per unit would have been about equal to gas supplied at 2s. per 1,000 cubic feet. This estimate ignores the cost of lamps. At the present day the use of mantles has very much cheapened the cost of gas light. Gas companies say that gas is about 30 times as cheap as electric light, but Mr. Swinburne calculated that the cost of gas was about nine times as cheap as electric light. This, however, is only one side of the question. If cheapness were the only consideration, it would be best to light a house up by providing a large fire in the middle of each room; but, of course, the fumes from the fire would do so much damage to the house that this method would be quite impracticable. The fumes from gas, although not so obnoxious as those from a fire without a chimney, are, nevertheless, very damaging; a house lighted by gas needs redecorating every four years, while with electric light it would not need redecorating more than once in six years. If you take a house in London and use electric light, and thus render it possible to redecorate it every six instead of every four years, the economy in redecorating will just counterbalance the extra cost of the electric light. In addition, the injury done to leather-bound books, and the extra cost for servants necessitated by the tarnishing of plate, when gas is used need to be considered. Taking everything into consideration, the electric light would be cheaper than gas for lighting purposes, even if the gas companies would supply their gas for nothing. Mr. Swinburne referred to the fact that light is obtained more economically if the carbon-filament lamp is "over-run," but over-running means a shorter life for the lamp. Most householders run their lamps at too low an efficiency, and also for too long a time. In many cases lamps are still used in houses after they have become so blackened that a large percentage of the light emitted by the filament is absorbed.

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Within the last few years several improved forms of incandescent lamps have been put on the market. The first of these was the Nernst lamp. In this lamp zirconia is used as the basis of the conductor to be heated by the electric current; its high melting point renders it possible to raise the conductor to a much higher temperature, and therefore to obtain light which is both more economical and more like sunlight. The worst thing about these lamps is that they give a good deal of trouble. When switched on they do not light up at once, since a current has to be sent through a heating coil in order to raise the temperature of the glower to the point when it becomes conducting before the electric current can pass through the glower. This is sometimes very annoying. For instance, a man goes down to his wine cellar, where a Nernst lamp is in use; he turns on the switch and nothing happens, when he probably says something and lights a match, gets what he wants, and goes away. Afterwards the lamp lights up and burns until someone again visits the cellar. On going into a dark room you will probably have to wait a quarter or half a minute before you can get a light. In the latest types of Nernst lamps small carbon-filament lamps are provided, which become luminous when the Nernst lamp is switched on, while when the Nernst lamp lights up the subsidiary lamps are switched out automatically.

One of the latest forms of electric incandescent lamp is the tantalum lamp. Tantalum is a metal which is not in general very well known. It is nearly, or quite, as hard as the diamond, and rather stronger than steel. The German firm of Siemens and Halske have succeeded in shaping this metal into very fine filaments, and making these into lamps. The high melting point of tantalum renders it possible to raise the filament to a much higher temperature than would be practicable in the case of carbon filaments, and thus greater economy is effected. In addition, the resistance of tantalum increases with the temperature, while the resistance of carbon remains stationary, and under certain circumstances decreases with the rise of temperature, with the result that an accidental rise of pressure that would destroy a carbon filament has no harmful effect on a tantalum filament Were it not for the high price of tantalum lamps, carbon-filament lamps would no longer have a chance against their latest rival, but when a carbon-filament lamp can be obtained for a few pence, people are loth to pay three, four, or five shillings for a tantalum lamp, however great its advantages may be.

The osmium lamp was invented by Auer von Welsbach, the inventor of the gas mantle. Osmium is about as rare as tantalum, and about as difficult to work. The osmium lamp is a very promising lamp, indeed, but the difficulty is to obtain a filament long enough and thin enough to possess a sufficiently high resistance for the ordinary pressure at which electricity is supplied. However, lamps have been made to withstand a pressure of 110 volts, and two of these may be coupled in series across 220-volt mains. The osmium lamp has the further advantage that very efficient lamps can be made from it to run at very low pressures, even below 50 volts. Portable osmium lamps lighted by means of a secondary battery have been supplied by the Electrical Power Storage Company; these should be very popular, as they can be turned on at an instant's notice wherever they happen to be wanted.

The Cooper Hewitt lamp utilises the light emitted when an electric current passes through mercury vapour. In its original form it was unsuitable for domestic lighting, since the colour of the light emitted is something between green and blue, and would render the most beautiful lady's complexion hideous. It is, however, excellent for use in drawing offices, and it is being used with great success in photography. It has a very high efficiency—that is, it dissipates very little power in proportion to the light which it emits. Mr. Bastian has invented an improved form of mercury lamp specially arranged for domestic lighting; a carbon-filament lamp is run at so low a pressure that it only emits red light, and this combined with the blue and green light from the incandescent mercury vapour forms a very good light indeed. This lamps brings the cost of electric light down to that required in the case of gas, without taking into consideration the deleterious effects of the latter.

ELECTRIC LIFTS AT OLYMPIA.

BY A. H. SHAW, M.I.E.E.

Although the number of lifts exhibited at the exhibition is not large, several well-known firms being unrepresented, sufficient may be seen to prove to visitors that great improvements have been effected during the past 10 years in this industry. The general tendency has been to perfect the various systems of electric control, and to develop the various safety devices so as to render the operation of the lift perfectly safe and "fool-proof." These results have been so successfully attained that nearly all passenger lifts now erected are fitted with some form of electric control in preference to the old hand rope, and the safety devices adopted are such that in ordinary work it would be almost impossible for an accident to occur, all causes of accident being efficiently guarded against.

The only lifts working in the exhibition are the two passenger lifts erected by the Easton Lift Company, Limited, and used for conveying visitors from the floor to the gallery. Each equipment is of sufficient capacity to carry 12 passengers at each journey, and the method of control is the

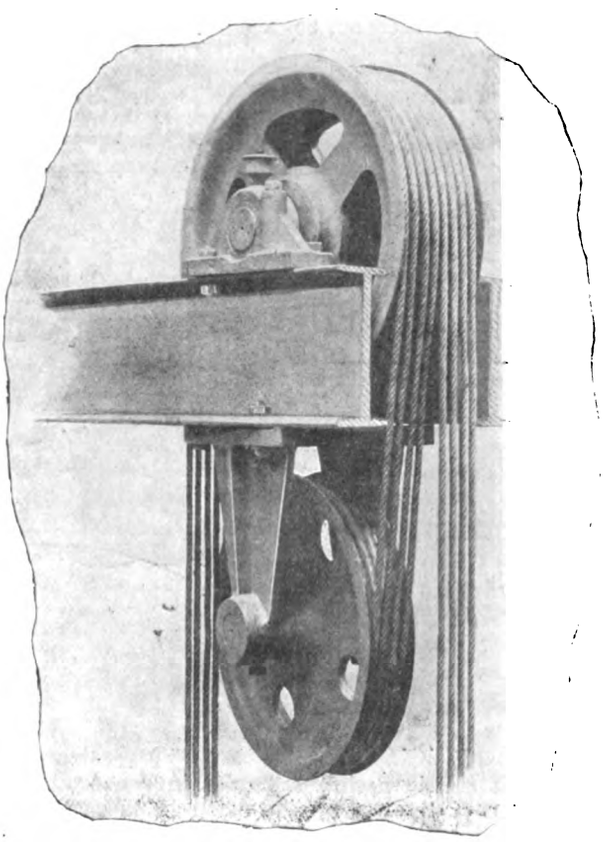

FIG. 1.—Easton's Patent Cross-over Drive for Lifts.

company's special "car-switch control." This form of switch is claimed to have several advantages over other makes, the following being a few of the more noticeable: it is fitted with magnetic blow-outs at all points where arcing might set up; it contains a special shunt-break switch by means of which the shunt circuit is never opened, but may discharge through the armature circuit when the supply is switched off; it enables the attendant to slow up gradually when stopping, and by its use the car may be moved any distance, even as little as ¼in. if required. The switchgear in connection with the controller is mounted on a panel fixed adjacent to the motor and driving gear, and consists of main switches and a solenoid switch, which cuts resistance out of the armature circuit when the motor is started, automatically reinserting it again in the armature circuit whenever the lift is stopped. Easton's patent cross-over drive (Fig. 1) is used and shown in connection with these lifts. Instead of using a wide drum and separate ropes for the car and counterbalance, as with the usual form of drum drive, the ropes connecting the car and counterbalance are continuous, and after passing around the driving sheave they are taken round an extra cross-over sheave fixed imme-

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diately adjacent. This driving gear takes up less space and headroom than the ordinary drum type, and as the ropes are continuous, and the drive is positive in effect, no slack cable device is required. Four ropes are used instead of two, as with the usual drum type, and by means of an equalising device the strain is distributed equally between all the ropes. In addition to the type of lifts exhibited at the exhibition the Easton Company also manufacture goods and service lifts of all types operated either by hand rope, car switch, or push button, and they are now able to supply a high-speed lift with push-button control, the car automatically speeding up when starting, and slowing down when approaching the floor at which it is desired to stop.

Messrs. Geipel and Lange exhibit a working model of a passenger lift operated by their system of car switch control, the switch and controller being of the usual working size. The switchboard erected by the side of the model is of special interest. The whole of the gear controlling the motor is fixed on this panel, which is supplied complete ready for connecting up. At the top of the panel a double-pole main switch is fixed, this switch being fitted with magnetic blow-outs. Adjoining this switch is a solenoid operating a six-contact switch. Under these two double-pole direction switches are fixed, only one of which can be operated at a time, according to the direction in which the car switch is thrown over. There are also five single-pole switches, which are operated by the solenoid switch above referred to. Four of these switches are connected to a resistance in the motor armature circuit, while the fifth controls a rheostatic brake. This brake is provided in addition to the usual magnetic brake, and consists of a resistance which can be inserted across the armature, thereby slowing up the motor without the assistance of the magnetic brake if necessary. The switchboard also contains a single-pole switch, which operates the solenoid hand brake, and a solenoid switch for inserting resistance into the field of the motor for increasing the speed if required. The car switch is fitted with a spring, by means of which, when at rest, it is always kept in the centre or "off" position. If when running the attendant releases his hold of the switch, it returns to this position, stopping the car. In operating, the switch handle is first moved a short distance to either side, according to the direction in which it is desired to travel. This movement closes the main switch, one of the direction switches, and the switches actuating the magnetic and rheostatic brakes, the motor starting up with all resistance in the armature circuit. The solenoid switch then comes into operation, the speed of this being regulated by an adjustable governor. This switch actuates the single-pole switches, which cut out the armature resistance, accelerating the speed of the motor. By moving the switch handle farther over, the field solenoid switch is brought into action, resistance being cut into the field circuit and the speed further accelerated. The lift is provided with the usual safety devices to prevent overrunning, etc. In addition to the working model shown, Messrs. Geipel and Lange also supply controllers for use with all types of lifts, including hand-rope, car-switch, or push-button control.

A working model of the "Stigler" lifts is shown by Messrs. J. E. Spagnoletti and Co., for which they are the sole agents in the United Kingdom. This lift is controlled by push buttons, and is particularly adapted for use in private houses, flats, etc., as no attendant is required. Push buttons are fitted inside the car, numbered to correspond with the different floors, and to operate the lift it is only necessary to close all gates and to press the button corresponding with the floor required, when the lift will immediately travel to the floor required, stopping automatically. After leaving the lift and closing the gate, a push button outside may be pressed, returning the car to the ground floor. Contacts are fitted to all the gates, and if any gate is left open the lift is rendered inoperative. A special regulator is fitted to these lifts by means of which the car stops level with the floors irrespective of the load. The controlling switches are actuated by a series of relays fitted with carbon contacts, which are actuated through floor contacts fixed in the lift well. The usual safety devices for stopping and holding the car, should any accident occur to the ropes or the driving gear, are also fitted. A very large number of these lifts have been erected on the Continent for use without any special attendant, and are giving every satisfaction.

The Sturtevant Engineering Company's car-switch system of control for lifts (Fig. 2) is shown in operation, the controlling switch and subsidiary switches being mounted on a panel and actuated by the operating switch, which would be fixed in the car. They also exhibit types of their lift controllers for operating by hand rope, in addition to many other types of controllers for various purposes.

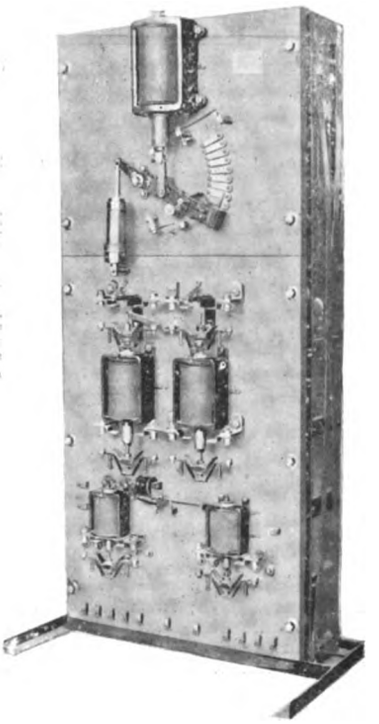


FIG. 2.—The Sturtevant Automatic Control Gear for Electric Lifts.

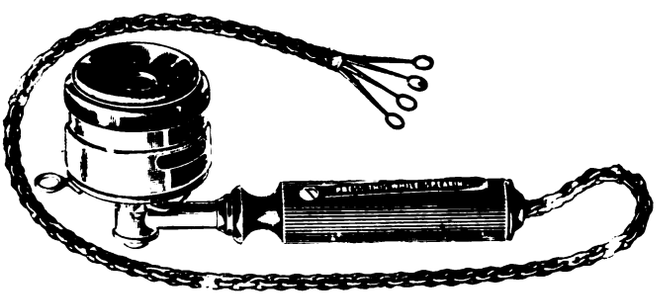
Messrs. Rumney and Rumney exhibit lift controllers connected to alternating and direct current motors. The alternating motor exhibited is a single-phase motor designed specially for this purpose, and has a high starting torque. It is supplied by Mr. T. Harding Charton, and may be started, stopped, and reversed as easily as a direct-current motor.

Dinner or service lifts, operated by push buttons with automatic stops, are also shown in operation by Messrs. Drake and Gorham and Electromotors, Limited.

TRADE NOTICES AND NOVELTIES.

Hygienic Telephones.

To those to whom the ubiquitous bacteria constitute not an imaginary but a real danger, the introduction of the instrument shown in the accompanying illustration will be particularly



welcome. The difficulties attending the effective sterilisation of the germ-infested telephone mouthpiece have been cut by the General Electric Company by the simple means of doing away with the mouthpiece altogether. They are now placing on the market a combination of receiver and transmitter which is contained in a small metal case shaped like a watch. This is kept continuously to the ear both when speaking and listening, the person speaking apparently addressing himself to the empty air. The usual handle with spring switch is attached to the case. The trans-

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mitter has two large apertures which admit the sound waves, and has been made more sensitive by means of carbon plates which contain 40 little cells, each being filled up with shot carbon, consequently the whole of the transmitter is rendered sensitive instead of the centre portion only. We had an opportunity of testing this instrument, and found that the transmission of sound was equally as good as if a mouthpiece had been used. Our illustration represents the article as it will be placed on the market. The experimental instruments shown us were not a hand combination, but were of the watch type. Both the ringing key and the switch for the speaking circuit were mounted on the same. They were distinguished by different coloured press buttons.

STOCKTON-ON-TEES ELECTRICITY ACCOUNTS.

The accounts of the Stockton-on-Tees electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £51,275. Abstracts of the revenue account and balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	2,098	6	8
Distribution of electricity	53	17	0
Attending and repairs to public lamps	147	18	9
Repairs to buildings	9	12	8
Rents, rates, and taxes	401	2	10
Management expenses, salaries, etc.	636	12	3
Special charges—insurances	40	1	6
	3,387	1	8
Amount carried to net revenue account	2,885	12	3
	£6,272	13	11

Cr. Income.	£	s.	d.
By sale of current, less discounts	5,260	3	6
Public lamps	806	13	4
Rental of meters	129	0	9
Fittings account	71	11	7
Miscellaneous guarantees	5	4	9
	£6,272	13	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	47,356	5	1
Sundry creditors and deposits	910	15	1
Mortgage debt extinguished	5,425	14	11
Sinking fund accumulations uninvested	1,259	10	9
	£54,932	5	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	51,275	15	10
Store on hand	427	3	8
Sundry debtors for current supplied, etc.	2,252	6	4
Cash in hands of treasurer	967	0	0
Cash in hand of engineer	10	0	0
	£54,932	5	10

CHELTENHAM ELECTRICITY ACCOUNTS.

The accounts of the Cheltenham electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £152,266. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5,350	6	0
Distribution of electricity	724	5	0
Attending and repairs to public lamps	1,412	16	4
Rents, rates, and taxes	938	12	7
Management expenses, salaries, etc.	1,222	13	1
Special charges, insurances, etc.	81	1	9
	9,729	14	9
Amount carried to net revenue account	11,303	15	7
	£21,033	10	4

Cr. Income.	£	s.	d.
By sale of current by meter, less allowances	11,474	1	2
Ditto for public lighting	9,182	4	8
Rental of meters and other apparatus	197	8	11
Goods sold and miscellaneous receipts	179	15	7
	£21,033	10	4

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	152,698	10	0
Sundry creditors	991	14	1
Debenture interest, bank interest, etc.	2,458	18	3
Sinking fund provision account	1,425	15	9
Cash due to treasurer, revenue account	16,609	13	5
Balance—amount of loan repaid out of revenue	2,582	10	0
Amount of sinking fund	25,270	2	4
	£200,037	3	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	152,266	16	7
Stores on hand	776	3	10
Sundry debtors for current supplied, etc.	3,460	8	11
Other debtors	194	7	9
Balance at debit of net revenue account	16,869	13	10
Cash in hands of engineer	129	3	4
Capital cash in hands of borough treasurer	3,070	7	3
Sinking fund investments and cash at bank	25,270	2	4
	£200,037	3	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,718,665
Quantity sold: Private consumers by meter	477,065		
By contract	7,190		
Traction	283,081		1,389,591
Public lamps	622,255		
Quantity used on works			134,012
Total quantity accounted for			1,523,603
Quantity not accounted for			195,061
Maximum supply demanded (kilovolt-amperes)			1,090

Number of public lamps: 388 arcs, 18 incandescents, 3 Nernst.

PERSONAL.

Mr. Portley, Limerick, has been appointed junior assistant at the Limerick Corporation's power station.

Mr. Burnie, chief lecturer in the electrical engineering department of the Royal Technical Institute at Salford, has been appointed principal of the Croydon Polytechnic.

Mr. Chas. Gorick has left the General Electric Co. to take over the position of general manager to the Amalgamated Dry Batteries, whose offices are 16 and 17, Devonshire-square, E.C.

Mr. F. O. J. Roose, assistant electrical engineer of Bournemouth, having been appointed assistant resident engineer under the London County Council, Mr. H. G. Andrews has been appointed to Mr. Roose's position, Mr. Keene to Mr. Andrews's position, and Mr. J. H. Chick, of Acton, as shift engineer.

We understand that Mr. A. Eckstein, who has been connected with the General Electric Co. for the last 18 years, and since the formation of the company in 1900 has held the position of managing director and head of the Manchester factories and supply house at Victoria Bridge, will terminate his connection with the company on Oct. 15. Mr. Eckstein has not yet finally settled upon his future work, but as he has been connected all his life with electrical manufacturing we shall no doubt hear of him in that capacity again.

A unique gathering took place at the Hotel de Bale, Hatton-garden, on Saturday evening (Oct. 7), when a score of the old boys who were at Scott's Engineering Works in 1888 and 1889 met together, mostly for the first time after an interval of 16 years. There were present Messrs. F. Armfield, E. S. Davidson, E. Eberzein, R. M. Elmhurst, F. N. Haward, Jackson, A. B. Lillywhite, H. Marryat, E. C. Moyes, E. L. Pinching, W. M. Rogerson (Halifax), C. N. Russell (Shoreditch), H. Sadd, J. R. Smith, H. Squire (Chelsea), C. E. W. Talbot, W. C. Thomson, W. E. Toy, and J. Watts. Letters and telegrams of regret at unavoidable absence were received from Messrs. B. Arkell, C. D. Asprey, J. H. Garrett (Colombo), A. J. Hodgson, L. A. Jinks, E. C. Patey, H. A. Place, C. E. Tickner, and Tubbs. The function, which was of an informal nature, was voted a complete success. An excellent concert followed, and a proposal to make the reunion an annual affair was carried by acclamation. Another proposal to repeat the function before the close of the present year was received with favour, and we learn will be brought about if possible. Mr. H. Marryat, of 28, Hatton-garden, E.C. was appointed the hon. secretary, and will be glad to receive the addresses of old boys whose names do not appear in the above report.

APPOINTMENTS VACANT.

Junior Assistant Engineer, York City Council. Salary, 30s. per week.

Traffic Manager, South Shields new electric tramways. Salary, £200 to £250.

Premium Pupil, Electricity Works, Canterbury. See advertisement in last issue.

Electrical Foreman. Applications to Box P 50, *Electrical Engineer* Office. See advertisement in last issue.

Switchboard Attendant. Wages 20s. per week. Applications to Engineer, Electricity Works, Canterbury, by Oct. 14. See advertisement in last issue.

Chief Lecturer, Salford Royal Technical Institute, electrical engineering department. Salary, £250. Applications by Oct. 19. See advertisement.

Junior Assistant, Aldershot Urban District Council electricity works. Salary £65 per annum. Applications by Oct. 18. See advertisement in last issue.

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THE INFLUENCE OF ELECTRICITY ON POWER ENGINEERING.*

BY W. B. ESSON, M.I.C.E., M.I.E.E.

Gentlemen,—My first duty in taking this chair is to thank you for the honour you have conferred upon me in electing me your president. So many good men have occupied the chair previously that a somewhat high standard has been set, and I can only promise to do my best towards keeping it up during my term of office. My next duty is to congratulate the society on its continued prosperity. Though a small society, we are very much alive, and the report of the council for the forty-sixth session and auditors' report are most gratifying, and must be a source of considerable satisfaction to the hon. secretary, who works so hard in the interests of the society, and to the hon. treasurer, who has to foot the bills. There are few things more comforting than the knowledge of a good bank balance, but the council recognise that there is much yet to be done, and something fresh for the good of the society is always under consideration.

Amongst the things which are expected of a president is a presidential address. Apparently there is no escape from this, and I should think it must always be a very difficult matter to decide upon the subject of such an address. To me the choice of a subject has presented, I must admit, considerable difficulty, for though one feels that one can speak best on some special matters with which one's work has been principally associated, on the other hand one must not in a presidential position specialise too much, but must try rather to interest in some degree all the members, notwithstanding that the special work upon which they are severally engaged is so greatly diversified. As you will know, I have been intimately connected for the past 25 years with electrical undertakings, and the change which electricity has made in the methods of industry during that period are little short of revolutionary. Electricity is now of universal application, and it is quite safe to say that there is no branch of engineering to which it cannot in some shape or form bring advantages. I will take it as a fortunate circumstance if, in addressing you from the chair on a subject which is specially my own, I can command your attention, and I trust that in talking for a short time on "The Influence of Electricity on Power Engineering" I will be saying something which is of some interest to all.

The early seventies saw the inventions of Gramme and Von Hefner Alteneck and the beginning of the electric lighting era. The first of Gramme's dynamos was brought to London in 1873, but needless, to say, it little resembled its progeny. Six years before Gramme obtained his first patent Pacinotti had illustrated and described in the "Nuova Cimento" the remarkable machine of his invention, and though this probably embodied in crude form all the elements of Gramme's dynamo, it required the mechanical genius of Gramme to convert into a practical machine what had been till his time a scientific toy. About the same period the Von Hefner Alteneck machine was being developed in Germany, but the early designs of both types were flimsy and built on the lines adopted by mechanicians and instrument makers rather than on engineering lines. Soon the designing passed into the hands of engineers, and the flimsiness of the earlier patterns disappeared. It was realised that the dynamo was a machine which might have to deal with the conversion of considerable amounts of power, and that only the best engineering methods should be adopted in its construction. From these early days till now progress has been continuous. In 25 years the size of electric generators has increased from 5 h.p. to 5,000 h.p., from the machines which fed the Jablochkoff candles in the Avenue de l'Opera in Paris to the magnificent triumph of engineering realised in the generators at Niagara.

The principle of reversibility of electric machines seems to have been understood some considerable time before the advent of Gramme's machine, and very soon after its appearance power was transmitted, using the ordinary lighting dynamo as motor. The first public demonstration was made during the Vienna Exhibition of 1873, when the current was transmitted from a machine working as a generator to a second machine, about 550 yards distant, working as a motor and driving a pump. But in these early days there were only arc lamps used for illumination, and for some considerable time engineers devoted their energies to the design of machines for feeding arc lamps. Power work was accordingly put on one side, and for a time there was very little progress in this direction.

It was not until 1880 that the first incandescence lamp factory was started on a commercial basis. In the early seventies not only was there no practical incandescence lamp, but, as the result of much experimenting, we have it from Mr. Swan that there was no expectation or faith among scientific men of the probability of such a thing being produced. However, the unexpected came to pass, as I say, in 1880, and gave a tremendous fillip to electrical engineering. In 1882 Gaulard and Gibbs came along with the transformer, but it was not until 1885 that transformers were taken seriously. By that time Ganz, of Budapest, had worked out a system of distribution in which transformers were connected in parallel on a high-tension primary circuit, and supplied consumers from a low-pressure secondary. They exhibited one of their transformers at the Inventions Exhibition in 1885, and from that time it may be said that the era of alternating currents commenced. With a few exceptions, all the long-distance power transmission enterprises of to-day are dependent upon alternating currents.

The transformer appeared on the scene in the nick of time, because just then the continuous-current three-wire system for supplying 100 to 110 volt lamps was finding its limit as regards distance for distribution from the generating station. Accordingly, the alternating-current transformer system had a splendid run for lighting from 10 to 15 years. This was until the 220-volt incandescence lamp made its appearance. As working at double the pressure enabled the current to be distributed over four times the area with no greater cost for mains per lamp supplied than before, the advent of the higher voltage lamp brought continuous current to the front again. So far as lighting was concerned, alternating-current distribution then practically ceased, and continuous current still holds its own.

From 1880 onwards power transmission made progress. The arc lighting work had taught manufacturers how to make machines for higher pressures, and the demand consequent on the invention of the incandescence lamp gave the necessary stimulus to development. To Marcel Deprez belongs the honour of conducting the first long-distance transmission experiments. During the Munich Exhibition of 1882 a demonstration was made. On this occasion Deprez transmitted power from Miesbach to Munich through a double line of telegraph wire over a distance of 37 miles with a pressure of 2,400 volts at the generator. The machines used on this occasion were two ordinary Gramme dynamos, but with the usual winding replaced by coils of many turns. About this period many installations were erected for the transmission of power to moderate distances. These were chiefly in places where water was abundant, but in 1887 several installations had been set to work in British collieries for pumping and haulage. A notable example of these early undertakings was the installation at the Falls of the Rhine, erected in 1887 to transmit 500 h.p. at 700 volts to the Schaffhausen spinning mill, rather less than half a mile distant from the power-house. The Kriegstettin and Solothurn installation, put down in 1888 to transmit 50 h.p. a distance of five miles at a pressure of 2,000 volts, was another. Still another was the installation at Domène, erected near Grenoble in 1889 to transmit 250 h.p. rather over three miles at a pressure of 2,850 volts to drive a paper mill.

A point to be noted here is that there was no such thing as transmission of power in the sense that we now understand it until the electric motor made its appearance. There was on the Continent the wire-rope transmission system of Hirn, by which the power of turbines could be conveyed to short distances, but there was no system by which transmission could be effected to distances of even a few miles without enormous loss. Hirn's system had met with great success, for within 10 years of its intro-

* Presidential address to the Civil and Mechanical Engineers' Society, delivered Oct. 5, 1905.

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duction there were no less than 400 transmissions at work in South Germany and Switzerland transmitting in the aggregate 4,200 h.p. For short distances the system was very efficient, giving a return of about 96 per cent. for 100 yards and 93 per cent. for 500 yards; but at the best it was but an extension of ordinary rope driving, and calculation shows that for a three-mile transmission the return would not have reached 60 per cent. Hydraulic and compressed-air transmission were both of them capable of doing excellent service in their own domain, but they were both useless as a means of transmitting power economically to any considerable distance.

The fact that similar alternators could be run as generator and motor was clearly established in 1884, and the principles underlying their interdependence formed the subject of a mathematical paper read by the late Dr. J. Hopkinson in the same year, but it wanted the demonstration of Mordey in 1889 to push the fact home in a practical manner, and it was not until experiments had been carried out showing the transmission of 50 h.p. with two Mordey alternators used as generator and motor respectively that the possibility of employing machines in this way received general recognition. Little result, however, followed from the demonstration. Some few plants were installed, but in alternating current there was at that time nothing over 2,000 volts or so, and as continuous-current machines had been built for as high a pressure, the reason for change to alternating was not apparent. In 1892 the Westinghouse Company of the United States installed an alternating-current plant at Telluride, in Colorado, and transmitted at 50 h.p. to a distance of three miles by single-phase current at a pressure of 3,000 volts, using a synchronising motor to drive a 40-stamp mill. At this date, be it observed, there was no manufacturer in America who would tackle the problem of making continuous-current machines to transmit 150 h.p. five miles at any kind of efficiency, and we have it on the authority of Louis Bell that no one dared make a 2,000-volt machine of this capacity. In 1893 at Bodie, in California, another single-phase transmission was installed. There 150 h.p. was conveyed to a distance of 12½ miles at a pressure of 3,000 volts to drive by a synchronous motor the stamp mill and other machinery of a gold mine. But as a system, single-phase transmission did not make progress. For one thing the motors were not self-starting, and a certain amount of extraneous gear was required to set them going. The system was simple and perfectly suitable for cases in which the power was transmitted to one motor or a group of motors, but it was not suitable for a general scheme of power transmission where the motors might be of different sizes and distributed over a large area. For one large motor or group of motors the gear was not objectionable, but it would have utterly disqualified the system when repeated on a large number of scattered motors.

About this time (1889) engineers on the Continent were faced with a very important problem. They saw in their waterfalls thousands of horse-power running to waste. They knew that by adopting electric transmission this power could be utilised and distributed to great advantage amongst manufacturers scattered over a wide area, but they also recognised that success could only be obtained by the use of high pressure—that is, of a pressure considerably higher than the 2,000 or 3,000 volts then in use. With alternating current, the increase in pressure was perfectly feasible, but for this system there was no motor available. For reasons I have just given the use of small alternators as motors could not be entertained. The continuous-current motor was at this date perfectly reliable, but 400 to 500 volts was the utmost pressure that in the then state of the art was thought safe for medium-sized motors, rising possibly to 2,000 volts or so for large ones. To continuous-current generators the same remark applied, as 2,000 volts or so was deemed the highest safe pressure to put on commutators of the Gramme type. This pressure has not been greatly exceeded at the present day, but to carry out the schemes our friends on the Continent had in view required much higher pressures. It will be seen that the problem required a considerable amount of study, the position being: for alternating currents, pressure all right, but no motor available; for continuous currents, motor available, but pressure not high enough. As the supply of power was the leading idea, the system which possessed the motor had to be chosen, and continuous current was consequently adopted, with the brilliant device, however, of joining up all the motors in series, and spreading the high pressure over the lot, while connecting the generators in series to keep down the pressure on the commutators of individual machines. In this system the current is kept constant, the pressure varying according to requirements, and at the date I am speaking of it does not appear that there was any other way of providing a general power supply. It says much for the engineering of the installations on this system that they are in most successful working to-day, and, what is more, they are being added to in competition with the three-phase system. The first installation on this system was erected for the transmission of power to Genoa in 1890. At the present date there are three generating stations, in each of which are turbine-driven continuous-current dynamos all coupled in series. In the two larger stations there are eight dynamos, and the pressure is from 6,000 to 8,000 volts. At full load about 1,000 h.p. is transmitted from the three stations over the lines to Genoa, a distance of 18 miles, to drive motors varying from 10 h.p. to 120 h.p. in size, all being connected in series. A considerable number of installations on similar lines have been laid down, some of them of great importance. Amongst these is the Brescia transmission of 700 h.p. at 15,000 volts over a 12-mile line, and the larger installation for supplying La Chaux-de-Fonds with 2,400 h.p. at 14,400 volts over a 32 mile line. Another installation is at work transmitting 4,000 h.p. at 22,000 volts over a 34-mile line from St. Maurice to Lausanne, and there is in course of construction the largest of all designed to transmit 6,000 h.p. at 60,000 volts over a line 114 miles long from Moutiers to Lyons.

Now a system showing such strong vitality, though working on what nine-tenths of our engineers would call antiquated lines, cannot be dismissed in a sentence. The facts are that the system is going ahead in the face of the three-phase alternating system, and is successful on a scale commensurate with many of the larger three-phase installations. The Americans say that the success of such a system would be impossible in their country, because the motors would not there get the careful and skilled attention given to them on the Continent. This may be so, but with a large plant and sub-station the objection need not hold In any case it is certain that every engineer will look forward with the greatest interest to the completion of the large scheme now in progress.

It was at the Frankfort Exhibition of 1891 that the problem of long-distance transmission was satisfactorily solved. In 1885 Prof Ferraris had constructed a rudimentary motor which depended for its action on a rotating field produced by two alternating currents in quadrature. From this date, and independently, there were working at the same subject Cöerper, Haselwander, and Dobrowolsky on the Continent, and Bradley and Tesla in the States. The results which had been achieved by the Continental workers were apparent in the exhibition at Frankfort, several manufacturing companies showing machinery operated by two or three alternating currents having a phase difference between them with regard to time. The Allgemeine Elektricitäts-Gesellschaft of Berlin and the Oerlikon Machine Company of Zürich combined to demonstrate at this exhibition on a commercial scale the transmission of power to great distances by means of alternating circuits. For this purpose they chose to work with three circuits—that is, on the three-phase system—and their epoch-making experiments consisting in transmitting through three wires over a distance of 110 miles at 8,000 volts 110 h.p from Lauffen to Frankfort. Experiments with a pressure of 20,000 volts between the wires were also made, there being transmitted in this case 180 h.p. with results eminently satisfactory. Of the energy given to the generators at Lauffen about 75 per cent. was returned by the motor at Frankfort, a magnificent result as compared with the return of less than 50 per cent. which nine years previously was obtained by Deprez in the Miesbach-to-Munich transmission. This demonstration bore immediate

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fruit, for it was realised that the problem of transmitting power to long distances was no more a question of system. The system was found, and the matter was resolved into a case of merely working out the engineering details for particular schemes. A tremendous impetus was given to power transmission in Europe, and soon a large number of installations were working on the new system transmitting power to distances up to about 15 miles at pressures in the vicinity of 5,000 volts or so.

The first polyphase plant in America was erected at Redlands, California, in 1893, and worked at 2,500 volts to transmit the power eight miles. In the same year the Niagara contract for power-house No. 1 was fixed up, which now has a capacity of 50,000 h.p Since then power-house No. 2 has been erected, which has a capacity of 55,000 h.p., making 105,000 h.p. altogether, as representing one company's drain on the great cataract. But there is not only one company but several taking a water supply, and it is estimated that when all the power-houses in progress are completed they will send out an aggregate of no less than 700,000 h.p.

The pressure given by the Niagara generators is not high, nor is the pressure on the lines to Buffalo over which from Niagara 24,000 h.p. is transmitted. Originally the pressure on the Buffalo lines was 11,000 volts, but in 1901 it was raised to 22,000 volts, consequently it does not exceed that of the transmission from Lauffen to Frankfort 10 years before. It was not until 1897 that any increase over the Frankfort pressure was made, but in that year the South Californian Power Company transmitted power over 80 miles at 33,000 volts. Several plants were installed at this pressure, and in the meantime experiments were being vigorously prosecuted with the object of finding out whether a still higher voltage could not be successfully employed. These experiments culminated in the Telluride Company adopting in 1898 a pressure of 40,000 volts for their Provo transmission, and at the present time there are several installations in the States working at this pressure. The Shawinigan Water and Power Company is operating over a line 84 miles long with 53,000 volts. The Washington Power Company, the California Gas and Electric Company, and the Guanajuato Power and Electric Company are all operating at 60,000 volts, while the Kern River Power Company is busy with a line on which the pressure will reach 67,500 volts. This is for the time being the highest pressure in the world, but two companies are making provision for their apparatus to be capable of working at 80,000 volts, so that whenever suitable methods of insulating for this pressure are devised they will be able to adopt it. Lord Kelvin may yet see in actual practice the figure he assumed as a possible voltage at the 1881 British Association meeting. At that date there was no polyphase machinery in existence and no transformer, so 80,000 volts was purely a guess. Nevertheless, we have already passed it in the laboratory, and before long may realise it in practice.

In Europe the pressure on transmission lines does not rule high. The distances are not great, and under these circumstances it is preferred to keep the line pressure down to a figure which is possible to the generator armatures and does not require the use of step-up transformers. At the great hydro-electric stations of Vizzola and Paderno, for example, the pressure is only 11,000 volts and 14,000 volts respectively. On the power lines of the Milano-Verese Railway the pressure is 13,000 volts, while on those of the Valtellina Railway it is 20,000 volts. Lately a power installation for the transmission of 3,300 h.p. from Gromo to Nembro through 22 miles of line has been put to work at 40,000 volts, but this is quite exceptional, and stands alone amongst European undertakings. A most interesting example of a power installation in the Far East is furnished by the Mysore transmission of 4,000 h p. from the Cauvery River Falls to the Kolar goldfield, a distance of 92 miles, at 30,000 volts. The Falls of Foyers, in Scotland, have been utilised by the British Aluminium Company to generate the electricity necessary to their process of aluminium manufacture, but this is not electrical power transmission as we understand it. In North Wales, however, a pioneer hydro-electric transmission installation is close upon completion, which the engineers tell me will be supplying current very soon. The power is derived from Llydaw, on Snowdon, and there will be transmitted in the first instance 4,000 h.p. at 11,000 volts for the working of light railways in the district and for power purposes generally. A scheme which the Scotch Water Power Syndicate have in view is the transmission of 5,000 h.p. to the Vale of Leven from a hydro-electric power station 22 miles distant supplied with water from Loch Sloy, which is situated 750ft. or so above Loch Lomond. Here the pressure proposed on the overhead transmission line is 40,000 volts. But the scheme is at present in the air, and whether the conductors will ever get there I would not like to say.

Unless the power transmitted is very large the lower the pressure the better, provided that it is high enough to allow of the transmission being carried out economically. It would be folly to assert that there are no greater risks with the higher pressures, for, as a matter of fact, with pressures of 40,000 to 60,000 volts "the highest intelligence, vigilance, and excellence must be employed to avoid accidents and ensure success." These pressures are not to be used indiscriminately or when they can be avoided. A large number of plants are operating pressures between 10,000 and 20,000 volts, and of these it may be said that the overhead lines give very little trouble. The latter figure represents a voltage which can be produced in the armatures of machines of moderate size without difficulty, so this pressure may be considered a limit below which step-up transformers may be dispensed with. When we get much above this we enter a zone where we begin to experience the line troubles which very high pressures bring without obtaining all the corresponding advantages they confer. It is very questionable, therefore, whether there should be any halting place between 20,000 and 40,000 volts. At 33,000 volts Dr. Perrine tells us that the special difficulties due to capacity, insulator size, erratic lightning arrester effects, and switching begin to make themselves seriously felt, and it is just as well if we have to redesign the apparatus with special reference to these difficulties, that we may carry the pressure to the other extreme of the zone referred to, and so get the full return for our trouble. If high pressures are ever standardised, the figures for the standards will be probably 20, 40, 60, and 80 kilovolts.

With pressures of the order of 40,000 volts quite a new set of phenomena is brought to our notice. In the first place, the insulators, in order to prevent flashing over to the supports, must be very much larger, and an increase of pressure from 20,000 to 40 000 volts necessitates their diameter being increased by 50 per cent. or more. A usual size of insulator for the former pressure is 6in. diameter, while the latter should not be less than from 9in. to 10in., with the addition of at least one intermediate bell between the outside dome and the inside cup. When these high pressures are used, the phenomenon of brush discharge has to be provided against. This results from the break-down of the air as an insulator owing to electrostatic strain set up in the space between the wires, and it was very thoroughly investigated by several leading engineers in America in 1893. Their experiments showed that while the loss of power due to this cause at 40,000 to 50,000 volts was, with the usual line construction, inconsiderable, after the higher figure was reached the loss increased rapidly. Prof. Ayrton has lately worked out the distance wires of different diameters have to be placed apart to ensure that with certain pressures there shall be no brush discharge. The cure of the evil, of course, is to keep the wires far enough apart and keep them large enough in diameter, for it is common knowledge that in the vicinity of a sharp point or a sharp edge, less pressure is required to break the air down than in the vicinity of a knob or well-rounded edge. A thin wire presents along its whole length a comparatively sharp edge, and while with wires of $\frac{1}{10}$in. diameter 40,000 volts will discharge through about 10ft., if the wire is $\frac{1}{4}$in. diameter discharge will only take place when the distance between the wires has been reduced to 15in. As it is usual to space the wires on a 40,000-volt line about 48in. apart, and as in no lines requiring such high-transmission voltage are wires likely to be less than $\frac{1}{4}$in. in diameter, it will be seen that there need be no loss

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from this cause, but there is enough trouble with switches, lightning arresters, and higher pressure surges in the line without brush discharge.

It is not the high pressure that makes the trouble last mentioned; indeed, raising the pressure reduces surging, since the current is reduced with the increased pressure. Experience has shown that if a large amount of power is transmitted, it is easier to operate lines at a pressure of 60,000 volts than at a pressure of 30,000 volts, because in the former case the current flowing is only about half. Suppose we are transmitting 5,000 h.p. to a distance of 50 miles at 30,000 volts. Roughly, the current in each wire will be 80 amperes, and it is possible that if this be suddenly interrupted the surge pressure would rise to 20,000 volts. If it happened that the line was momentarily short-circuited by a lightning discharge, and that during the short four times the working current passed, the surge voltage on the removal of this short-circuit might rise to 60,000 volts, which pressure would be superposed on the pressure. With 30,000 volts between the conductors, the pressure between any conductor and earth is 17,300 volts, so in this case the surge voltage makes the possible nearly four and a half times the working pressure. If we worked at 60,000 volts, however, the rise on breaking the short would only be 30,000 volts, and this superposed on the working voltage gives a possible pressure of rather less than twice the working pressure. The momentary strain which insulators, transformers, and other apparatus should be capable of standing is in the case of the 30,000-volt transmission 77,300 volts, while in the 60,000-volt transmission it is 64,400 volts. The higher working pressure has therefore the advantage, and if the power transmitted were increased, the advantage would be more pronounced. It is probable that on account of this rise in pressure due to circumstances the occurrence of which the greatest precaution will not always prevent, the current to be transmitted through each wire of long-distance transmission lines will not as a general rule exceed 100 amperes.

There is no hard-and-fast rule for pressures to be used, but 1,000 volts per mile is recognised as good practice. This is subject to limitation, on the one hand, by the highest pressure of which we have commercial experience, and, on the other hand, by the condition that the current in any wire shall not be excessive—a point which has just been dealt with. According to Mr. C. F. Scott, a distance in miles equal to three times the number of thousands of volts may be covered without incurring an excessive annual charge per horse-power for copper. This means that 5,000 volts would cover 15 miles, 10,000 volts 30 miles, and 20,000 volts 60 miles. That 10,000 volts has reached 28 miles and 30,000 volts 92 miles is shown by the installations at work. But the solution to all engineering problems lies in compromising, and the pressure is eventually settled by striking a balance between the cost and the risks undertaken. In this country the necessity for a higher pressure than 20,000 volts is unlikely to arise, at least, for some considerable time.

(To be continued.)

COMPANIES' MEETINGS AND REPORTS

BRITISH COLUMBIA ELECTRIC RAILWAY.

For the 12 months to June 30 the gross receipts show an increase over the preceding year of 91,687dol., and the net earnings, after charging renewals, show an increase of 44 531dol. The following charges have been made against the revenue account of the year—viz.: provision for renewals maintenance (from which £8,645. 18s. 7d. has been deducted for expenditure on renewals during the year), £16,564; bonus to employés, £3,611; amount written off preliminary and issuing expenses, £1,862; amount added to capital amortisation fund, £1,725. The net profit for the year, after making the above reductions, amounts to £57,876, which, with the balance brought forward from last year, is increased to £60,099. Deducting interest on debentures to June 30, £13,586, and interim dividends on 5 per cent. cumulative perpetual preference stock for six months to Dec. 31, 1904, £2 875, on preferred ordinary stock for nine months to March 31, 1905, £10,187, and on deferred ordinary stock for six months to Dec. 31, 1904, £9,000, there remains available for distribution and reserves £24,450. From this the directors have decided to provide for the dividend on the cumulative perpetual preference stock for six months to June 30, £2,875; to provide for the dividend on the preferred ordinary stock for three months to June 30, £3,750; to recommend the payment of a dividend on the deferred ordinary stock at the rate of 3 per cent., making 6 per cent. for the year, which, including income tax, will absorb £9,947; to write off the balance of preliminary and issuing expenses amounting to £1,650; to transfer to reserve fund £4,460; and to carry forward to next account £1,767. The number of lights in use at June 30 was 136,512, an increase of 23,601 over the number in use on June 30, 1904. The number of passengers carried during the year was 10,352,451, an increase of 1,482,955. During the year £107,445 has been spent in extensions and improvement of the company's property and equipment. A line has been built to the Gorge in Victoria, and a recreation ground covering 10 acres has been laid out at the end of the line. The Gorge extension has, state the directors, proved very popular with the Victoria public and with visiting tourists. In Vancouver a line has been built to Kitsilano (Greers Beach). This line was opened on July 4, and has since been very largely patronised. A traffic arrangement has been made with the Canadian Pacific Railway Co. in reference to their line built from Vancouver to Steveston, the principal city on Lulu Island and the centre of the salmon fishing industry on the Fraser River. Under the arrangement made the Company has electrified the line and has operated it since July 4. The operation is an unqualified success. In pursuance of the Company's well-established policy of giving the public the benefit of cheapened cost of production, voluntary reductions have been made during the year in the prices charged for electric light. The Vancouver power installation has been completed during the year, and is now in full operation. The directors are much gratified by the success of this very important undertaking, the results of which have exceeded their expectations. The full benefit of this new source of power was not obtained until June 1, so that the year's accounts are not largely affected by it. Practically the whole of the share capital of the Victoria Gas Co. has been acquired, and steps are being taken to improve and extend its plant. The results for the current financial year of taking over the Vancouver Gas Co. have been entirely satisfactory to the Company, and have been equally beneficial to the consumers, to whom the charge for gas has been reduced.

LANARKSHIRE TRAMWAYS.

At an extraordinary general meeting of this Company, held last week, Mr. A. R. Monks (the chairman) explained that it was proposed to raise additional capital to meet additional expenditure on the Larkhall extension by the issue of 5,400 new shares of £10 each. The shares were offered to shareholders at par—£5 per share on application and £5 on allotment. The proceedings were purely formal.

A resolution sanctioning the creation of capital was moved by the Chairman, seconded by Mr. H. C. Levis, and carried.

NEW COMPANIES REGISTERED.

Improved Electric Supplies, Limited. — Capital, £15 000. Objects: to acquire and take over the business formerly carried on by the Improved Electric Glow Lamp Co., Limited, to adopt an agreement with W. Chamberlain, and to carry on the business of electricians, mechanical and electrical engineers, electroplaters, manufacturers of, agents for, and dealers in electric lamps, fittings, plant, tools, and apparatus used in the employment of electricity, etc. Registered office: 7, Great Newport-street, W.C.

Liens Registered and Discharged.

Barsi Light Railway Co., Limited, London, E.C.—Trust deed registered Sept. 30 for £140,000 4 per cent. debenture stock. Trustee: Indian and General Investment Trust, Limited. Charged on the interest of the company in the Barsi Town Railway and certain extensions, lands, works, rolling-stock and plant, the undertaking, and all other assets, present and future, except the uncalled capital.

N. S. Electric Storage Co., Limited, London, E.C.—Lien registered Sept. 29 for £1,000 6 per cent. debentures, part of £20,000; amount previously issued, £1,800; no trustees; charged to the undertaking and all the property and assets, present and future.

Lowden Electric Lamp Co., Limited, (Watford).—A debenture dated Sept. 22, 1905, to secure £100, charged on the company's undertaking and property, present and future, has been registered. Holder F. N. Bell, 3, Campden-hill-square, Holland Park, W.

Motor Traction Co, Limited.—A memorandum of satisfaction in full of charges, dated Sept. 3, 1901, and Feb. 4 and March 4, 1902, securing in all £11,000, has been filed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Burslem (Staffs).—The Corporation require tenders for lighting St. John's Market by arc lamps. Tenders by Oct. 18.

Edinburgh.—The Corporation require tenders for arc lamps and arc lamp-posts. Tenders by Oct. 23. See advertisement.

Madrid.—The Public Works Department require designs for a scheme of electric tramways in the town. Particulars from Direccion General de Obras Publicas, Madrid. Tenders by Nov. 27.

Utrecht.—The Government Railways require tenders for Contracts 215-219—for steel plates, tirefonds, bolts, etc. Specification (1s.) from

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the Chief of Works and Stores, Morcelse Park, Utrecht. Tenders by Oct. 24.

London, S.W.—The London County Council invite tenders for wiring and fittings for the electric lighting of the bandstand in the Villiers-street section of the Victoria-embankment Gardens. Tenders by 10 a.m. on Oct. 25.

Great Western Railway.—The directors of this company invite tenders for the supply of various stores from Dec. 1 next to Nov. 30, 1906. Specification, with forms of tender, may be obtained at the office of the Stores Superintendent at Swindon. Tenders to Mr. G. K. Mills, secretary, Paddington Station, London, by Oct. 16.

RESULTS OF TENDERS.

Warrington.—Messrs. Thomas Piggott and Co. have obtained an order for a transporter bridge at Warrington.

Canterbury.—The City Council have accepted the tender of C. Browning, at £24, for external painting at the electricity works; and the tender of Philpot and Son, at £11, for electric fittings.

Stafford.—The Town Council have approved the terms of the agreement with the Tudor Accumulator Co. for the supply of a storage battery composed of 310 cells and the maintenance thereof for 10 years.

Battersea.—The tender of the Municipal Appliances Co., at £60, for one bitumen boiler of 600 gallons capacity, which is required particularly in connection with the extension of electric mains, etc., in Nine Elms ward, has been recommended for acceptance.

Oulton Broad.—The Urban District Council have accepted the tender of the Oulton Broad Electricity Co. for 16-c.p. lamps, at £2. 2s. 6d. per lamp per annum, moonlight schedule, which includes the upkeep of the fittings as well as the supply of current.

Brighton.—The Town Council have accepted the offer of the British Westinghouse Electric and Manufacturing Co. to provide and fix cast-iron facias to the switchboards now being erected by them at the Southwick power station and the North-road works, at £100; and the tender of the Chloride Storage Battery Co. for a battery booster, at £763, has also been accepted.

Ashton-under-Lyne.—With regard to the contract for the superheaters for the above which has been obtained by W. B. Haigh and Co., of Oldham, we are informed that these superheaters will be made by T. Sugden Limited, whom Haigh and Co. represent in the Lancashire and Yorkshire district. Messrs. Sugden report recent orders for superheaters for the following corporation electricity works: Erith (repeat order), Birmingham, Plymouth, Swindon, Cardiff, and Dartford.

Maidenhead.—The Corporation have accepted the following tenders for the supply of coal to their electric power station until March 31, 1905: Graigola Merthyr Co., Cambrian-place, Swansea; G. Mattingley, Maidenhead. Also tendered: Bradbury, Son, and Co., 7 Victoria-street, S.W.; H. H. Deacon, 1, Pier Head-chambers, Cardiff; Foster and Co., 21, John-street, Adelphi, W.C.; W. Cory and Son, 52, Mark-lane, E.C.; Hinchliffe and Co., 9, Gracechurch-street, E.C.; C. T. Huxtable; Jeanes, Vrasner, and Co., Maidenhead; Plummer and Son, Maidenhead; Speakman and Sons, 138, Leadenhall-street, E.C.; Stephenson, Clarke, and Co., 4, St. Dunstan's-alley, E.C.; R. Webster and Sons, Maidenhead.

London County Council.—The Highways Committee have received the following tenders connected with the supply of 150 electric cars:

(*a*) Car Bodies.—Six tenders, as follows, were received for this work:

Hungarian Railway Carriage and Machine Works, Hungary	£58,200
Hurst, Nelson, and Co., Motherwell	63,525
Brush Electrical Engineering Co., Loughborough	74,175
United Electric Car Co., Preston	74,850
Metropolitan Amalgamated Railway Carriage and Wagon Co., Birmingham	75,375
St. Louis Car Co., U.S.A.	75,750

Note.—The lowest tenderers, the Hungarian Railway Carriage and Machine Works, did not comply with the Council's specification for the work, and, further, were not prepared to accept the Council's conditions of labour. In these circumstances, therefore, the next lowest tender—namely, that of Hurst, Nelson, and Co., amounting to £63,525—was accepted. The amount includes a sum of £1 a car body in respect of a steel underframe, and has been accepted upon condition that not less than 40 cars are delivered by Jan. 15, 1906, a further 40 by Feb. 15, a further 40 by March 15, and the balance on or before April 15, 1906.

(*b*) Trucks.—Seven tenders, as follows, were received for the maximum traction bogie trucks required for the 150 cars in question:

Hungarian Railway Carriage and Machine Works, Hungary	£13 800
Brush Electrical Engineering Co., Loughborough	14,400
Alternative tender	17,400
United Electric Car Co., Preston	14,925
Alternative tender	17,925
Hurst, Nelson, and Co., Motherwell	16,800
Mountain and Gibson, Bury	18,000
Alternative tenders	18,250 / 18,750 / 19,650
Peckham Manufacturing Co., U.S.A.	21,000
H. T. Bradford, London	24,000

Note.—The following report of the committee was adopted on Tuesday: It is of great importance that the trucks used with the electric cars should be of reliable and satisfactory design, as under the conditions now obtaining with the use of roof covers and the additional load due to the increased number of passengers thereby carried, it is very necessary that the trucks should bear without injury the increased strain thus put upon them. It has been found in the past that a very heavy item in the expenditure due to the repair of cars has been in respect of the trucks, and in these circumstances it has been necessary to examine very carefully the designs submitted by the several firms who have forwarded tenders. As the result, the tender of Mountain and Gibson, amounting to £18,000, has been accepted. Permission has been given to that firm to sublet to the undermentioned persons or firms, or to such other persons or firms as may be approved by the chief officer of tramways under the contract, the following portions of the works in connection therewith: (1) to the Hadfield Steelfoundry Co., the manufacture of the wheels; and (2) to Cammell, Laird, and Co. and to the Glasgow Engineering Co., the manufacture of the axle forgings. The tender of Mountain and Gibson has been accepted upon condition that deliveries of the work are made at the same time as the deliveries of the car bodies above referred to.

(*c*) Electrical Equipment and Assembly of Cars.—Four tenders, as follows, were received for this work, which includes the supply of special brakes:

British Westinghouse Electric and Manufacturing Co., London*	£43 300
British Thomson-Houston Co., Rugby	45 475
Dick, Kerr, and Co., London	45 550
Brush Electrical Engineering Co., Loughborough	56,050

* Accepted on the same conditions as to delivery as in the case of car bodies and the trucks. Permission has been given to the British Westinghouse Co. to sublet to A. Reyrolle and Co., or to such other person or firm as may be approved by the chief officer of the tramways under the contract, the supply of plugs for the equipments.

Nine tenders have been received for the laying of cable ducts and the supply of high and low tension cables required for the construction or reconstruction of tramways in South London, as follows:

Reid Bros., London*	£31,132	6	3
Muirhead, Greig, and Matthews, London	32,307	15	6
Westminster Construction Co., London	33,282	12	4
J. A. Ewart, London	34,276	12	7
British Insulated and Helsby Cables, Prescot	39,000	5	6
J. Mowlem and Co., London	40,380	0	0
S. Kavanagh and Co., Surbiton	41,267	2	3
J. F. Cummings and Co., London	42,812	17	8
Cunningham, Forbes, and Co., Fleet, Hants	69,712	15	6

* Accepted. Permission has been given to this firm to sublet to W. Penfold, London, or to such other person or firm as may be approved by the engineer under the contract, the casting work in connection therewith.

BUSINESS NOTES.

TRACTION.

London United Tramways Co.—The track-laying operations in Kingston are approaching completion.

Perth.—At the monthly meeting of the Town Council Councillor Macpherson gave notice of a proposal to run a Sunday service.

Birkenhead.—The Corporation have under consideration a proposal to extend the system of through tickets between the trams and the ferry.

Levenhall.—Another step towards the extension of the tramway system from Levenhall to Port Seton was carried out last week, when the necessary surveying operations were carried out.

Liege.—The British Vice-Consul reports that several lines of light railways are proposed in that district. The section from Melreux to Erezée will probably be given out for public contract towards the end of the year.

Southend.—The Town Council have decided to extend the tramways along the sea-front to Shoeburyness, a distance of about five miles. The cost is estimated at £70,000, including the continuation of the sea-wall and Marine drive.

Bournemouth.—The Branksome Urban District Council have decided to make representations to the Corporation as to an improved service. The Corporation have decided that they cannot at present entertain the suggested extension to Parkstone.

Bromley (Kent).—At a meeting of the Borough Council last week it was decided to refer to committee the question of promoting a Bill to authorise motor 'buses, as it was considered that tramways would detract from the residential character of the place.

Yarmouth.—The traffic return for four weeks in September showed the total receipts to be £2,530. 17s. 8d., the increase on the Yarmouth section being £112. 10s. The Tramways Committee have asked the Electricity Committee to grant a reduction in the charge for current.

Swindon.—The receipts for the Corporation trams for the first year total £10,227, the passengers numbered 2,862 697, the car miles were 206,266, and the traffic receipts per car mile work out at a trifle over 11½d. It is expected that a net profit will be shown. The projected extensions have been deferred.

Paisley.—It is reported that the company may shortly undertake extensions of the Potterhill and Johnstone routes. The proposals for inter-running between the company and the Glasgow Corporation appear to be hung up, chiefly because there is some difficulty as to apportioning the costs for electric power between the Paisley and Glasgow Corporations.

Falkirk.—The route work in connection with the tramway scheme is now practically completed. The new bridges across the Forth and Clyde Canal at Camelon and Bainsford are not yet completely finished, but it is expected they will be open for traffic within the next few days. Last week several satisfactory trial runs were made on the Camelon and Larbert road by the tramway company officials.

Reading.—The Corporation have appointed a sub-committee to consider the question of the desirability of obtaining powers to provide

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motor omnibuses in connection with the tramways. It has been decided that the cars shall not travel at the maximum speed sanctioned, as it is stated that passengers are occasioned inconvenience through being carried beyond the stopping points.

Halifax.—Two tramcars on the Corporation electric tramways collided violently during a fog on Tuesday morning, one car having just emerged from a loop on to a single line, where the other was travelling. Both cars were badly smashed in front. The driver of one car was injured internally, and taken to the infirmary. The other driver was slightly injured. The passengers escaped practically uninjured.

Oxford.—At the meeting of the Corporation last week, the following recommendations of the Tramway Committee were adopted: (1) That Mr. Stephen Sellon be appointed to make the valuation referred to in the first portion of the memorandum; (2) that steps be taken to promote a Bill in the next session of Parliament, as suggested by Mr. Olease, containing the widest possible powers, without pledging the Council at this stage either to work or not to work the undertaking.

Chili.—The *Diario* of Aug. 17 contains the terms of a concession which has been granted to Don Ambrosio Olivos for the construction and working of an electric railway from the port of Valparaiso through the valleys of Casablanca and Curacavi to Santiago, with a branch uniting the valley of Curacavi with the town of Melipilla. This concession is for the term of 100 years from the date of the opening of the railway to the public, subject to a right of purchase by the Government at the expiration of 40 years.

Lowestoft.—At the monthly meeting of the Town Council the Tramways Committee reported that the receipts for three weeks in September were £802, against £823 in the corresponding period of last year. The engineer submitted plan and estimate of the cost of converting the single track to double from the Suffolk corner to the Hempland. The total length of track to be converted is 840 yards, and his approximate estimate, exclusive of alterations to sewers, gas, and water mains, was £1,608. Further consideration of the matter was deferred.

Gomersal.—At the meeting of the District Council it was reported that complaints were being made of the delay in the progress of the work of relaying the Gomersal, Birstall, and Dewsbury tramway by the electric traction company. The Chairman of the Council stated that he had seen the company's manager, and that in regard to the Gomersal end the company were waiting for the sanction of the London and North-Western Railway Co. to the lowering of the bridge carrying their line. It was not thought necessary, therefore, to take any action in the matter.

Electric Sprinkler.—Last week there was tried on the electric tram system in Leith a device for the sprinkling of water and the sweeping of the line. In front of the car there is fitted a perforated tube, which is supplied with water from a tank in the inside. The brushes are behind the tube, so that the ground is first watered and then swept, the dust being thrown into a receptacle. The work was effectively done, and the car proceeded at about the ordinary rate of the passenger car, so that the work can be carried out without any interruption to traffic.

Edinburgh.—A sub-committee of the Town Council had under consideration last week a proposal by the tramways company regarding the method of paying their rent as lessees of the Corporation. It is understood that the company suggests that the annual increments by which the rent rises should be increased from the stipulated sum of £2,500 to £5,000 per annum so that the maximum at the end of the lease would probably be £95 000, instead of £100,000. The proposal of the company was regarded with favour by the sub-committee, and it will be fully discussed by the Lord Provost's Committee.

Beckenham.—At the meeting of the Urban District Council the Tramways Committee reported that the solicitors to the British Electric Traction Co. and the Council had exchanged agreements for cancellation of the Beckenham tramway scheme. A letter having been received regarding the Penge tramways, in which it was stated that if current was to be available by the date specified in the agreement with the British Electric Traction Co. the necessary extensions should be proceeded with at once, the clerk was directed to communicate with the British Electric Traction Co. with a view to determining the price to be paid by them for current to be supplied by the Council.

Birmingham.—The generating station for supplying Birmingham with electric light and motive power, which for rather more than a year has been in course of erection on the site of the old General Hospital, Summer-lane, is now approaching completion. Arrangements have been made for putting in, as the first instalment, engines of 12,000 h.p., and there is provision for extensions as the demand for the electric current increases. Eight water-tube boilers of the largest construction are also being installed in the first portion of the scheme. This enormous undertaking has been rendered absolutely necessary in view of the electric tramway extension scheme and the increased public demand for illumination and motive power by electricity.

Tramways Rating.—The adjourned test case originated by the Wakefield Corporation to determine whether light railways are entitled to be assessed at one-fourth only will be held on Oct. 18. The same point has been raised at Swansea, as Wakefield and the Swansea Councils have agreed to contribute towards the cost (with other Corporations) of the test action, provided the case is contested upon circumstances precisely similar to those which obtain at Swansea. According to a Midland paper, "the British Electric Traction Co. has apparently abandoned its demand to have its lines assessed at one-fourth to the general district rate, on the ground that the track is a railway. It raised that position in letters to the Lye, Kingswinford, and other Councils, but has now paid the demands of Lye in full."

Longton.—At the meeting of the Town Council, the Improvement Committee reported that the surveyor had laid before them correspondence which had taken place with the Potteries Electric Traction Company with reference to the paving of the lower portion of Anchor-road, and the company had consented to pave the whole width of the road throughout the length of the tramway where the level was altered near to the railway bridge, and to run the gradient out to the middle of the old tramway, subject to the Corporation undertaking to pave the remainder of Anchor-road. The borough surveyor's estimate of the cost of repaving Anchor-road amounted to £3,860. The committee recommended that the tramway company's offer be accepted, that Anchor-road be repaved, and that application be made to the Local Government Board for their sanction to a loan of £3,860. The report was adopted.

Fatality.—In the Hammersmith Coroner's Court last week Mr. C. L. Drew held an inquiry with reference to the death of Theophilus Biddle. A witness stated that deceased was healthy and sober, and had good sight and hearing, although he wore glasses for reading. On August Bank Holiday deceased went out for a short walk and within an hour he was carried in again with injuries to his legs. He was at once taken in a tram to Hammersmith and removed from there on the ambulance to the hospital. On the way he said the tram had hardly stopped when he jumped off and fell under a van. He was unconscious the whole time he was in hospital, and died on Sept. 26. Eventually the jury returned a verdict of "accidental death," and added that they wished to draw the attention of the company to the advisability of having the gates kept closed whilst the trams were running between stopping places.

Cheshire Tramways Scheme.—At a meeting of the Highway Committee of the Macclesfield Town Council a letter was read from Messrs. John Newton, Sons, and Bayley, engineers, of Manchester, forwarding a sketch plan of a proposed tramway connecting Stockport, Macclesfield, Cheadle Hulme, and Wilmslow for the construction of which it is intended to seek powers during the coming parliamentary session. It was resolved that as regards the highways under the jurisdiction of the Council, consent be given authorising the construction of the above, subject to the gauge 4ft. 8½in., and to an undertaking being given that the promoters shall widen, where necessary, all the highways repairable by the Council along which the proposed tramways run, so that there shall be a minimum width of macadamised or paved roadway of 20ft., in addition to the width of the existing footpaths, and that the rails shall be laid so that there shall be 15ft. of roadway, exclusive of footpath, on one side of such rails. The minutes have been confirmed by the Council.

Harrow-road Tramways.—At the meeting of the Kensington Borough Council it was reported that letters had been received from the Harrow-road and Paddington Tramways Co. giving notice that, in the exercise of their powers under the Harrow-road and Paddington Tramway Acts, 1903 and 1904, they proposed to proceed with the work of reconstruction of the existing tramways for the electrical working of the system, and forwarding plans showing the position of the tracks, the approximate position of the tramway poles, the method of track construction, etc. The committee have given directions to the borough engineer to place himself in communication with the company, with the view of ascertaining how far it may be possible for an agreement to be arrived at for the wood paving of the portion of Harrow-road situate in this borough, and have intimated to the company that, subject to the borough engineer being able to report that a satisfactory arrangement has been arrived at, no objection will be taken to the plans as submitted.

South Staffordshire Tramways Co.—At the meeting of the Darlaston District Council the Clerk reported having written to the South Staffordshire Tramways Lessee Company with reference to the condition of the tramways. He had received a reply to the effect that the matter was receiving the fullest attention of the directors, and the managing director had recently had an interview with the town clerk of Walsall with a view to the reconstruction of the portions of the lines in that borough. Several members expressed the opinion that, as this reply was dated early in August and nothing had been done since, the position was most unsatisfactory. The Chairman said there was no doubt that the lines were now in an absolutely dangerous condition, and unless pressure were brought to bear it seemed as though nothing would be done. Mr. Robinson suggested that the Council should press for some improvement, and state plainly that in the alternative they should appeal to the Board of Trade. The Clerk explained that he had already taken this course. It was decided under these circumstances to lay the whole of the facts before the Board of Trade.

Manchester.—At Tuesday's meeting of the Tramways Committee the report was received of the sub-committee which had received a deputation from the Corporation of Ashton-under-Lyne as to the running of through trams between that town and Manchester, and a similar request was received from the Oldham Corporation. The committee came to no decision on these applications, which were reserved for further consideration. In considering the carriage of parcels by the trams, it was decided that in future the guards should be permitted to receive at any stopping station parcels up to the weight of 7lb. which bore the necessary value of the stamps issued by the Tramways Committee. The guards are not to be permitted to receive payment for carriage, nor, at present, to receive parcels the carriage of which is to be paid by the consignee. During the week ended Oct. 7 2,589,220 passengers were carried by the trams, and the total receipts amounted to £12,734. 19s. 5½d. The figures for the preceding week were: number of passengers, 2,588,649; receipts, £12,814. 10s. 3½d. The Corporation have decided to increase the number of top-covered cars, as these have been found to give excellent results.

Falkirk.—At the meeting of the Town Council an agreement with the Scottish Electric Central Power Co. was approved in regard to the supply of power for the new trams, as mentioned last week. T

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terms of the agreement are as follows: "(1) The agreement to subsist for a period of 21 years from the commencement of the supply of the electric energy by my company to the tramways company, and to be subject to breaks which may be exercised by either party at the end of either 10 or 15 years on six months' previous written notice; (2) the agreement shall cover the supply of electric energy to the tramways company within any part of the existing burgh of Falkirk; (3) the sum of £100 towards the expenses incurred by the Town Council to be paid by my company to the Town Council on the execution of the formal agreement to be entered into embodying the terms of the arrangements; (4) my company to make payment to the Town Council of the sum of £30 annually, by equal portions half-yearly on May 15 and Nov. 11, the first payment (which will be made on Nov. 11, 1905) being the proportion applicable to the period from the commencement of the supply to the tramways company to that date; (5) the agreement to be entered into to bear that it is without prejudice to the rights and pleas of both parties."

King's Norton.—At the meeting of the Urban District Council the Tramway Committee submitted its report, which stated that they had effected a settlement with the City of Birmingham Tramways Co. as to the payments due to the Council under the agreement for lease of Pershore-road tramways, and as to their claim for loss of profit in consequence of the delay in opening the tramways. The committee had considered an objection raised by the company to the payment of interest and sinking fund charges on the total sum of £40,000, the amount actually borrowed by the Council by reason of the fact that the approximate capital outlay did not exceed £35 0^0. and it was finally agreed that the interest and sinking fund charges on the amount of unexpended borrowed capital should be borne by the parties in accordance with their respective interests in the tramways, the company being, therefore, called upon to pay 7½-40ths of such interest and sinking fund charges, the Council bearing the remainder. The report was adopted. The Chairman of the special committee *re* tramways stated that, in view of the erroneous ideas prevailing with regard to the date upon which the Corporation of Birmingham would commence that portion of the Moseley and King's Heath routes which lies within the city, they had ascertained that the Corporation would not commence working such routes until Dec 31, 1906. There was, therefore, plenty of time for the committee to make arrangements and to carry out negotiations. He did not apprehend the slightest difficulty with the Corporation once they had settled with the tramway company.

Belfast.—In the course of his reply to the allegations of the Belfast Citizens' Association, the city surveyor (Mr. H. A. Cutler) makes the following remarks: "With regard to the allegation that sand had been used instead of compo, I do not for a moment believe that such a thing has occurred, except where it is specified for such to be used. The loose paving does occur in several places; but, considering the magnitude of the job, and the heavy loads drawn by traction engines which have passed over the new work, I consider the amount of loose paving to be relatively small. Wherever loose paving shows itself Messrs. White will have it put in proper condition before the period of maintenance has expired, whether it arises from bad work or any other cause. With regard to the complaint of the association that setts wider than specified have been allowed at places specifically mentioned, on the Cramlin and Shankhill roads, it is rather unfortunate for their argument that the setts which are said to be in accordance with the specification are the new ones supplied by Messrs. White, and those which are larger, with the exception of five yards, are setts which were taken up from the old tramways and reused. I might have been considered to have performed my duties more faithfully, and have avoided the complaint of the Citizens' Association, had I had all the old setts dressed down to 3in. and 3½in., although such is not required by the contract; but this I could not have done without feeling that I had robbed the ratepayers of the value of 25 per cent. of all the old setts, which would amount to £16,000. All the other points drawn attention to by the association were answered in my report on Councillor Gregg's letter of Sept. 4, but the assertion that the setts on the Shore-road were condemned in consequence of my attention having been drawn to the matter from outside sources is totally incorrect. I condemned the setts as soon as I saw them. They were only parts of shipments delivered and condemned in other parts of the city."

London County Council.—At the reopening meeting of the Council on Tuesday the Highways Committee recommended that authority be sought in the session of Parliament of 1906 to enable the Council to construct new tramways as follows: (1) from the Plough, Clapham (London County Council tramways), *via* Clapham Common north side and Cedars-road, to Lavender-hill (London County Council tramways); (2) from Seven Sisters-road (existing tramways), *via* Amhurst-park, to Upper Clapton-road (existing tramways); (3) from Aldgate (existing lines), *via* the Tower Bridge northern approach, to a point near the Tower Bridge; (4) from the Lea Bridge-road terminus (existing tramways), *via* Lea Bridge-road, to Upper Clapton-road (existing tramways); (5) from Tooting-broadway (London County Council tramways), *via* Mitcham-road, to the county boundary near Tooting Junction railway station; (6) from High street, Streatham (London County Council tramways terminus), *via* Streatham High-road, to the county boundary at Norbury, with do n line *via* Gleneldon-road, Bournvale-road, and Stanthorpe-road; (7) from near the Marble Arch, *via* Edgware-road, Maida-vale, and High-road, Kilburn, to the county boundary at Cricklewood. This was postponed. The Board of Trade have certified as ready for traffic the short extensions from the Tooting terminus along Tooting High-street and Defoe-road. The circular steamboat and tram tickets proved so popular that it was decided to extend the scheme. The Board of Trade have approved the conduit system for the subway from the Strand to Theobald's-road. Permission has been granted to the National Telephone Co. to use for its works a 6in. space along the subways in course of construction, the company paying rent according to the scale laid down in the Council's by-laws. At the meeting of the Court of Common Council on Monday Mr. John Harris asked that, at the conference of the Bridge House Estates Committee with the London County Council on the subject of tramways across the Thames, it should be suggested to the London County Council that they should form a new street on the south side of the Thames, between Westminster and Blackfriars Bridges, and by means of a tunnel. or otherwise, provide direct communication between the trams from Kingsway and the South London trams. Mr. Algar, replying for the committee, said they had been invited to consult with the London County Council, and would carefully consider any proposal the London County Council might put forward. The Works Committee of the Stepney Borough Council reported on Saturday that they had considered an important letter from the London County Council with reference to the forthcoming electrification of the tramways in the East of London. The London County Council pointed out that, owing to the nearness of the Whitechapel and Bow Railway to the surface of the roadway, it was practically impossible to adopt the conduit system, and that therefore in Mile End-road and other thoroughfares they proposed to use the overhead system. The letter also stated that the Poplar Borough Council had agreed to the adoption of the overhead system, and suggested that, with the view to expediting the electrification, the Stepney Council should take the same course. The Works Committee, however, in their report point out that at only two places does the Whitechapel and Bow Railway present difficulties, and that it would not be difficult to overcome these. While in favour of doing all they can to expedite the electrification, they advise the Borough Council not to depart from their previous decision against the use of the overhead system in the borough. For the fourth time the County Council, preparatory to seeking parliamentary powers, have asked Paddington whether it is prepared to contribute a third of £60,350, which is the estimated cost of widening Edgware-road, so as to permit electric tramways from the Marble Arch to Cricklewood. The General Purposes Committee of the Borough Council recommend that the central authority be again informed that Paddington is prepared to consider the tramway scheme if the County Council bear the total expense of road widening "as part of their tramway policy." At the meeting of the St. Marylebone Borough Council, the General Purposes Committee had on the agenda a report that it has had under consideration a letter from the County Council suggesting the widening of Edgware-road, High-road, Kilburn, and Shoot-up-hill, in connection with the proposal to construct a tramway from the Marble Arch to Cricklewood, and asking whether, in the event of the County Council resolving to undertake the work, the Borough Council will give consent to the construction of a tramway along the portion of the route within the borough of St. Marylebone. The committee states that the estimated total net cost of the street widenings contemplated by the scheme is £94 000, and recommends the Council to consent to the construction of the proposed tramway, provided the Council be not asked to incur any expense for any street widenings necessitated. A deputation of members of the Highways Committee of the London County Council attended at the Guildhall on Wednesday to confer with the Bridge House Estates Committee on the question of some legislative co-operation between the Council and the Corporation with refererence to running tramways over Blackfriars Bridge and along the Victoria embankment. The question was discussed generally in private but it is understood that no definite scheme was formulated. Subsequently the whole question was adjourned until Monday, when the Bridge House Estates Committee will meet for the purpose of submitting definite recommendations to the Court of Common Council. The Stepney Borough Council have decided that they cannot consent to the use of the overhead system.

LIGHTING AND GENERAL.

Canterbury.—The electrical engineer has been deputed to visit the Olympia Exhibition.

Bath.—The question of lighting the new Midland bridge by electricity is being investigated.

Worthing.—Sanction has been received to the borrowing of £3,300 for electric lighting purposes.

Irvine.—The proposed electric lighting scheme has been deferred owing to opposition by the ratepayers.

Rochdale.—The Town Council are about to apply for powers to borrow £42,405 to pay for extensions at the electricity works.

Dewsbury.—The General Works Committee have received five tenders for the supply and erection of a new refuse destructor.

Hamilton.—Cables are now being laid into the pipes provided for the underground telegraph system between London and Glasgow.

Berwick.—Sir Hubert E. H. Jerningham, K.C.M.G., on Tuesday opened an electrical exhibition at Berwick before a large company.

Birkenhead.—Two members of the Electricity Committee, together with the engineer, have been deputed to visit the Olympia Exhibition.

Llangollen.—The Council have decided to postpone the adoption of the electric light for the whole of the town. Further investigations are to be made.

Sunderland.—The County Borough Council propose to place eight arc lamps on the concrete balustrade of the Roker promenade at an estimated cost of £504.

Removal.—Messrs. James Willing, jun., newspaper advertisement contractors, have removed their West-end branch from Piccadilly to 73, Knightsbridge, London, S.W.

Bromley.—The supplemental agreement with the National Telephone Co. relating to the proposed underground work in Tweedy-road and College-road has been approved.

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Sunningdale.—The Parish Council are considering a proposal from an electric light company in London who desire to supply the parish with electricity for lighting purposes.

Frimley.—The Urban District Council have referred to the Lighting Committee the question of sanctioning the proposed electric lighting order of the Camberley Electric Supply Co.

Eastwood.—The Urban District Council have decided to adopt public electric lighting providing favourable terms can be arranged with the Notts and Derbyshire Electric Power Co.

Hull.—Arrangements are to be at once made for reinstalling the National Telephone system to the Humber Pilotage Commissioners' office and the Alexandra Dock at an inclusive annual rental.

Widnes.—A sub-committee has been empowered to take the necessary steps for obtaining further powers of transfer to the Mersey Electric Supply Co., the term authorised having expired Aug. 15.

London County Council.—On Tuesday it was agreed to lend the Islington Borough Council £13 000 for electric lighting and the Woolwich Borough Council £10 223 for electric lighting purposes.

New Firm.—The firm of James E. Sayers, 157 West George-street, Glasgow, consulting engineer, has been changed into James E. Sayers and Caldwell, by the admission of Mr. James Caldwell to the firm.

St. Pancras.—The Borough Council are fitting up 5, Camden-road for showroom purposes for the electricity department. On Wednesday an extension of arc lighting (Section D) at a cost of £8,250 was approved.

Yarmouth.—The borough surveyor has been instructed to proceed with the work of electric lighting of the Marine-parade, Gorleston, and neighbourhood, by means of 10 arc lamps, at a total outlay of £57. 10s. per annum.

Brighton.—The Lighting Committee have been requested to attend the electrical exhibition at Olympia, and other members of the Council will be invited to accompany them. The expenses of the members attending are to be paid by the Council.

Battersea.—Electric mains are to be extended to Heathfield House at an estimated cost of £550. The subway recently formed by the Council between Latchmere-road and Cabul-road is to be lighted by means of Nernst lamps at an estimated cost of £70.

Hereford.—The Town Council intend to apply for sanction to borrow £5 300 for cable extensions, supplementary feeders, purchase of electric motors for hiring out, etc. The annual revenue from the extensions for lighting is estimated at £492.

Nernst Electric Lamps.—The A.E.G. English Manufacturing Co., 4 and 5, New Compton-street, Charing Cross-road, W.C., inform us that they have taken over the business of the Nernst Electric Light, and are now doing the export as well as the home trade.

Anglo American Telegraph Co.—The directors have resolved, after placing £5,000 to credit of renewal fund, to declare an interim dividend for the quarter ended Sept. 30, 1905, of 15s. per cent. on the ordinary stock, and £1. 10s. per cent. on the preferred stock.

Taunton.—At the last meeting of the Town Council a motion that the Council request the Electric Lighting Committee to revise its charges to private consumers so as to meet present and future liabilities was defeated by a large majority, only three voting in its favour.

Partnership.—Mr. James E. Sayers has taken Mr. James Caldwell, formerly his assistant, into partnership. The new firm will practice as consulting engineers and electricians at 157, West George-street, Glasgow, under the name of James E. Sayers and Caldwell.

Middlesbrough.—The electrical engineer (Mr. Taylor) in his last report states that the extensions to the plant are practically complete. During the month 150,000 units were sold as against 58,000 in the corresponding period of last year. The profit for the month amounted to £586.

Cheltenham.—It has been decided to provide a spare motor-driven pump at the station. It appears that a very large demand for power for traction is now compelling the Council to work their plant almost to its utmost capacity. The cost, estimated at £154, is to be met out of current revenue.

Market Harborough.—The Urban District Council have decided to proceed at once to take the necessary steps to obtain power for the establishment of an electrical supply within the urban district during the next session of Parliament. Messrs. Rees and Freres will act as their parliamentary agents in the matter.

Bolton.—At the last Town Council meeting a long discussion arose upon the decision of the Electricity Committee that it was inadvisable to allow the Co-operative Society to lay an underground electric cable from their premises in Bridge-street to those in Bark-street. An amendment to refer the matter back was lost.

Camberwell.—Notices having been received from the County of London Electric Supply Co. of intention to lay electrical conduits along both sides of Wagner-street, St. James's-road, and Olmar-road, the Council have decided to reply that they have no objection to the laying of the mains proposed, subject to such mains being used solely for the purpose of supplying electricity within the borough.

Croydon.—The Post Office have notified their willingness to establish telephone exchanges at Purley and Kenley. They also proposed to erect overhead wires in a number of streets. The District Council have been recommended to oppose all overhead wires, and arrange the best terms they could with the Post Office.

Morley.—Mr. J. E. Ellis, the borough electrical engineer, in his last report states that the total output from the electricity works during the month of August was 7,181 units, against 7,925 the same month last year, and that there had been 4,664 units sold to consumers by meter, against 3,616. There had been 275 lamps connected during the month, the total number of lamps to date being 13,001.

Louth.—The application of the Town Council for sanction to borrow £17,000 for the purposes of electric lighting has been refused. The Council think satisfactory arrangements may be made with a private company, and, in that case, would apply to the Local Government Board for leave to transfer the order. With that object in view application will be made for an extension of the time limit of the order.

Lowestoft.—The last report of the resident engineer states that during the month nine new consumers have been connected to the mains, representing 785 8-c.p. lamps. One 35-h.p. motor has been connected during the month. There are now connected to the mains 652 consumers, representing 33,195 8-c.p. lamps. The question of reducing the charges for power for tramways will come before the next meeting of the Electric Lighting Committee.

London Gazette.—The partnership between Edwin C. Wallis and E. H. Watson, electrical engineers, 36, Trinity-street, Leeds, has been dissolved by mutual consent. A receiving order has been made out on debtors' petition in the estate of George Robson and John Samson Robson, electrical engineer, Empire-buildings, Newgate-street, Newcastle-on-Tyne. The first meeting will be held at the Official Receiver's Office, 30, Mosley-street, Newcastle-on-Tyne, on Oct. 14, at 11 a.m.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 18 special settling day for the Newcastle and District Electric Lighting Co.'s £150,000 4½ per cent. mortgage debenture stock, and have ordered the said securities to be quoted in the official list. The committee have been asked to allow the following securities to be quoted in the official list: County of Durham Electric Power Distribution Co.'s 20,000 5 per cent. preference shares of £5 each, fully paid, Nos. 1 to 20,000; Electric Supply Corporation's £50,000 4½ per cent. debenture stock.

Edinburgh.—The Town Council have received a report from the Electric Lighting Committee recommending that condensing plant should be provided at Dewar-place station at a probable cost of £13 0 0, and at McDonald-road station at a probable cost of £28 500; and that authority be granted to make arrangements with the North British Railway Co. to take water from the Union Canal for condensing at Dewar-place station; and that provision be made in the Bill which is to be promoted in Parliament for powers to take water from the Water of Leith for the McDonald-road station.

St. Marylebone.—The Electric Supply Committee reported at the meeting of the Borough Council last night that the number of consumers now being supplied from the Council's electricity generating station was approximately 4,000. With regard to supply in bulk, the committee state that owing to the fact that the supply to large areas have been taken over from the company, and that (owing to the delay consequent on the Board of Trade inquiry *re* the change of pressures) in the case of some of the consumers the supply is necessarily at the old voltage, whereby a considerable proportion of electric energy is wasted, the load required to be provided for at the Council's generating station is heavier than had been estimated (the engineer having reckoned on larger areas being changed over to the higher voltage) and they have considered it advisable to approach the company with a view to obtaining the benefit of the option of a supply of electricity in bulk from them in case the same may be required during the next few months, by which time the critical period will be passed, as a larger number of consumers will then be changed over to the higher voltage. They are according negotiating with the company for such a supply in bulk, which the company are bound to give to the Council, on terms to be agreed, under the heads of agreement of May 8, 1901. The committee have provisionally arranged the following tariff—viz.: ordinary lighting purposes, 8d. per unit for 500 hours' supply on maximum demand and 1d. per unit afterwards; basement lighting, 2d. per unit; and for power purposes, 2d. per unit for 500 hours' supply on maximum demand, and 1d. per unit afterwards.

Tantalum Lamps.—Experience with a large number of these lamps has shown that when used on alternating-current circuits the results are not so good as on continuous-current circuits, the life of the lamp frequently being considerably shortened and the globe showing a tendency to blacken. We are informed by Messrs. Siemens Bros. and Co. that they recommend, for the present, that the use of tantalum lamps should be restricted as far as possible to continuous-current circuits. They further say that experience has shown that on continuous-current circuits the useful life may be assumed, generally, as being between 400 and 600 hours, and in many cases it is actually even larger, whilst the total life often greatly exceeds 1,000 hours. The candle-powers of the lamps of various voltages are proportional to the standard candle-power of the 110-volt lamp (23 British candle-power). Messrs. Siemens have had many inquiries as to why they do not put the 110-volt lamp on the market with a candle-power somewhere about 16, the general opinion being that 23 c.p. was too high for most requirements, although the current consumed is actually less than for the carbon filament of the lamp of 16 c.p. They say that, according to present manufacturing arrangements, in order to reduce the candle-power it is necessary to have a lower voltage lamp so as to secure the same high efficiency, and that they are now prepared to accept orders for 2·2-watt lamps for pressures of 50, 55, 60, 65, 73-75, 100, and 110 volts. These lamps have a useful life of about double the duration of the lamps described above, and give 30 to 40 per cent. less light, with an efficiency at starting of 2·2 to 2·4 watts per candle-power. For instance, the 110-volt lamp of this type gives a light of about 14½ c.p. with an efficiency of 2·2 watts per candle-power. Its useful life is about 800 to 1,000 hours, and the total life often reaches 1,500 to 2,000 hours. With the efficiency mentioned, a lamp having such a long useful life is a great improvement on anything that has been done in connection with carbon-filament lamps.

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Wimbledon.—An inquiry has been held into an application for sanction to borrow £5 000 for the purposes of electric lighting capital expenditure during the 12 months ending March 31, 1906, made up as follows: mains and pilot wires, £3,000; meters, £600; transformers and sub-stations, £1,190; contingencies, £210. Mr. Lee, the engineer, stated that the present power was inadequate, and in the event of a breakdown they would be placed in a very difficult position.

Colchester.—The electrical engineer's last report states that the output of electricity during August, 1905, was 32,945 units for lighting, against 27,000 in 1904 and 19,099 in 1903, and for traction 36,566, against 38,444 in 1904. The number of consumers at end of August was 757, against 529 in 1904 and 370 in 1903. The total number of 8-c.p. lamps connected was 34,212, against 26,728 in 1904 and 23,206 in 1903. New mains are to be laid at an estimated cost of £185.

Oulton Broad.—The Oulton Broad Electricity Co. have offered to take over the Reason lamps on the understanding that, should the Council terminate the lighting contract within three years, the Council should take back the lamps at their original cost. The Council have suggested the following terms: that if the company carried on the lighting for one year, the Council should pay two-thirds of the cost of the lamps; if for two years, one-third; and if for three years, the cost to be borne by the company, and that no additional annual payment be made.

Chester-le-Street.—The County of Durham Electric Power Supply Co. last week renewed their application to the Rural District Council for consent to an application for the carrying of overhead mains, and pointed out that the two companies are in reality one financial interest, but have separate statutory powers, and the Board of Trade preferred separate consents. The letter also stated that offices had been taken in Chester-le-Street, and land obtained on which to erect a power station. Notice of motion to rescind the former refusal has been given so that the main question can be discussed.

City of London.—Last week a report from the Streets Committee was submitted with reference to a letter received from the City of London Electric Lighting Co. in reply to a notice from the Corporation to remove their electric lamps from Queen Victoria-street, Fleet-street, Monument-street, and part of Lower Thames-street. The committee reported that they had informed the company that they saw no reason to recommend the Corporation to vary the decision arrived at on May 4 in regard to the lighting of the thoroughfares in question by means of incandescent gas. This was agreed to.

Beckenham.—The cost of laying a cable to supply Wickham Hall would be £225, in addition to which the station cost would amount to £15. The probable number of units to be used is 10 000 per annum. This matter is being held over. Extensions amounting to £210 are to be made. In accordance with the provisions of the contract for the working of the Beckenham electric lighting station, the engineers therein named—viz., Messrs. R. P. Wilson and J. A. Angell—are about to make an inspection of the whole of the premises, dust destructor, plant, machinery, and apparatus, and report thereon to the Council.

Rothwell.—At the last meeting of the Council a resolution was carried appointing a deputation to meet the directors of the gas company, with a view to the purchase of their undertaking by the Council. During the discussion it was stated that the Wakefield Tramway Co. was prepared to supply electricity in bulk. It was also suggested that the West Riding County Council be asked to further a project by parliamentary permission, whereby all electrical current, etc., shall be supplied by the County Council to the district councils, so as to secure for the ratepayers all the advantages and profits now enjoyed by private companies.

Poplar.—The Visiting Committee of the Poplar and Stepney Sick Asylum Board reported at the last meeting that they had considered the question of engaging firms to execute the engineering and electrical repairs of the institution, and whether it would not be advisable for the managers to engage their own workmen for the carrying out of the repairs in question. The cost of the work for the preceding year was £772. 14s. 5d. The committee recommended that the Board employ its own workmen to carry out the engineering repairs at the institution. The materials and labour for the year ended Midsummer, 1905, for electrical repairs cost £234. 1s. 6d. It was decided that, when necessary, the Board employ its own workmen to carry out the electrical repairs which may require to be done in the institution.

Dundee.—With regard to the recent failure of the electric light supply, we have received the following report. On the night of Oct. 5, owing to a failure of one of the lead-covered cables in one of the outlying districts, which were laid a few years ago, a bad fire was started in one of the manhole boxes in Scouringburn, threatening to ignite the adjacent buildings. It being impossible to disconnect this length of cable during such a heavy short-circuit in the old type of disconnecting boxes, owing to their small size and being in such deep manholes, it was absolutely necessary to shut down a large part of the town at the station for a few minutes to allow of the disconnection of the faulty length. The fault was not due to bad cables, the same being perfectly good British Insulated Wire paper cables in good condition, but was due to the way the cables were laid.

Kensington.—A notice has been received from the Notting Hill Electric Lighting Co. relative to proposed extensions of their mains in Ladbroke-road, but the Council are not prepared to grant permission for the carrying out of the proposed works, inasmuch as the plan shows a crossing of the roadway which might, they think, be avoided by the laying of a main on the south side of the road. With regard to a notice received from the Kensington and Knightsbridge Electric Lighting Co. relative to proposed extensions of their mains in Palace-gate, the Council had previously refused to grant permission for the carrying out of these works for a similar reason. On learning, however, that the mains referred to were to be laid in connection with the erection of certain trial lamps for public lighting, and that the roadway crossing shown on the company's plan was necessary in order to avoid the duplication of mains in the grouping of the proposed lamps on the one circuit, permission has been given on the usual conditions.

Birmingham.—It is expected that the electricity station in Summer-lane will be in full working order before the end of this year. At present plant of 12,000 h.p. will be installed, and arrangements have been made to allow of extensions when required. The site of the new station covers 4½ acres. Seven high-speed enclosed steam-engines, fitted with condensers, are in course of erection—four are of 2,500 h.p. each and three of 800 h.p. each. The British Westinghouse Electric and Manufacturing Co. are supplying three-phase generating plant of an aggregate capacity of 3,000 kw. This will consist of one 1,500-kw. rotating-field 25-period 5,600-volt generator, running at 166⅔ r.p.m., and three similar machines of 500 kw. each, running at 250 r.p.m. An electrically-driven crane of a lifting capacity of 40 tons has been fixed, which will come in useful during the erection of the engines and dynamos. There will be eight water-tube boilers, the largest of which will be capable of evaporating 24,000lb. per hour. Coal-bunkers capable of containing 2,000 tons will be served by bucket conveyors, which on their return journey will carry away the refuse from the boiler fires.

Sutton.—At the recent enquiry it was stated that the number of the electric light consumers had increased from 51 in 1901 to 403 at the present date. The output for the 15 months ending March, 1903, was 56,710 units, and for the 12 months ending March, 1905, 156,602. For the current year the output was estimated at 220,000. The deficiency for the 15 months ending March, 1903, was £1,727, as compared with £690 for the 12 months ending March, 1905. No deficiency at all is anticipated on the current year, as the revenue is increasing and the working cost decreasing. The total expenditure to date is approximately £38,500, and the amount raised by loan £31,208. The deficits have been met each year by a call upon the district fund. The current is supplied to private consumers on a sliding scale of from 5½d. per unit for less than 400 units per annum down to 4d. per unit for over 4,000 units per annum. For power or heating purposes the price is 2d. per unit. The cost of public electric lighting, including labour, capital, and maintenance charges, works out at 1·4d. per unit, including the 14 arc lamps, for which £13. 10s. each was charged per annum, as against 1s. 1d. per 1,000ft. (or 18s. to 20s. per lamp per annum) for gas.

Aston.—An inquiry has been held into an application of the Borough Council for sanction to borrow £50,000 for extensions of their electric power station and plant. The original loan obtained by the Council in 1902 for the purposes of erecting the electrical station was £52,435. This sum, however, has been exceeded by £20,000, mostly on account of the necessity of laying new feeders in various parts of the borough owing to the rapidity with which the current supply was taken up. A sum of £5,362 was spent in the purchase of free wiring and motors. In addition to this sum of £20,000, the Council require £30,000 for the extension of the power station and plant, rendered necessary by means of the increasing demand for the supply of electricity. It was stated at the inquiry that on March 31, 1904, the number of consumers was 237, representing 16,190 8-c.p. lamps. In March, 1905, there were 349 consumers, equivalent to 33 219 8 c.p. lamps. At the present date there were 364 consumers connected, equivalent to 40,440 8-c.p. lamps, or an increase during the six months ending Sept. 30, 1905, at the rate of 44 per cent. The current sent out for all purposes for the 12 months ending March 31, 1905, was 1,049,653 units, and it was estimated that for the year ending March, 1906, there would be an output of a million and a half units. It was anticipated that the undertaking would be self-supporting within the next two years.

Dartford.—The accounts of the electricity undertaking for the year ending March 31 show a working profit of £598. Capital charges for principal and interest amount to £1,873, so that a sum of over £1,270 has to be provided from the rates. Of this £1,873 of capital charges, £861 represents repayment of capital, but no provision is shown in the account for depreciation of plant. The capital indebtedness stood at a total of £37 800 on March 31 last, showing an increase in the 12 months of £3,088. The total revenue was £3,556. Sales of current amounted to £3,284, including £1,033 for public lighting. The expenditure was as follows: coal, £1,120; oil, water, and stores, £201; wages and generating station, £385; repairs and maintenance, £252; repairs and maintenance of distribution in the town £146; repairs and renewals to public lamps, £312; and management expenses £355, making a total of £2,958. The deficiency in the preceding year was £2,316, or nearly double that of this year. The improvement is due to the expansion of income from £2 388 in 1903-4 to £3 556 in 1904 5, whilst the expenditure had remained about the same in the two years, being respectively 1903 4, £2,817; 1904-5, £2,958. Mr. J. D. Pember, the electrical engineer, in his report refers to the lack of a motor load, and says that, although there are 120 h.p. of motors connected to the mains, the demand for power is so remarkably intermittent that a 10-h.p. motor, if running for nine hours per day per 300 days per annum at or about full load, would take as much current a year as the whole of the motors now supplied. Another difficulty arises from the number of small lighting consumers, especially sub-meter consumers, whose average receipts per yard of main laid for them come out very low. The capital expenditure also is high for the present output. The engineer considers that the rates of the capital expenditure per unit sold would be almost halved when the trams were supplied, owing to the greatly increased output of the station and the small addition of capital expenditure necessary. As much as 6½ times as many units could have been sold in the year ended March, 1905, if the maximum load had continued day and night all through the year.

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PROVISIONAL PATENTS, 1905.

Oct. 2.

19853. Improvements in electrical secondary batteries for propulsion. Walter Nathaniel Caton, The Hill, Bakewell, Derbyshire.

19865. Improvements in apparatus for producing unidirectional high-potential electric discharges for the dispersion of fog and for other purposes. Ernest Wilson and William Hamilton Wilson, 64, St John's-park, Blackheath, London.

19866. Electromobile, with charging plant combined. Peter Kopp, 41, Grosvenor-mews, New Bond-street, London.

19867. Improvements in and relating to telephones. André Gabeaud, 2, Boulevard Beaumarchais, Paris, France.

19889. Improvements relating to alternating-current motors. Robert Lundell, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19906. Improvements in electric clocks and clock systems. Isaac Hardy Parsons and Alfred Ernest Joseph Ball, 40, St. Saviour's-road East, Leicester.

Oct. 3.

14660A. Improvements in and relating to vapour electric rectifiers and lamps for alternating current. Francis Harrison, 14, Ossian-road, Stroud Green, London. (Date applied for under Rule 5 of the Patents Rules 1905, July 17, 1905.)

14660B. Improvements in apparatus for heating and in mercury vapour electric lamps used therein. Francis Harrison, 14, Ossian-road, Stroud Green, London. (Date applied for under Rule 5 of the Patents Rules, 1905, July 17, 1905).

19937. Improvements in and relating to electric arc lamps. Crompton and Co., Limited, and Charles Franklin Tubbs, 55, Chancery-lane, London.

19967. Improved construction of insulator device for connecting electric lamps to their supports. Louis Carl Henry Mensing and Bruce Peebles and Co., Limited, 173, Fleet-street, London.

19968. Improved construction of electric switch. Louis Carl Henry Mensing and Bruce Peebles and Co., Limited, 173, Fleet-street, London.

19969. Improved combination of case or holder for electric resistance coils. Louis Carl Henry Mensing and Bruce Peebles and Co., Limited, 173, Fleet-street, London.

19978. Improvements in and relating to electromagnetic separators. William Blackmore, 18, Southampton-buildings, Chancery-lane, London.

19989. Improvements in apparatus for electrically opening and closing railway carriage or like doors and for operating locks in connection therewith. Alfred Craven, Palace-chambers, Westminster, London. (Complete specification.)

19992. Improvements in switches for intercommunicating and central-station telephones. Bernard Hahner, 6, Lord-street, Liverpool. (Bernard Hahner, England.)

Oct. 4.

20024. Improvements in electro-deposition apparatus. Albert Frederick Harris, Prudential-buildings, Corporation-street, Birmingham.

20040. Improvements connected with railway and tramway points operated by or from the vehicles and with points or switches for use in or upon the overhead equipments of electric railways and tramways furnished with points. John Wild, 288, Hollins-road, Hollinwood, Oldham, Lancs.

20051. Improvements in automatic transmitters for electric fire-alarms or other signals. Harold Hawthorn, 79, Fenchurch-street, London.

20058. Improvements in mounting the field coils of dynamo-electric machines. Siemens-Schuckertwerke G. m. b. H., 12, Queen Anne's-gate, Westminster, London. (Date applied for under Patents Act, 1901, Nov. 12, 1904, being date of application in Germany.) (Complete specification.)

20068. Improvements in receiving systems for wireless transmission of signals. Valdemar Poulsen, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 8, 1904, being date of application in Denmark.) (Complete specification.)

20069. Improvements in or relating to electric alternating-current switches. Charles William Scott Crawley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20100. Improvements in or relating to Rontgen-ray tubes. "Polyphos" Elektrizitäts-Gesellschaft, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 5, 1904, being date of application in Germany.) (Complete specification.)

20102. Improvements in electric carrier systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Oct. 5.

20104. Improvements in or connection with brushes for electrical machines especially adapted for turbo-generators. John Conrad Bedford Ingleby, 30, Park-row, Leeds.

20106. High-tension distributor for electric ignition of internal-combustion engines of more than one cylinder which is worked by one induction coil. Harry John Simmons, 12, Gartmoor-gardens, Wimbledon Park-road, London.

20143. Improvements in electric batteries or accumulators. Douglas Hamilton Whitehead and Quinton Marinon, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20152. Improved electric ship log and indicator. Egbert Vincent Hector Rizzo, 9, Warwick-court, Gray's-inn, London.

20155. An automatic device for use in conjunction with the automatic control of electric arc and incandescent lighting circuits. Charles Frederick Trippe and Charles Norman Staniland, 71, Queen Victoria-street, London.

20158. An improved electric switch. Alan Wright, 33, Cannon-street, London.

20169. Improvements relating to systems of electrical distribution. Rudolf Braun, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

20175. Improvements relating to the manufacture of incandescing bodies for electric incandescent lamps. Alexander Just, Franz Hausman, Heinrich Landesberger, Ignaz Salzmann, and Vereinigte Electricitäts Actien-Gesellschaft, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20184. Improved electrically-operated displaying mechanism for advertisements and the like. Harry Sanders Woodyer and William Edgar Woodyer, 322, High Holborn, London.

Oct. 6.

20197. Improvements in and appertaining to the making of talking machine "records" by means of electricity. Malcolm Macnaughton Robertson and James Leo Parry, 9, Tempest Hey, Liverpool.

20217. Improvements in apparatus for the electrolysis of water. Karl Joseph Vareille, 6, Bank-street, Manchester. (Complete specification.)

20231. Improvements in and connected with buzzers or sounders for telephone stations. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Akt.-Ges. Mix und Genest, Germany.)

Oct. 7.

11036A. Improvements in alternating-current measuring instruments. Frank Conrad and William Maple Bradshaw, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 27, 1904, being date of application in United States. An invention comprised in application No. 11,036, May 26, 1905.) (Complete specification.)

11036B. Improvements in alternating-current measuring instruments. Frank Conrad and William Maple Bradshaw, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, May 27, 1904, being date of application in United States. An invention comprised in application No. 11,036, May 26, 1905.) (Complete specification.)

20269. Electric mains telephone and fault detector, for use on continuous-current mains of electric light system. Ivan Arthur Carr, 38, Northbourne-avenue, Morpeth.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 26.

1904.

20968. Central-station electric installations. Highfield.

21142. Variable-speed mechanisms. Carolan. (General Electric Company.)

24022. Recording instruments. Edgcumbe and Everett.

24605. Wattmeters. Sumpner.

25478. Electric fuse-boxes, single and double pole. James.

25729. Dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

26082. Dynamo-electric generators. Leitner and Lucas.

26171. Armature windings for dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

26288. Electrical apparatus for training and elevating heavy guns. Vickers, Sons, and Maxim, Limited, Williamson, and Sumpter.

26327. Electric switches. Large.

26374. Automatic electric switches, particularly for use in charging electric accumulators. Leitner, Lucas, and Hill.

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26445. Brushes for dynamo-electric machines. Feeny. (Wirt.)

26662. Apparatus for the production of reactions in gases by means of electric arcs. Johnson. (Badische Anilin und Soda Fabrik.)

1905.

269. Electromagnetically controlled fluid pressure motors. Malan.

1136. Electrical condensers. Rymer-Jones.

1732. Controller and brake mechanism for electrically-driven road vehicles. Russell and Ford.

2631. Ships' telegraphs. Lynch.

2890. Apparatus for electrically operating gas-valves. Scott.

3076. Electric signalling apparatus. Evershed and Vignoles, Limited, and Evershed.

3265. Electrical switches. Tyer.

5866. Electrically-operated tubes or bulbs containing rarefied gas or vapour. Howorth. (Moore Electrical Company.)

6053. Electric lamps for illuminating timepieces and for other uses. Vickery.

8127. Gasproof and disconnecting plug for electrical switches. Carter.

12466. Telephone mouthpieces Knoll.

13093. Electric drills. Boult. (Duntley).

13586. Method of and means for supplying current to branch stations of telephone exchanges. Siemens Bros. and Co., Limited. (Siemens und Halske Akt.-Ges.)

14210. Regulating switch apparatus for increasing or decreasing the pressure of a network in finely-divided stages. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke, G. m. b. H.)

14700. Apparatus for electric welding. Lake. (Clinton Wire Cloth Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2⅞-2⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-⅝
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1⅝
—— 4½ per cent. 1st Debenture Stock	100	..	91-94
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	10½-11½
—— 5 per cent. Pref.	5	..	5⅛-5⅛
Crompton and Co.	3	..	1⅞-1⅞
—— 5 per cent. Debentures	100	..	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅜-1⅜
—— "A" Shares, 01-017,139	5	..	2-2¼
—— 5 per cent. Debentures	100	..	92-97 xd
—— 4 per cent. Deb. Stock, Red.	100	..	85-90
Electric Construction, Nos. 1 to 112,100	2	..	⅝-1⅛
—— 7 per cent. Cumulative Pref.	2	..	1⅝-1⅞
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-100 xd
W. T. Henley's Telegraph Works, Ordinary	5	..	12 13
—— 4½ per cent. Preference	5	..	5⅛-5⅜
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16⅛
—— 4 per cent. Debentures	100	..	99-102 xd
Parker, Thos., Limited, Ordinary	10	..	10-10⅛
Telegraph Construction and Maintenance	12	..	34-36
—— 5 per cent. Bonds	100	..	102 104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	12 12½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red.	100	..	106-108
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜ xd
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	9⅜-10¼
—— 7 per cent. Preference	5	..	9⅜-10⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9¼-9½
—— Nos. 60,001-80,000	5	..	9-9⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13¼
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	104-107
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	6⅜-7¼
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5⅛-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— ditto (1903) 40,001-80,000	5	..	4⅞-5⅛
Chelsea Electricity Supply	5	..	5⅜-6⅛
—— 4½ per cent. Debentures	100	..	109-111
City of London, Ordinary	10	..	12-13
—— 6 per cent. Cumulative Pref.	10	..	13½-14½
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104-106
County of London Electric Supply, Ordinary	10	..	9-9¼
—— 6 per cent. Cum. Pref.	10	..	12-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6⅛
—— 6 per cent. Cum. Pref.	5	..	6⅛-6⅜
—— 4½ per cent. First Mort. Deb.	100	..	108-110
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜ xd
—— 4½ per cent. First Deb. Stock, Red.	100	..	99-102
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	8-8½
Isle of Wight Elec Lt. and Pwr., 4½ p c. Db. Stk. Rsd.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	15/16-1 1/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	12-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10⅛
London Electric, Ordinary	3	..	2-2⅛
—— 6 per cent. Pref.	5	..	4⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	10½-10⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅜ 5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98 100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5	..	7⅜-8¼
—— do., 57,0 0-75,000	5	..	7⅜-8¼
—— 5 per cent. Pref., 1-57,000	5	..	6¼-6⅜
—— do., 57,0 0-75,0.0	5	..	6¼-6⅜
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98 100 xd
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	..	6⅜ 6⅞
—— 4 per cent. Debenture Stock	100	..	100 102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103 xd
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2¼ 2⅜
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3½-4
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108 xd
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	£8 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅜-4¾ xd
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5-5½ xd
Westminster, Ordinary	5	..	12⅛ 13⅜
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6⅛-6⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5⅞-6⅛
—— Ord.	5	..	8¼-8⅜ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	104-106
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	27/32-31/32
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3⅜-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	96-98
British Columbia Electric Railway Co., Ord. Def.	100	..	126-129
—— Ord. Pref.	100	..	109-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	105-108
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	105-105 p.c
—— 4½ per cent. Vancouver Power Deb.	100	..	99-102
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	9-9½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10⅜-11⅛
—— 5 per cent. Perpetual Debenture Stock	100	..	121-125 xd
—— 4½ per cent. 2nd Deb. Stock	100	..	99-101
Buenos Ayres and Belgrano Trams	5	..	3⅜ 4
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5⅜-6
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5½
—— 5 per cent. Deb. Stock, Red.	100	..	106-108
—— Prov. Cert., all paid	100	..	102-105
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,268	5	..	9-9⅜ xd
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1¼-1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	3½ 4¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	101-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13¼-14½
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14¼
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2¼-3
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	85-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8 8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9⅜-10⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-3/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9⅜-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8⅜-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9-9¼
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	91-93
—— 4 per cent. Pref.	100	..	101-103
—— " deferred	100	..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99½-100½
Waterloo and City, Ordinary	100	89-91

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	112-113
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref.	10	13¼-14¼
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅝-6⅜
—— 3½ per cent. Deb. Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	104½-106½
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 7	1,312	1,334	− 42	− 1,609h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 7	209	213	− 4	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 8	1,001	1,032	+ 31	− 534	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 7	387	311	+ 76	—	1	—	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 4	1,167	957	+ 209	+ 898	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	,, 5	962	879	+ 83	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 7	476	459	+ 17	− 803	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 8	1,950	1 823	+ 127	—	40	38	March 31	95,765	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 4	1,386	1,060	+ 326	—	16 82	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 7	4,357	4,548	− 191	—	77	77	,, 31	—	—	—	—	—	—	—
Brighton Corporation	,, 8	922	968	− 46	+ 756	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 6	4,803	5,180	− 377	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 7	1,218	1,140	+ 78	—	10 60	10·60	March 31	—	—	—	—	—	—	
Burton Corporation	,, 8	331	367	− 36	− 1,131	8¼	8¼	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	Sep. 30	1,946	2,065	− 119	+ 233	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	Oct 7	190	196	− 6	− 109	8·5	8·5	Dec. 31	—	—	—	—	—	—	—
Central London Railway	,, 7	6,776	6,750	+ 26	− 1,859	6	6	,, 31	347,588	44,875,547	1,281,214	1·86	65·10	57,931	35·60
City and South London Railway.	,, 8	2,733	2,768	− 35	− 573	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 5	490	504	− 14	+ 793	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	Sep. 1	250	251	− 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Oct. 6	115	129	− 14	+ 314	6½	6½	Dec. 31	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 6	3,915	3,980	− 65	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5·55
Dublin S. District, Electric	,, 6	894	930	− 36											
Dundee City Tramways	,, 4	994	874	+ 120	+ 584	22	23	May 15	—	—	—	—	—	—	—
East Ham Corporation	,, 7	787	665	+ 122	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 7	15,601	14,736	+ 865	+14,421h	144¾	143	May 31	756,480	195,767,519	17,945,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	Sep. 20	1,803	1,618	+ 185	+ 1,781	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	Oct. 7	1,351	1,248	+ 103	+ 998	35	35.	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 7	2,179	2,091	+ 88	+ 603	27	26	,, 31	—	—	—	—	—	—	—
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 4	112	135	− 13	− 725	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 4	224	243	− 19	—	7½	7½	May 15	12,201	3,632,855	432,396	·775	6·519	—	7·649
Leeds Corporation	,, 7	5,874	5,741	+ 133	—	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 7	2,001	1,761	+ 240	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	Sep. 30	10,593	10,670	− 77	+ 8,915	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	Oct. 8	1,394	1,504	− 110	− 854h	6·57	6·57	June 30	—	—	—	—	—	—	—
London County Council	Sep. 30	14,558	13,641	+ 917	+67,656	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	Oct. 5	133	143	− 10	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 7	12.738	12,354	+ 384	+15,187	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Metropolitan District Railway	,, 8	7,397	7,071	+ 326	− 2,710	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 8	17,610	17,699	− 89	+ 133	70¼*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 7	136	120	+ 16	+ 346	—	2¾	,, 31	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation.	,, 7	3,787	3,660	+ 127	+ 2,933	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 8	1 668	1,194	+ 474	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 7	1,745	1,753	− 8	+ 1,498	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 7	331	317	+ 484	+16,287	6½	4½	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 5	471	457	+ 14	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 9	4,125	4,040	+ 85	—	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 8	4,923	4,621	+ 302	+ 6,461	—	52½	,, 31	—	—	—	—	—	—	—
Southampton Corporation	,, 4	502	818	− 316	− 388	—	18	,, 31	—	—	—	—	—	—	—
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 6	805	556	+ 250	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	Oct. 8	1,224	1,201	+ 23	+ 931	—	20	,, 31	—	—	—	—	—	—	—
Swindon Corporation	Sep 30	193	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D C.	Oct. 7	729	726	+ 3	+ 651	11·85	10·5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 5	2,089	1,088	+1,002	+20,101	46	8·62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 4	829	—	—	—	—	7½	,, 31	—	—	—	—			

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Books Received. — "Theorie der Elektrizitaet" (vol. ii., "Elektromagnetische Theorie der Strahlung"), by Dr. M. Abraham. B. G. Teubner, Leipzig. 10s.

Wireless Telegraphy.—The s s. "Inkosi," of Messrs. John T. Rennie, Son, and Co.'s Aberdeen line, has just been fitted with the Marconi system of wireless telegraphy, and the s.s. "Inanda," of the same line, will be similarly fitted before she leaves on her next voyage to Africa. These are the first passenger steamers going into southern latitudes to be so fitted, but at present it will only be possible for communication to be kept up as far as Las Palmas, except when they are in touch with his Majesty's ships at sea, or at Simon's Bay.

Electricity for Pottery. — The question of the utilisation of electricity in the potteries is at present engaging the attention of potters, and under the auspices of the Ceramic Society a meeting was held in Stoke on Saturday last for the purpose of a lecture by Mr. Axel Odelberg on experiments made in Sweden in the working of potters' machinery by electricity. Mr. Odelberg is connected with the Gustafsberg Pottery, near Stockholm, and the results of his experiments with electrical power, which at first were on a small scale, and were gradually increased, went to show that, as compared with steam, electricity is cheaper, handier, and quite as efficient.

London's Electric Supply.—In our previous week's issue we called attention to the possibility of the London County Council undertaking supply of electricity in bulk. The borough councils are moving in the matter, and a circular, signed by the chairmen of the Poplar, Shoreditch, and Stepney Electric Lighting Committees, has been addressed to the other borough councils inviting them to send representatives to a conference to consider the question of the municipal supply of electricity in bulk, and, if thought fit, to promote legislation in the ensuing session of Parliament. The Electric Lighting Committee of the Bermondsey Borough Council have signified their approval.

Labour Difficulties.—The differences which arose over the wages question between two of the leading German electrical firms and their employés, which at one threatened to culminate in a lengthened lock-out, have now been adjusted. Several conferences were held with a view to effecting a settlement, but these proved abortive, owing to neither side being prepared to concede any of its claims. The expected extension of the strike to other industries strengthened the men in their resistance, but the lock-out announced by the hardware manufacturers greatly weakened their position, and caused them to surrender. Work was resumed on Monday last on the terms agreed to by the companies before the strike.

Milan Exhibition.—Supplementary to the announcements which have previously appeared in these columns, we are now able to announce that the sum of £1,600 has been offered by the King of Italy for distribution as prizes among the exhibitors. This will be allocated in the following manner: £400 for the best and most original exhibit of machinery or manufacturing process; £200 for automatic safety railway couplings; £200 for the best and safest method of testing high-voltage currents; £200 for the best established method of distributing pure milk in centres population; £200 for the best type of popular dwelling adapted to the climate of Northern Italy; and £200 for motor boats. The exhibition will occupy close upon 200 acres, of which the buildings will occupy 42.

School of Economics and Political Science.—The new curriculum of the University of London at the School of Economics and Political Science comprises lectures on railway subjects, which are to be allowed as an alternative subject for the honours degree, and it is gratifying to note that eight of the leading railway companies are lending their support. Lectures have been arranged for the present session on "Railway Economics and Statistics," by Prof. Chapman and Mr. Bowley; "Law of Contract and of Carriage by Railway," by Mr. Disney; "Economic Factors in Railway Alignment," by Mr. Lynden Macassey; and on the "History and Geography of Railways," by Mr. H. J. Mackinder. On Oct. 25 Mr. W. M. Acworth will give a lecture dealing with the recent history of federal control of railways in the United States.

The Kingsway.—The gates of the Kingsway, which was opened on Wednesday last by his Majesty the King, were operated by electrical apparatus furnished by Electromotors Limited, of Openshaw, Manchester. The gates were attached by means of ropes to electric winches, one on each side of the roadway. These winches consisted of 2½-b.h.p. motors, direct-coupled to worm gears provided with drums for hauling in the ropes. The gold key inserted by his Majesty into the pedestal on the dais closed an electric circuit, which in turn brought the automatic solenoid self-starting switches into circuit, thus starting the motors and gradually opening the gates. When the gates were fully opened, they automatically disconnected the circuit by means of trip switches, thus bringing the winches to rest. The solenoid self-starting switches are of the Sturtevant Company's make.

Tramways and Light Railways Association.—The *Official Circular* for October contains notices of lectures at the Society of Arts, where Mr. T. W. How will read a paper on "Roller Bearings" on the 25th inst., and Mr. A. L. C. Fell one on "Brakes" on Jan. 10. Several other lectures are arranged. A visit is to be paid to the North Metropolitan Electric Power Supply Company's power station at Brimsdown, and also to the sub-stations. The circular also contains the regulations for overhead lines prescribed by the Board of Trade in August under the Electric Lighting Acts, and there is a copy of the Board report for the 1905 session under the Tramways Act. A joint conference of this association with the Municipal Tramways Association and the Association of Tramways and Light Railways Officials is to take place on Nov. 1, under the auspices of the Board of Trade, to further consider the question of amalgamation.

Submarines.—While the submarine A4 was lying in Stokes Bay on Monday last an explosion took place, which was fortunately not attended by any serious personal injury. The submarine had been submerged, and was apparently proceeding all well, when sea-water found its way into the interior, probably through a defect in the valve in the exhaust pipe by means of which spent gasoline vapours are expelled when the submarine is proceeding on the surface. The water got to the accumulators of the electric batteries, and chlorine gas was consequently generated. The officer in command at once took measures to get the boat to the surface, but some gas evidently was ignited by some electric sparks from the batteries, for there was a small explosion, and A4 reached the surface at an angle of about 35deg., with her bows submerged. She regained her equilibrium and was towed towards Portsmouth Harbour, where she was found to be rather badly damaged internally.

The Nelson Light Railways.—The light railway of the Nelson Corporation is one of those concerns which render the public a great service in an unobtrusive way. During the year ended March 31 last a population of

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42,000 was carried some 43 times at reasonable fares. This enabled the Corporation to realise a gross profit of £1,703 out of a revenue of £6,159. Interest and sinking fund absorb £1,668, leaving a small surplus of £30 odd. Hitherto the Corporation has been unable to make any provision for depreciation, though this is scarcely a pressing matter at the moment, as the system is only a couple of years old. At the same time, it is gratifying to note that Mr. W. Alan Fraser, the manager, is alive to the desirability of building up a reserve fund, which he recommends the Corporation to start at once. But for the unremunerativeness of the Barrowford section the undertaking would probably have shown an appreciable margin. To remedy this, Mr. Fraser counsels an increased fare, so as to make the section at least self-supporting. The Burnley Corporation run through cars, and now that the Colne and Trawden Light Railway Company have completed their lines the Nelson Corporation have again approached the company with a view to inter-running. As both parties stand to gain by the arrangement we imagine the company will return a favourable response, which should result in enhancing the value of both undertakings.

The Rugby Engineering Society.—This society made an excellent start on Oct. 5, and met again on the 19th inst., when Mr. J. Whitcher read a paper entitled "Electric Switchgear." The following further papers and lectures have been arranged: "High-Lift Pumps," by P. A. Mossay, member; "The Testing of Metals," by T. S. Dick, member; "The Design of a Large Shop for Electric Manufacturing," by F. J. Sharr, member. A series of four papers on the economical distribution of energy from coal, as follows: "The Generation of Steam," by J. Brierley and T. Robertshaw, members; "The Conversion of Steam Energy into Mechanical Energy," by E. R. Briggs and A. E. Reynolds, members; "The Conversion of Mechanical Energy into Electrical Energy," by F. H. Clough, member; "The Transmission of Electric Energy," by C. McCarthy Jones, member. The following gentlemen have also kindly consented to give lectures: W. F. Parrish, Esq., chief of technical department, Vacuum Oil Company, on "Lubrication"; J. M. Gledhill, Esq. (of Sir W. G. Armstrong, Whitworth and Co., Limited), on "High-Speed Steel." The council also hope to arrange visits to the Humber Cycle Works, Coventry; the Herbert Machine Tool Company, Coventry; the National Physical Laboratory, Bushy Park, and other places of interest. As no other nominations have been received, the council's nominees are declared elected. The officers are, therefore, as follows: president, F. Samuelson; past-presidents, W. J. Larke (1903-4) and C. H. Wingfield (1904-5); first vice-president, W. R. Watson; second vice-president, E. R. Briggs; hon. recording secretary, E. H. Walker; hon. corresponding secretary, G. Ward; hon. treasurer, F. W. Cooke; hon. librarian, A. W. Fell.

Single-Phase Locomotives.—The Westinghouse Electric and Manufacturing Company have recently secured an important contract from the New York, Newhaven, and Hartford Railway Company for the supply of 25 single-phase electrical locomotives for service on the company's main line, which is being converted to electric traction. The single-phase overhead wire system has been adopted, but the locomotives, which are being built by the Baldwin Locomotive Company, will also use direct current where they traverse the line of the New York Central, which serves the suburbs of New York. Each locomotive will be equipped with four 400-h.p. Westinghouse single-phase motors of the straight series gearless type, and the unit switch system of multiple control will be used. The weight of the locomotives is approximately 78 tons, and with a 200-ton train making stops every 2·2 miles, and attaining a maximum speed of 45 miles an hour, the schedule speed will be 26 miles per hour. Express trains of 250 tons will be propelled at from 60 to 70 miles an hour by one locomotive, but heavier trains will be run by two or more locomotives coupled together and controlled from the forward cab. The motors are to be spring-supported and connected by flexible drive in such a manner that all dead-weight will be taken off the axles. They will be permanently connected two in series, and on direct current the pairs will be operated on the series-parallel system and on alternating current by means of voltage control. Much interest attaches to this new electrical railway, which is the first to adopt electricity over the whole line. The results obtained on the Indianapolis and Cincinnati Railway and other lines which have adopted the same system have proved satisfactory.

Electrically-Driven Printing Plant.—The first installation of electric motors for driving printing presses in Australia has just been laid down on the premises of the *Sydney Daily Telegraph*. The electrification was made practicable by the advent of the Corporation electricity supply, from which the energy is obtained. The order for the construction of the plant was placed with the Australian General Electric Company, and comprises 40 motors, ranging from ¼ h.p. to 35 h.p., with their controlling apparatus, switchboards, etc. The electric current is taken from the three-wire street network at 480 volts on the outers, and to ensure reliability against failure of current a duplicate service is provided. Electric power is used in the composing-room and in the basement for each of the presses. The system which has been adopted by the *Sydney Daily Telegraph* embodies the latest developments of the systems in operation in some of the leading printing establishments in America. In addition to the application of electric power to the printing machines, a number of small motors have been installed in various parts of the establishment for driving saws, air propellers, and lifts. The aggregate power of the electric motors is 154¼ h.p., besides which there are three small auxiliary engines connected with the printing presses. The total cost for power amounts to considerably over £1,000 per annum. There is a direct saving on the cost of running the steam plant under the new conditions, inasmuch as there is no unnecessary waste of power. Each machine has its own independent motor, and no more than the energy actually required for each minute of the day or night is expended. Under the steam system a large engine may have to run for considerable periods to supply power for one small machine, whilst the loss and delay of getting up steam, and the power wasted after the engine is finished with, are factors which have to be taken into consideration. Mr. E. Kilburn Scott acted as consulting engineer for the scheme.

Single-Phase Railway Working.—Mr. C. F. Scott in his paper read before the annual convention of the American Street Railway Association, held at Philadelphia last month, revealed the salient features of single-phase railway working. He also gave some valuable conclusions from experience already obtained with the system. He claimed that amongst the realised advantages of the system were the following: A high-voltage trolley construction had been developed, and proved to be simple, strong, and thoroughly practicable. Thirty-three hundred volts were used, and proved to be safe and reliable. A sliding contact device which does not require reversing when the direction of the car is changed is found more satisfactory, especially for high-speed operation, than the trolley wheel. Its wearing surface lasts longer than trolley

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wheels operating lighter cars on direct current. Transformer sub-stations supply current satisfactorily without feeders on the trolley-wire side, and without station attendants. The car equipments show simplicity and effectiveness in the control apparatus. Less than half the controller notches required for direct current give equally smooth and as rapid acceleration with alternating current. Platform controllers are simpler, as no magnetic blow-out is required. Difficulties have been met with in the operation of this system. A weak point developed in the armature insulation when the cars had been running for some time. The remedy was obviously the strengthening of the insulation. This brings out the interesting fact that operation on alternating current at 3,300 volts with an intervening transformer is less severe upon the motor than operation on direct current at 500 volts. Experience has shown wherein the control apparatus suitable for both alternating and direct current could be simplified. A company which has been operating two substantially similar suburban lines, one by single-phase current and the other by direct current, could throw out the direct current and substitute single-phase alternating current.

London Traffic Commission.—Our readers are already familiar with the general conclusions arrived at by the Commission, but the report of the Advisory Board of Engineers to the Commission will be of special interest. The volume is a somewhat bulky one, being liberally supplemented by plans and appendices, so in the present note we will review some of the Board's observations contained in the preliminary chapter. Attention is directed to the great number of highway authorities in Greater London, the total being something over 100, and besides this the boundaries appear to be fixed in an irregular manner. The Board emphasise the prejudicial effects of this anomalous state of affairs upon any comprehensive proposal, and point out that in other cities where somewhat similar conditions have existed they have been met either by centralising the component local government, or by realising that street and traffic questions are matters of common interest to the whole community, and by placing such matters in the hands of a single body. The Continental capitals and New York have not hesitated to put themselves to great expense in order to bring themselves up to modern standards and requirements, and Paris, during the latter half of the nineteenth century, constructed a system of new boulevards and avenues, and has lately made a complete underground railway, leased on a profit-sharing plan to a private company. New York and Boston have laid out new streets and widened old ones, and have also assisted private enterprise by placing municipal credit behind extensive railway projects. This policy has in every instance proved successful, either directly or indirectly. The total sum expended out of the county rate and local rates towards new streets and improvements within the administrative county of London during the past 48 years amounted to £18,879,573, whilst in Paris, during a similar period, the sum total expended upon extensions and improvements amounted to £24,772,034. The Commission do not disguise the fact that the proposed improvements will involve a large increase in expenditure, but they are of the opinion that the authorities should take up the matter boldly, and appoint a central body to carry out the improvements outlined in the original report.

Dynamo Iron Loss Increment.—In the *Electrical World* of New York Mr. A. Press discusses the additional iron loss that is generally conceded to occur when a dynamo takes on load. The cause of this iron loss is generally assumed to be due to the flux distortion, in virtue of the armature conductors carrying current setting up a cross flux which compounds with the flux entering from the magnet frame. The author investigates the phenomena of superimposition of such fluxes mathematically, and ascertains the result to be that the eddy-current loss on open circuit of the armature is ordinary no-load loss, and to this should be added the eddy-current loss calculated on the assumption that only the cross flux exists, to give the total iron loss on full load. Comparing the empirical formula devised by the author himself with that used by one of the largest European concerns, it is found that there is quite a substantial agreement in the character of the formulæ. Whereas the one can be reduced to

$$\text{Incremental loss} = D\left(\frac{W}{p\,F}\right)^2$$

the theoretical formula is

$$\text{Incremental loss} = \frac{l\,\lambda}{r\,\delta^2} \cdot D\left(\frac{W}{p\,F}\right)^2.$$

The loss is in watts, and f is the pole-pitch factor—*i.e.*, ratio of pole-shoe span to the pole-pitch; r is the tooth-pitch ratio—*i.e.*, the ratio of the tooth width to the tooth width plus the slot width; W is the output in watts; p is the number of poles; F is the flux per pole in C.G.S. lines; δ is the depth of the air-gap in centimetres; λ is the depth of slot and l is the length of core. Checking in this way five machines, the following results are obtained:

Size of machine.	Empirically derived loss. / Theoretically derived loss.
60 kw.	1·64
125 ,,	2·2
250 ,,	2·43
500 ,,	2·65
1,000 ,,	3·32

It is to be noted that the experiments were conducted with a machine of about 50 kw. capacity. It was well understood that the above empirical formula was not entirely satisfactory. It gave much too large values for machines of considerable output.

Electricity Supply.—The electricity department of the Fulham Borough Council, which last year converted a deficit of £2,569 into a net profit of £1,029, evidently intends to improve upon this result, judging by a well-illustrated circular just received from Mr. A. J. Fuller, the electrical engineer. The Council has considerably reduced its charges, which now stands at 3½d. per unit, with a graduated discount, meters being supplied gratuitously. In addition to its economic advantages, the opinion of the Phœnix Insurance Company is quoted in regard to the safety of electricity, while an extract from the *Lancet* is given in proof of its hygienic qualities. Mr. Fuller does not omit to impress upon shopkeepers its great superiority over other illuminants for the purpose of display, as there are no flames to set fire to flammable materials or soot to discolour them. We are glad to see that consumers are enjoined not only to purchase standard lamps, but, when the blackening becomes bad, to promptly renew them. As the life of a lamp is a matter which, though simple enough, the average consumer does not appear to comprehend very well, Mr. Fuller wisely offers to send assistants to advise consumers as to the state of their lamps, or to test free of charge any lamps brought to the electricity works. Having recently tested various types of small arc lamps with eminently satisfactory results, Mr. Fuller is prepared to give advice on this special branch of lighting. Several types of radiators are shown, and as the Council supplies power at 1d. per unit it is calculated that the cost per hour would be only about ½d. Illustrations are included to show the artistic effects that may be obtained with these radiators in drawing-rooms, libraries, etc. It is evident that the value of electrical energy for power purposes is meeting with increasing recognition from the

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manufacturers of the districts, as in two years the quantity of energy consumed for this purpose has increased more than eightfold. The circular points in this connection to the advantages of electric motors as requiring very little repair and small space, and as a much cheaper form of mechanism than the gas-engine. The department has a list of contractors who are willing to instal motors on the hire-purchase system. It may be mentioned that the National Boiler and General Insurance Company, Limited, insures electric motors at lower rates than gas-engines. Cogent reasons, supplemented by interesting illustrations and eloquent testimonials, are given why the electric motor should also find its way into printing rooms, tradesmen's machinery rooms, hairdressers' premises, and even into private houses. With the numerous advantages of electricity as stated, the Fulham Council should be in a fair way to increasing its volume of business.

Obituary.—We deeply regret to record the death of Mr. Alfred Morcom, the chairman of the well-known firm of Messrs. Belliss and Morcom, Limited, which took place at Edgbaston on Monday last. Mr. Morcom was but 57 years of age. He was born in the Isle of Man, but his parents were Cornish, and he was educated at the Tavistock Grammar School, Devonshire. From school he passed into Keyham as an engineering student at the Royal School of Naval Architecture, which is now merged in the Royal Naval College, Greenwich. A successful career with the Admiralty followed. He was appointed chief engineer at the Portsmouth Dockyard, where he had to do with transport and warship arrangements for the Egyptian expedition and bombardment of Alexandria. Then he was sent in the same capacity to the dockyard at Sheerness, where he rendered conspicuous service to the Admiralty and the nation. It was during his official connection with the Government at Portsmouth and Sheerness that Mr. Morcom became interested in the work of Mr. G. E. Belliss, the founder of the well-known marine engineering firm in Ledsam-street, Birmingham. At that time Mr. Belliss was chiefly engaged in the construction of steam pinnaces and launches for the navy, and after remaining at Sheerness five or six years, Mr. Morcom, in 1884, decided to leave the Government service and join Mr. Belliss in partnership. From that time the business of the firm of Belliss and Morcom was largely developed. Under Mr. Morcom's supervision the machinery for torpedoes as well as for torpedo boats and torpedo-boat destroyers was added, and in 1890 practically a new industry was commenced, consisting of the manufacture of high-speed engines for electric generating purposes. The Belliss engine was perfected for this purpose, and now holds the premier position of its class. Electrical engineers will remember with interest the keen fight between the forced system of lubrication adopted for this engine and the splash lubrication as used on many of its rivals. Commercial experience has proved that Mr. Morcom was right in his choice of forced lubrication. The firm in 1893 was converted into a private company, Mr. Belliss becoming the chairman and Mr. Morcom the managing director. Then in 1904, when Mr. Belliss retired from the activities of a business life, Mr. Morcom succeeded him as the head of the concern. The success of the firm has been due to a gradually built up reputation for thoughtful and able design and perfect workmanship, and the credit of this achievement has been largely the result of the inventive energy and ability shown by Mr. Morcom in the management of the works and in the training of the staff. Mr. Morcom was a member of the Institutions of Naval Architects, Civil Engineers, and Mechanical Engineers, and he was also a member of the council of the Birmingham University.

Electrical Manufacturers' Association. — On Monday last a meeting of the National Electrical Manufacturers' Association was held at the Olympia, to which a number of manufacturers who have not yet joined the association were invited. The chair was taken by Mr. Walter Davenport. He explained that it was the first meeting since the association had been incorporated. After referring to the general objects of the association, he said that as the membership extended they would divide into special sections, which would each deal with special branches of the industry. Amongst the business considered was that of provincial exhibitions. It was decided that members of the association should not send goods to such exhibitions unless the supply undertakers organising the same paid carriage on the goods both ways and were responsible for any damage done. It was stated that the Exeter Corporation had agreed to organise its forthcoming exhibition on these lines, which would save manufacturers very large expense. The question of railway rates was also discussed, and a committee appointed to secure more equal treatment in the transit of goods between various manufacturing centres in the United Kingdom. The meeting decided to appoint an expert insurance broker, whose services would be at the disposition of the members with a view reducing insurance premiums. There would be no charge for such advice. The success of the circulars issued by the association declining to contribute to "beanfeasts" led to a suggestion that Christmas boxes might be treated in a similar way. A considerable discussion revealed great want of unanimity on this point. Christmas boxes were termed "blackmail" by one speaker, and "friendly presents" by another. The views of the engineer who finds his hall occupied with nine turkeys, eleven boxes of cigars, and a liberal supply of whisky when he returns home on Dec. 24 were not communicated to the meeting. There is no doubt that the practice of giving extensive Christmas boxes should be curtailed. It was decided that the members of the association should not take stands in any exhibition organised by an outside authority. It seemed the opinion of the meeting that, in spite of the very great success of the present exhibition, three years at least should elapse before another one was held. In the evening a dinner was held at which the members of the association met a few special guests. The toast list was commendably short, and included, besides the loyal toasts, the following: "Success to the Association," proposed by Mr. J. E. Edgcome and responded to by Mr. C. S Northcote; "Success to the Exhibition," proposed by Mr. David Smith and responded to by Mr. Albion T. Snell and Mr. Russell, joint consulting engineers for the exhibition. In reply to this toast, Mr. Snell said that 21,000 persons passed the turnstiles on Saturday last, which was a record for exhibitions at Olympia. The toast of "The Chairman" was proposed by Mr. E. Cuncliffe Owen, and Mr. Walter Davenport's reply terminated an enjoyable function.

Technology of the Law.—The leading American electrical companies make liberal provision for a patents fund, and the number of judgments delivered in the United States courts which reach this office from time to time explain how a goodly portion of this fund becomes transferred from the debit side of the company's books to the credit side of their lawyers' ledger. The latest of these judgments to arrive is that in which the American Thomson-Houston Electric Company sought an injunction against the Salem Electric Company to restrain them from infringing the plaintiffs' series and multiple distribution system. After the usual lengthy formalities, the case came on for trial, and resulted substantially in a victory for the plaintiffs. It is tolerably certain that while there is a

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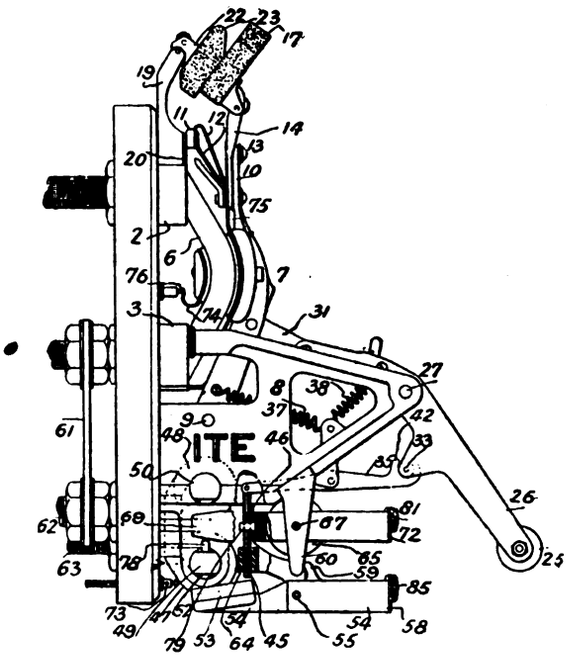
patent system there will be patent litigation, but the multiplicity of lawsuits suggests that something leaves a great deal to be desired—a remark which applies to both sides of the Atlantic. Does the fault rest with the Legislature, which enacts the laws; the Patent Office, which administers them; the judicial Bench, which interprets them—or whom? Speaking for this country, the patent system, by general consent, has hitherto been far from perfect, but it is considered to have been materially improved by the regulations which came into operation this year by virtue of the Act of 1902. Of the Patent Office it may be said that the majority of the officials, of all grades, discharge their functions with reasonable care, and occasionally with ultra-carefulness. Are we then to infer that much of the blame for litigation is to be laid at the door of the Bench? Assuredly not. Our judges weigh the facts with much care, but, despite their traditional omniscience, they cannot be expected to be technical experts as a matter of course, and consequently their decisions may lack lucidity. It will be remembered that when discussing this subject on previous occasions we suggested that either counsel with technical qualifications should be appointed especially for such cases, or, if at any time no such members of the Bar were available, that the judges should have the assistance of experts, much as the Admiralty Court is aided by nautical assessors. Certainly, such cases as that which occurred the other day at the Shoreditch County Court, where the Brockie-Pell Arc Lamp Company brought an action to recover £7. 5s. for repairs, are rather difficult to deal with. Judge Smyly, while remarking that the charge seemed to him, as a layman, to be decidedly excessive, frankly declared his incompetence to give a legal decision on the point, and stated that it would be necessary to call an expert. Plaintiffs' counsel strongly deprecated this, on the ground that the amount in dispute did not warrant such expense, and in this case the matter was compromised. It would clearly be impracticable to appoint special technical judges to county courts, and, as in the instance just quoted, the amounts involved do not justify the services of an expert; but these cases concern relatively small issues. For the larger questions, however, the need of some revision in the present mode of procedure is obvious, and we trust that ere long it will come in for serious attention.

Automatic Cut-Outs.—A patent has been granted in this country to Mr. Wm. Scott, of Philadelphia, U.S.A., for a form of automatic cut-out, which is described in the *Official Patents Journal*. In the accompanying illustration the terminals, 2, 3, of the circuit are adapted to be connected by an insulated laminated bridge, 6, carried by an arm, 7, pivoted at 9 to the frame, 8. An extension, 10, of the arm, 7, carries springs, 12, supporting a movable metallic contact, 11, and limited in their movement by a stop, 13. The contact, 11, engages a plate, 20, carried by brackets, 19, on the terminal, 2. A carbon contact, 23, carried in a bracket, 22, pivoted to the brackets 19 is engaged by a carbon block, 17, similarly pivoted in an arm, 14, secured to, but insulated from, the extension, 10. The arm, 7, is operated through a link, 31, from a lever, 26, pivoted at 27 to the frame, 8, and fitted with a handle, 25. The switch is held shut against the pressure of springs, 37, 38, by a hooked lever, 35, pivoted to the frame, 8, and engaging a roller, 33, on the lever 26. When the lever 35 is turned in a clockwise direction, its hooked end, 32, is released, and an inclined lug, 42, formed on it engages the roller, 33, and forces the switch open. The lever 35 is operated by a pin, 45, pivoted to the end of the lever, sliding in a fixed guide, 64, and fitted with a cross-pin, 46. On the occurrence of an overload, the pin, 45, is operated, so as to trip the catch, 32, by armatures, 53, of an electromagnet, 47, connected in parallel with a similar electromagnet, 48, between a terminal, 62, connected by a bar, 61, to the terminal 3 and a terminal, 63, connected through translating devices to the bus bars, etc. Flattened portions, 52, are formed at each end of the core, 49, of the magnet, 47, opposite to the armatures. The armatures are carried by bars, 54, pivoted to the frame at 55 and connected at their other ends, which are unequal in length, by a slotted bar, 58, in which is secured adjustably a weight, 85. By adjusting the weight, 85, according to the scale on the bar, 58, the



operating potential of the cut-out is varied. A lug, 59, on one of the bars, 54, engages a fixed stop, 60, and limits the outward motion of the armatures. Poles, 69, formed on bars pivoted at 67 and connected together by a weighted bar, 72, resembling the bar 58, and arranged between the cores, 49, 50. They are connected by the core of an electromagnet, 65, which is such that the polarisation of the parts, 69, is always opposite to the normal polarisation of the core 49, so that normally the poles, 69, are resting against brass pins, 78, secured to the core 49. On a reversal of current the polarisation of the cores 49, 50 is reversed, and the poles, 69, are attracted towards flattened portions of the core 50, so that an eye, 79, formed on a tie-bar between the bars, 68, and encircling the pin, 45, engages the cross-pin, 46, and trips the catch, 32. The weight, 81, is normally adjusted so as to balance the poles, 69. The armature, 53, may be normally held attracted by the electromagnet, 47, so as to be released and trip the circuit breaker on an underload. The coil 65 is usually of high resistance, and comprises a large number of turns of fine wire. One end of the coil is connected through a binding post, 73, to one bus bar, the other being connected to a fixed contact, 76, adapted to engage an insulated contact, 74, carried by the bridge, 6, and connected by a conductor, 75, to the part 14. The coil 65 is usually in shunt across the main circuit (the coils 47, 48 being in series), but it may be energised from a separate source, or from the secondary circuit of a transformer the primary of which is energised from the circuit to be controlled. The coils 47, 48 may be in series instead of in parallel; or the coils 47, 48 may be in shunt and the coil 65 in series. When used for alternating currents, the electromagnet cores are preferably laminated, and the core of the electromagnet, 65, is enclosed in a brass, copper, or other tube so as to operate like the short-circuited winding of a transformer, to reduce impedance.

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THE HASTINGS ELECTRIC TRAMWAYS.

(Concluded from page 516.)

The sub-stations are fed from the main station by Callender's three-core extra high-tension lead-covered cables. At the Silverhill sub-station (Fig. 4) there are three Dick-Kerr standard 200-kw. compound-wound rotary converters, running at 750 r.p.m. and generating direct current at 500 to 550 volts. Each rotary has its complement of three single-phase, oil-cooled, step-down transformers. The rotaries are capable of dealing with an overload of 25 per cent. for one hour. The Bulverhythe sub-station is similar to the one at Silverhill, and is equipped with a similar number of rotaries with the necessary transformers and switchgear. Each rotary has three 70-kw. single-phase oil-cooled transformers, designed and constructed by Dick, Kerr, and Co. The transformers, which are mesh connected, transform current from 6,600 to 340 volts; they are contained in ribbed cast-iron tanks. The secondary coils are insulated from the iron by mica insulation and oil-proof material, the high-tension coils, outside the secondary coils, being insulated in the same manner, special circulating ducts being provided for free circulation of the oil between the iron and secondary and secondary and primary, in order that the core and winding may be thoroughly cooled. The cores and yokes

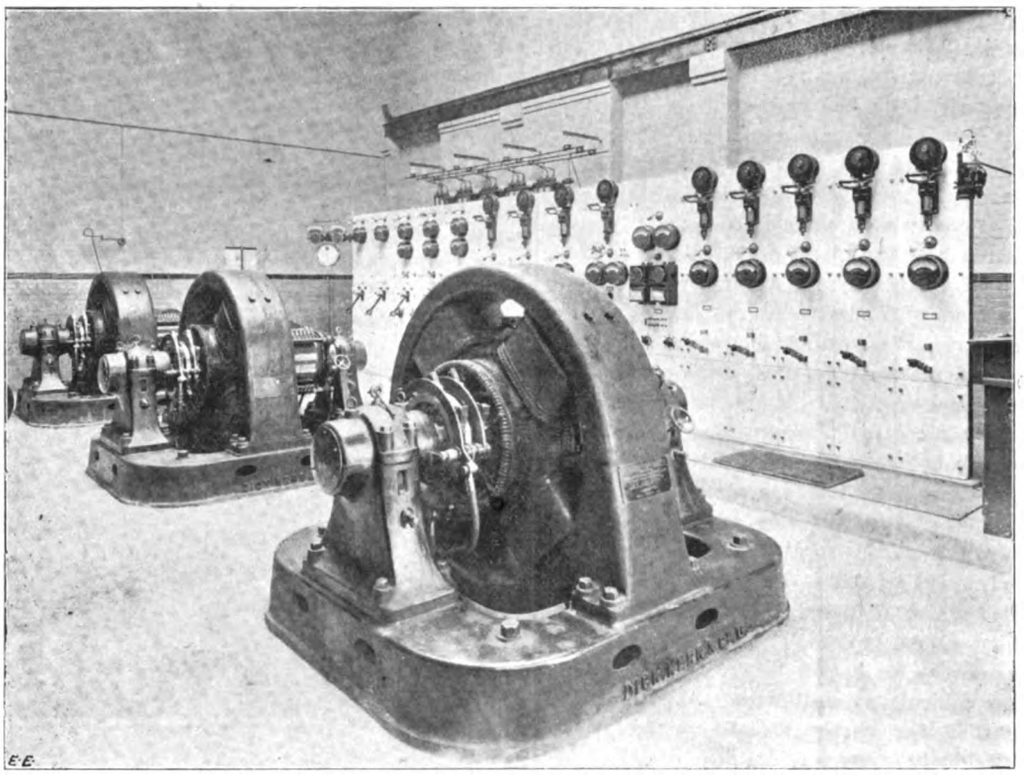

FIG. 4.—The Silverhill Sub-Station Equipment, with Three 200-kw. Dick-Kerr Rotaries.

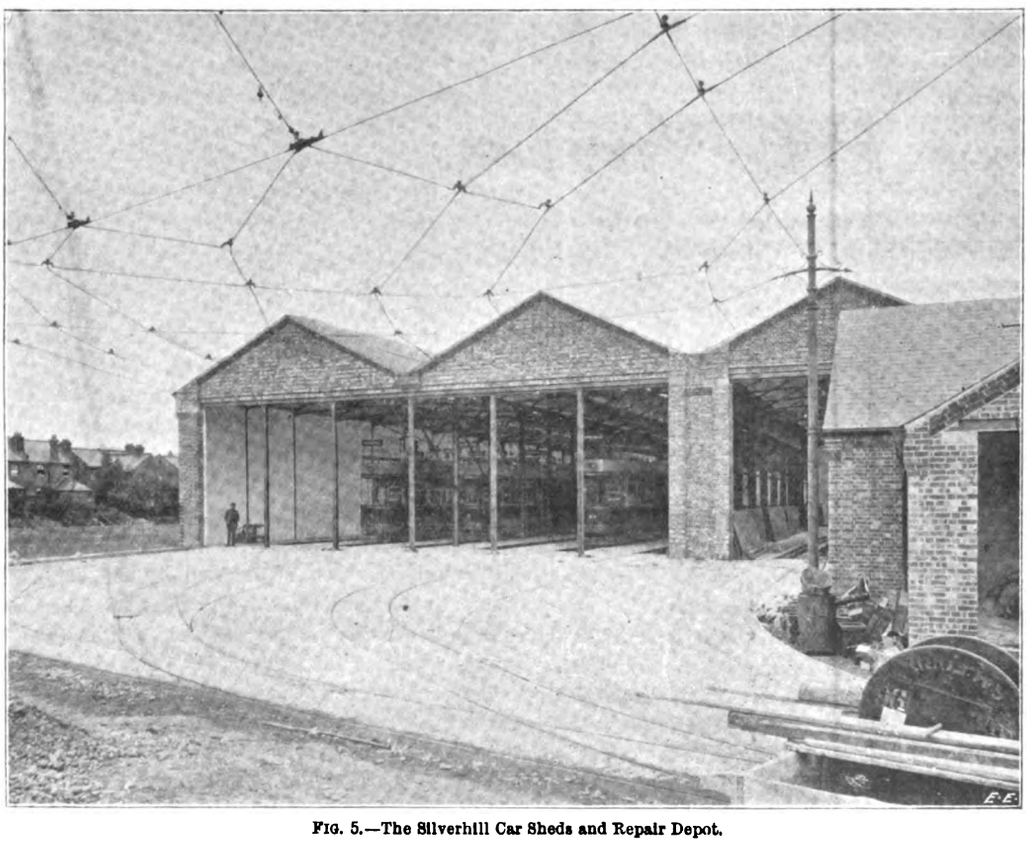

FIG. 5.—The Silverhill Car Sheds and Repair Depot.

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of the transformers are built up of annealed iron plates of special quality and high permeability, and of minimum hysteresis loss, the plates being insulated from one another by special varnish. The laminations used are free from ageing or increase in hysteresis loss. For mechanical reasons the cores and yokes are securely clamped together in order to reduce the magnetic resistance.

Two car-sheds have been constructed, the principal depôt being situated at Silverhill (Fig. 5), which has six tracks, and is capable of accommodating 36 cars; the other car-shed is in course of construction at Bulverhythe. A well-equipped repair shop has been provided in the former depôt.

The rolling-stock, of which there are already 30 cars in use and 10 more almost ready for delivery, are of the double-deck, single-truck (non-reversed), staircase type (Fig 6), with a seating capacity of 20 inside and 22 outside. They are built in accordance with the most up-to-date designs, and have all the latest improvements in the way of ventilation and finish. The car bodies were built for Dick, Kerr, and Co. by the United Electric Car Company, of Preston. The cars are fitted with lifeguards of the Tidswell pattern and the Waller folding steps. They are mounted on Brill 21-E type trucks, and fitted with a complete standard equipment, consisting of two 6A type traction motors. The controllers are of the D.B.1 form

FIG. 6.—A Steep Grade in Mount Pleasant Road.

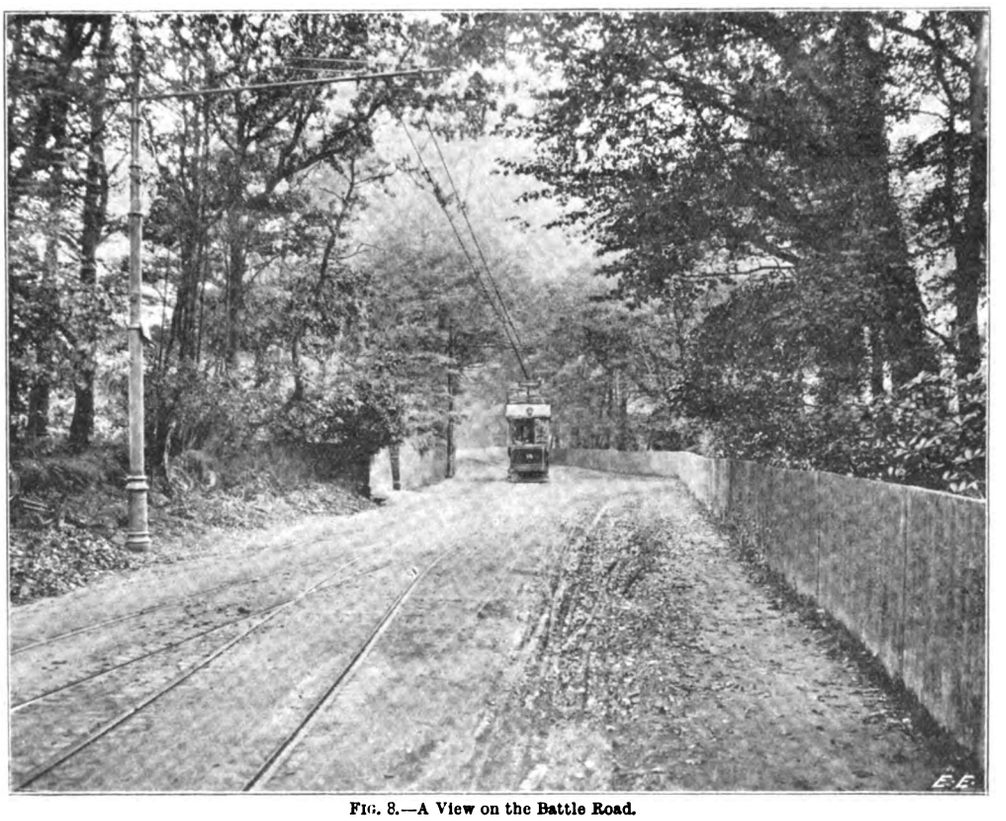

FIG. 8.—A View on the Battle Road.

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E type, with the patent metallic shield blow-out. Each controller is provided with a "run-back preventer," which makes it absolutely impossible for the car to run away down hill; the movement of the handle to the "off" position short-circuits the motors, in consequence of which there could be only a slow reverse movement of the car. This provision is a most valuable one in view of the heavy grades on the Hastings system.

As shown in the map (Fig. 7), the total length of tramways now in operation is approximately 16 miles of single track, laid to a gauge of 3ft. 6in. The form of track construction mostly used is macadam with granite setts serration, the rails and setts being laid on a 6in. bed of 6 to 1 Portland cement concrete. In cases, however, where traffic is heavy the roadway between the rails and for an average space of 18in. on either side, both double and single track is paved with granite setts 5in. deep and 4in. wide. On part of the route near the centre of the town wood paving throughout has been adopted. In all such cases a 6in. bed of Portland cement concrete extends for the full width of the tramway. The portion across country along the new roadway is of the tramroad sleeper construction, ballasted to rail level. The rails are of the girder type, weighing 90lb. per yard, and are laid in 45ft. lengths, with the customary proportion of shorter lengths to allow for closures. The rails are generally in accordance with standard tramway practice, 6in. deep, with a groove of $1\frac{1}{8}$in. width; ordinary butt joints are used with six-hole fishplates secured by bolts, each joint being fortified by a 24in. length of rail bolted on the under side and embedded in concrete, Neptune copper bonds being used for bonding throughout.

The construction of the overhead lines is carried out generally on the side-pole system (Fig. 8), with bracket arms and flexible suspensions. The poles, which have an over-all length of 31ft., are made up in three sections of lap-welded mild steel, and are erected about 40 yards apart in holes of a depth of 6ft., the excavations being entirely filled in with concrete. The trolley wire is of hard-drawn copper, 4/0 S.W.G., having a diameter of ·400in., with a breaking strain of 22 tons per square inch. Section insulators are provided so that each half-mile of trolley can be disconnected if necessary. The extra high-tension feeders are composed of three-core, paper-insulated, lead-covered, and armoured with steel wire, each cable being laid in a separate trough and run in solid with bitumen. The low-tension cables are insulated with vulcanised bitumen, and are also laid solid in troughs. The whole of the feeder cables, both high-tension and low-tension, were supplied by Messrs. Callender's.

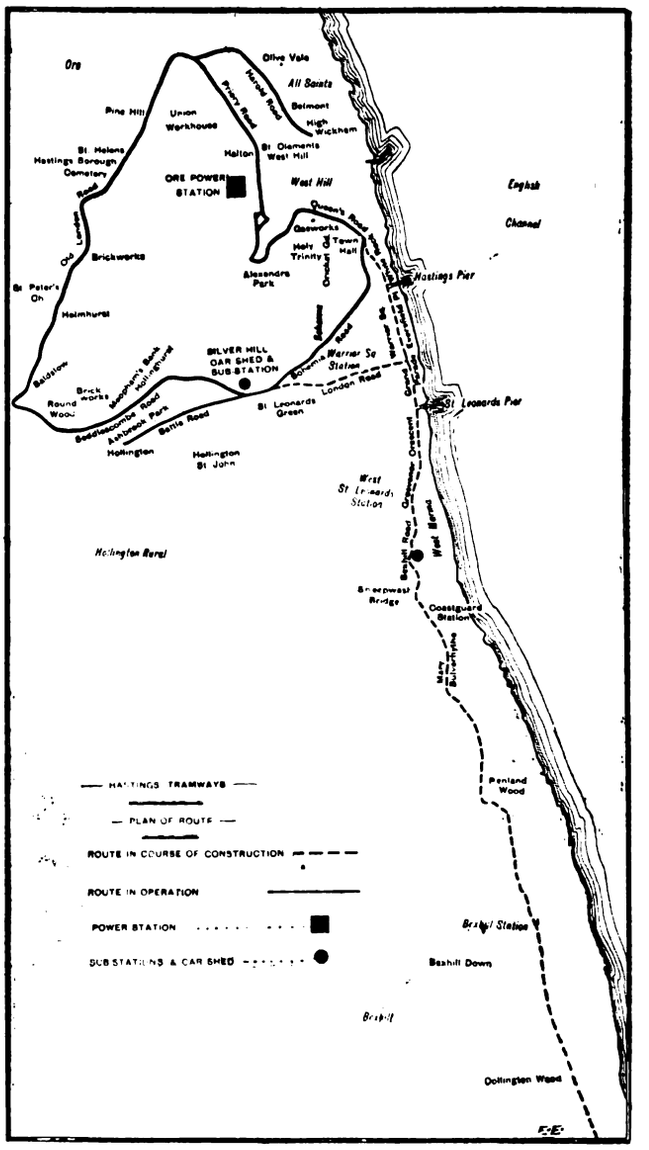

FIG. 7.—Map of the Hastings Tramway System.

The map (Fig. 7) shows the country the complete system will cover. Thus the scheme embraces two main routes: (1) a circular route through Baldslow and Ore, with branches to Hollington and the old town of Hastings respectively; and (2) a line along the front through

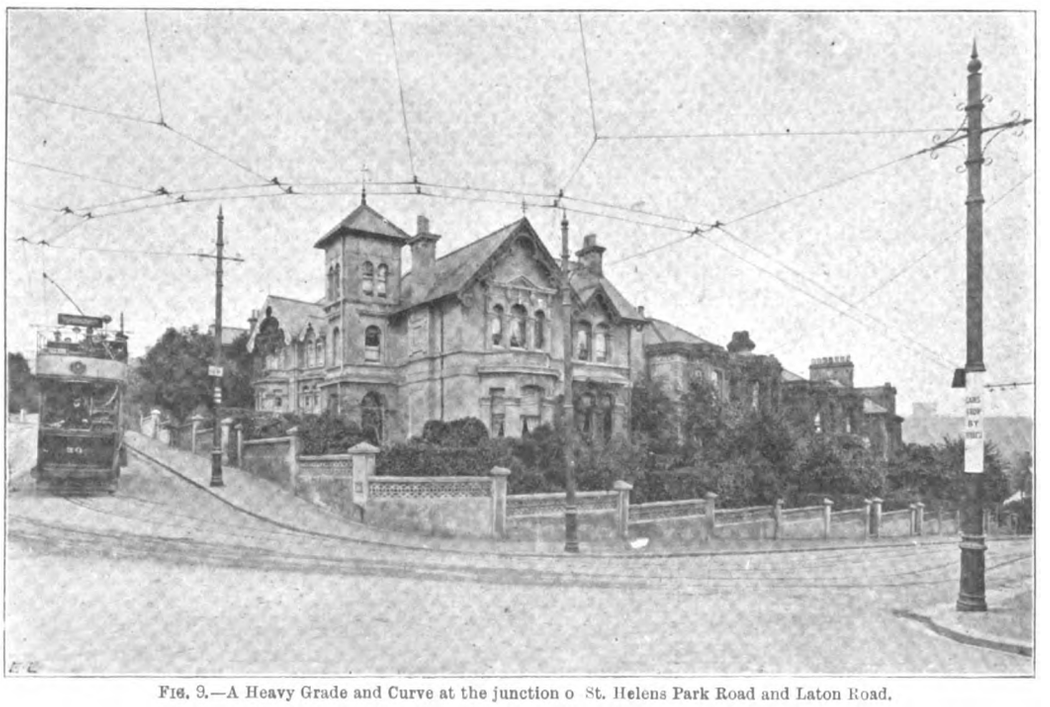

FIG. 9.—A Heavy Grade and Curve at the junction o St. Helens Park Road and Laton Road.

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St. Leonards to Bexhill. The first route is now in operation, but some little time will elapse before the line is completed to Bexhill, although the permanent way beyond St. Leonards is now in course of construction, and a considerable length has been completed. The main portion of the system is of the usual tramway construction, but on a section of the route towards Bexhill the line leaves the main road and crosses through fields by means of a new road, 30ft. in width and about five furlongs long, constructed by the company. When complete the system will be some 30 miles in extent. It should serve the needs of a large permanent population, and will be much appreciated by the numerous visitors to Hastings and Bexhill.

As mentioned last week, the contractors for the whole of the work have been Dick, Kerr, and Co., Limited, the consulting engineers for the scheme being Messrs. Kincaid, Waller, Manville, and Dawson.

THE LANCASHIRE ELECTRIC POWER COMPANY.

(Concluded from page 513.)

The floor of the turbine-house—like the firing floor of the boiler-house—is 9ft. above the foundation slab; on this basement are the foundation columns for the turbines and exciters, also the pumps for raising the circulating water from the river. The latter are direct motor-driven centrifugals, and each capable of delivering 160,000 gallons against 28ft. head, the inlets being separate and the outflow common. The end of the outflow is under water, so that air cannot get back and spoil the syphonic action. The oil-pumps for the system are also in the basement; these pump to a reservoir at the top of the building, the oil flowing by gravity to the various bearings. The pumps are driven by a rod actuated by the hydraulic pumps on the floor above.

The main cables from the generators and all the other cables are fixed to the ceiling of the basement, being thus in sight and at the same time in a safe and convenient position. They are brought through the wall into the switch-rooms. These are in three storeys — one on the basement level, one on the engine floor, and the third on the operating gallery above. In the basement are the potential transformers for reducing the pressure from the generating voltage to that suitable for operating the voltmeters. These transformers are each partitioned off in brick chambers.

On the floor above are the first main switches. The current is led from the generators to these switches, which are of the B.T.H. standard motor operated type, each in its own compartment, and consisting of a plunger with three limbs, one for each phase. The current is brought to a contact in the bottom of a tube, on the top of which is an insulator through which a plunger passes—the tube is filled with oil, so that when the contact is broken the arc is extinguished by the oil. The plungers are connected to wooden rods passing through to the operating mechanism, which consists of a small motor and a system of strong springs. This motor is connected by a magnetic clutch to the levers, and on being started releases one spring, closes or opens the switch, and compresses the spring in the opposite direction. The current now passes to the 'bus bars. These are in the centre of the same chamber, and are of bare copper supported on insulators enclosed in brickwork with suitable holes for inspection. They are in two sections, each section taking two machines. From the 'bus bars the current passes to the floor above to other oil switches, which connect the feeder circuits on to the bars. Each circuit has two mains, and one of each of the mains is connected to the various bars so as to give additional safety. From these circuit switches the mains pass out through the walls on to the overhead construction. Before leaving the building they are connected to a device for preventing undue rises of pressure, which consists of a series of metal discs placed in a row, with carbon resistances in series, and the end connected to earth. In the event of an undue rise of pressure the electricity jumps across the gaps and goes to earth, the carbon resistances causing enough obstruction to prevent an arc being maintained.

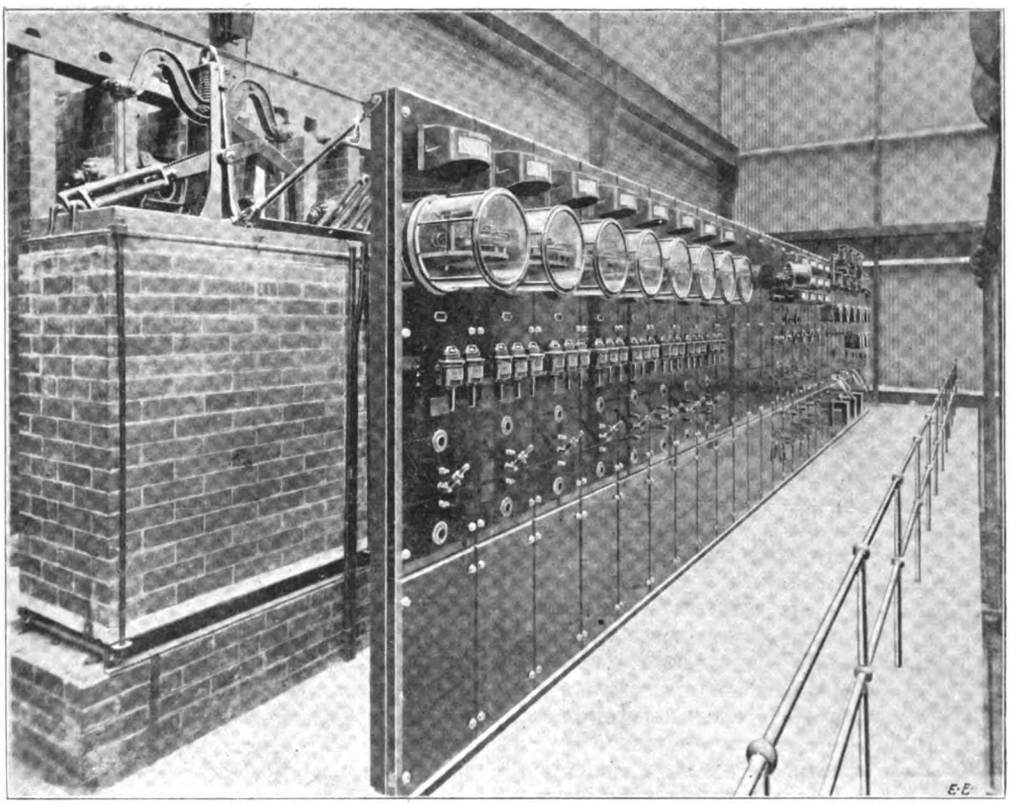

FIG. 8.—Radcliffe Power Station—Main Switchboard.

The control for the oil switch motors, and, in fact, all the controlling apparatus in the station, is mounted on the operating board (Fig. 8), low-tension current from the exciter circuits being used to drive the switch motors. Current from the current transformers operates the ammeters and automatic cut-outs, while the voltmeters are operated from the special potential transformers before described. Thus no high pressure is brought near the operating board, no heavy current and no big switches are there, and so the handling is extremely simple, one man being able to easily deal with the whole plant. The arrangement also is very safe, for there are no large powers

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to cause electrical fires, and even in the case of some small mishap, the main cables, being nowhere near, cannot be affected, and the supply in consequence is not interfered with. All the current from the exciter sets is brought up to a low-tension board at the end of the operating gallery and distributed from there.

Fig. 9 illustrates diagrammatically the general arrangement of the turbine-house plant and connections between it and the switchboards. We have cut out two of the main turbo sets to save space and gain clearness.

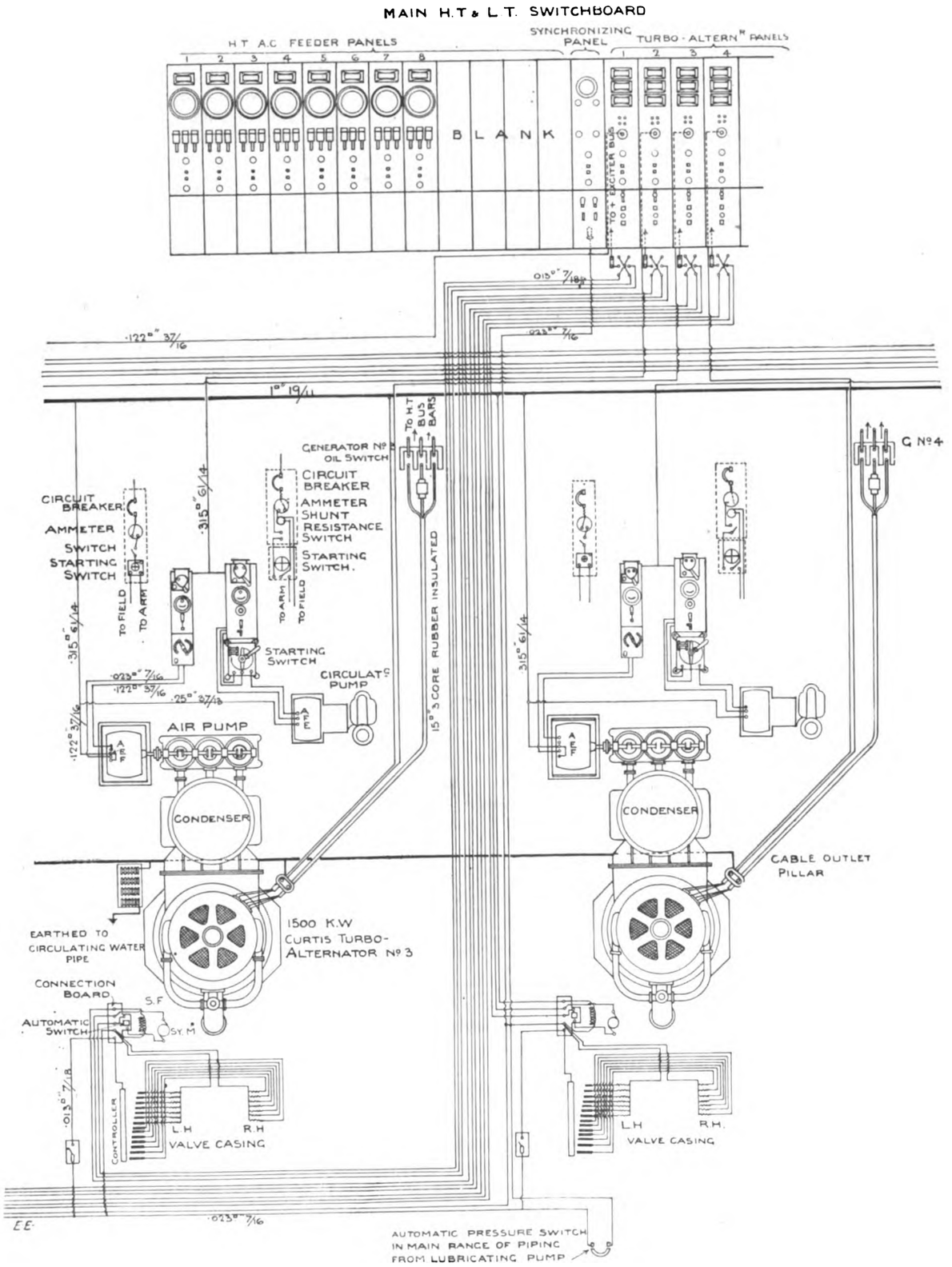

FIG. 9.—Radcliffe Power Station—Diagram showing the Connections between the Turbine House Plant and Switchboards.

There are, as will have been gathered, several interesting features about the design of this power station. It is laid out on the unit principle. One bank of three boilers with one chimney and auxiliary plant feed two turbine sets, which feed one section of the 'bus bars; these comprise one complete unit, and each unit can be worked quite independently of the other. When extensions are added this will be quite simple, as it will only mean adding one or two more units. The only difference will be that, instead of two small turbine sets to the unit, one large one will be installed. Economisers have been discarded, and the auxilary engines are run non-condensing, the exhaust being passed through feed heaters for raising the temperature of the boiler feed. This plan makes for simplicity, does away with the oil trouble, and saves first cost at the expense of a little—and only a very little—coal. The arrangement of the boilers enables the minimum possible of steam main to be used. Vertical turbines permit of an exceedingly compact engine-room. The whole arrangement is so simple that a shift of six or seven men can look after the entire plant of some 10,000 h.p.

The work of erecting the turbine-house plant has been superintended for the British Thomson-Houston Company

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by Mr. W. Kingsford, and from start to finish there has been no hitch—a fact which greatly redounds to the credit of all concerned.

Now with regard to the outside work. The mains, as previously mentioned, leave the station overhead, and are partly underground and partly overhead, as may be most suitable. They are arranged in duplicate on all routes, each being designed to carry 1,500 kw. at 10,000 volts.

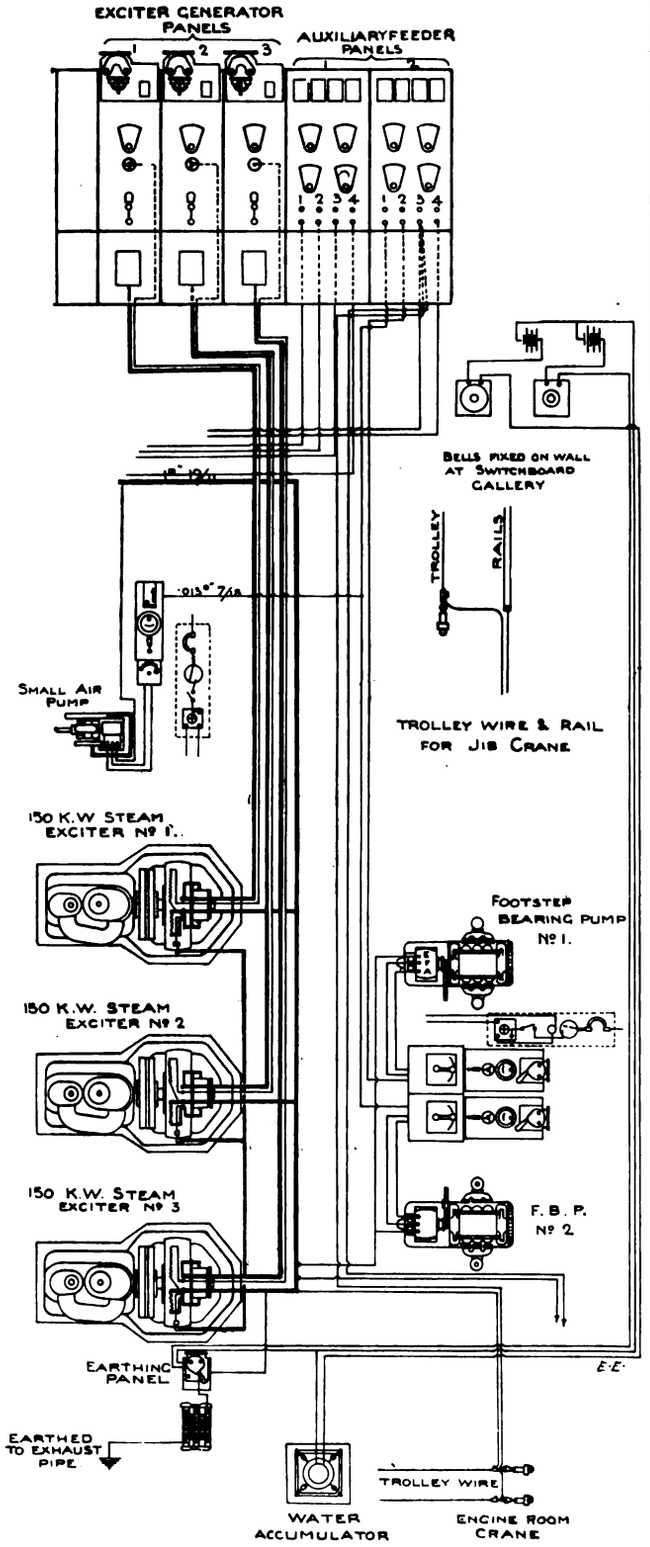

FIG. 9.

The aerial construction is distinguished by its simplicity, consisting of wooden masts carrying cross-arms, which in turn carry the mains. The latter are of bare copper wire supported on double porcelain insulators completely glazed, and the three wires, corresponding to the like number of phases, for each main are arranged in pyramid fashion, one set on either side of the supporting masts. Details of the method of connecting these wires with the underground cables must be held over till a later date. The underground cables are three-core, paper-insulated, lead-covered, wire-armoured, laid solid in wooden troughing for the most part. But in some cases ½in. iron troughs with covers are used, notably over Ringley Bridge for the mains to Swinton sub-station. These troughs are further protected by bricks between and on either side, then a layer of earth, a ¼in. boiler plate, more earth, and finally the ordinary paving setts over all. No doubt ample mechanical protection is thus given to these extra high-tension mains. The whole of the cable work has been carried out by Callender's Cable and Construction Company, Limited, and it is due to this firm's representative on the spot—Mr. W. Pierce—to record the highly satisfactory manner. Not a single fault has developed, which is remarkable when the great care and vigilance necessitated by the nature of the work is considered.

As to the commercial prospects of the undertaking, it will be gathered from what follows that much has been already accomplished in the way of obtaining a load. Contracts are being entered into with the various local authorities for supply, either by the local authority putting down the distributing mains and taking a supply in bulk, or giving transfer of their provisional order to the company and the company seeing to the distribution work. The company also enter into contracts with the users of power, supplying them on behalf of the local authorities interested. Several contracts of great interest have been entered into, notably one with the Acme Mill, which has 75,000 spindles, both mule and ring. This mill is of entirely new construction. Indeed, it is not yet working, the equipment being still far from complete. The power requirements are naturally very extensive. Two 10,000-volt, three-core, paper-insulated mains are led into a dividing box, whence bare conductors pass isolating switches to the high-tension sectionalised 'bus bars, and thence through oil switches to four transformers, each having a capacity of 300 kw. These transformers are of the B.T.H. type arranged for air-blast cooling. On the corresponding switch panels are mounted switches provided with an automatic tripping device. From the low-tension 'bus bars the current is conveyed to a switchboard placed in a separate room on the floor above, whence it is distributed to the various circuits. An indicating watt-meter is provided for each motor circuit, and the switchboard is further fitted with tripping switches of similar design to those on the transformer panels. High-speed lines of main shafting are fitted throughout the mill, the motors being direct coupled, their speeds varying between 585 r.p.m. and 565 r.p.m. This constitutes a feature of decided novelty, especially inasmuch as no floor space is occupied by the motors, all being fixed overhead. The motors are of the squirrel-cage type up to and including 75 h.p., while slip-ring machines are employed for higher outputs. They range in size from 5 h.p. to 200 h.p., and represent a total output of 1,200 h.p. The cables from the switchboard to these motors is three-cored, armoured throughout, and was fixed by Messrs. Eckersley and Co., Manchester. There is also a lighting installation, comprising 1,000 16-c.p. lamps or their equivalent. The wires to these lamps are run in screwed tubing all through, Messrs. E. M. Evans, Manchester, having carried out this part of the work. The motors are supplied with current at 400 volts, while a 230-volt supply is given for lighting. A 30 per cent. load factor is obtained, including the lighting of the whole mill.

It is interesting to compare the cost of the electrical power plant installed with that which would have been entailed in equipping the same mill for steam driving. This comparison shows that the millowners have effected a saving of, roughly, 10 per cent. on the total capital outlay, or, in other words, £10,000 on an expenditure of £100,000 for a mill containing 75,000 mixed spindles. This figure does not, of course, take into account the cost incurred by the power supply company. The same owners—*i.e.*, the Pendlebury Spinning Company—have a steam-driven mill of modern construction and the same size adjoining, so that electricity will be afforded a splendid chance of proving its superiority. A very considerable gain is anticipated in the output of the mill due to steady driving, and if any means can ensure that gain the Curtis turbine certainly will.

The Acme Mill is unique so far as Lancashire is

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concerned in that it has no chimney shaft, and for that reason we have reproduced the photograph herewith (Fig. 10). In another instance we saw preparations in progress for the application of electrical driving to flannelette making and other machinery, whereby beam engines of very ancient construction will be displaced. This is a comparatively small installation of 100 kw., but has interesting points, notably in connection with the sub-station. Naturally, this will be entered only by responsible persons connected with the power company, but provision is made whereby the transformer can be thrown over from one feeder to the duplicate main from outside should a fault develop in the supply. But the arrangement of the switchgear is such that while the load can be thrown in turn off the second feeder, it cannot be retransferred to the first without entering the sub-station. Thus every eventuality is provided for. It will have been gathered that the transforming from 10,000 volts to the supply voltage is accomplished at one step at the point of consumption, thereby ensuring maximum economy in transmission and distribution. We understand that the applications already made for a supply from the company's mains are sufficient to load half the generating

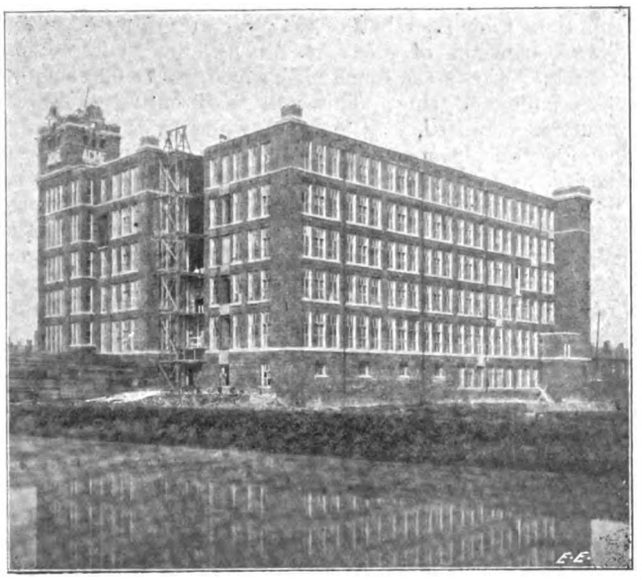

FIG. 10.—A Mill without a Chimney—The Acme, Pendlebury.

plant at present installed and pay all expenses on the capital outlay incurred. Of course the power house as it stands to-day is only the nucleus of what is to follow. It is intended that it will be increased to many times its present size in a very short time. Other power stations will be added in other districts as the necessity arises, each taking small coal from the surrounding collieries.

The consulting engineers are Messrs. Lacey, Sillar, and Leigh, and Mr. H. Parshall, while Mr. Robert Loraine Gamlen is the resident engineer and manager. It must be admitted that the commercial possibilities of electricity supply over wide areas with scattered centres of consumption are largely problematical, and that the solution of the problem calls for energy and abilities of no mean order, but we are convinced that Mr. Gamlen will attain success if it lies anywhere within the range of practical politics. The keenness which pervades the members of the staff under him is remarkable, and proves he has inspired them with some of his own enthusiasm. Moreover, due to his initiative, an association of the staffs of several power supply companies has been formed, the idea being to meet together, sometimes in one area and sometimes in another, to discuss questions of mutual concern This strikes us as being a particularly happy notion, since the interests involved are absolutely identical, and mutual assistance in overcoming the many difficulties which must necessarily arise in the process of development will be of immense value. Mr. Gamlen's grasp of the economics of electric power distribution is well illustrated by the paper which he recently communicated to the Institution of Mining Engineers in Manchester, and which was reported in our issue for Sept. 15 last.

In conclusion, we have to thank Mr. Gamlen for his courtesy in showing us round the Radcliffe power station and the sub-stations, etc., to which reference has been made; also for the photographs reproduced and most of the accompanying particulars.

RECENT PROGRESS IN ELECTRIC LIGHTING AS INDICATED BY THE OLYMPIA EXHIBITION.

BY FRANCIS H. DAVIES.

(Continued from page 484.)

INCANDESCENT LAMP MANUFACTURE.

The stall of the Ediswan Company—an illustration of part of which is given (Fig. 5)—is one of the most interesting in the exhibition, both from the up-to-date and the antiquarian point of view. Except for the actual operation of making the glass and blowing the globes, practically the whole process of lamp-making is carried out in the exhibition. The Ediswan Company claim to be the only British firm which manufacture their own glass, their works at Ponders End being equipped with the most modern appliances for this purpose. Several large furnaces, stoked by machinery, are kept going day and night, and here the raw material is melted down in large fireclay pots, being reduced to a white heat. The blowing process follows, taking place in the same rooms as the furnaces are situated. It consists of dipping into the molten material a long glass tube, upon the end of which a lump of fused glass adhers when it is withdrawn. By rapid motion through the air this lump is caused to assume an elongated shape, and when in this condition it is placed in a mould and blown, with the result that the globe takes exactly the right form. The bulbs are then broken off and sent to the sorting department, where they are subjected to a rigid scrutiny and faulty ones rejected.

As far as the glass goes, it is at this stage that operations are commenced at Olympia. The filament, likewise, is put through all the preliminary processes at the works, being delivered at the stand in unsorted bundles but ready carbonised. As is well known, it is made out of cotton wool, which, by chemical treatment, is converted into a cellulose thread. According to the approximate size of the filament required this cellulose is forced through nozzles of various sizes, falling into a spirit solution, where it hardens and attains something of the appearance of catgut. When this stage is completed the thread is thoroughly washed and wound on large drums, and it is now ready for the next process—namely, that of carbonising. For this purpose special plumbago formers are used, round which the thread is wound, taking the looped form of the finished filament. The whole is then baked in special furnaces for several hours, becoming thoroughly carbonised, hard, and, to a certain extent, elastic. Work on the filament at Olympia begins here, with the first girl on the right-hand side of the stall, who receives the filaments in bundles and separates them out into a filmy heap. The next girl takes them up one by one, and after carefully gauging their diameter in a micrometer places them in different heaps, according to the size of lamp they will be suited for. After this follows the important process of joining up to the leading-in wires, which consists of platinum where they pass through the glass and copper where they are joined to the contacts. A mechanical joint is first made, being completed by an electrical one effected in the following manner: A piece of paste of a special nature is smeared on the joint, and the filament is then placed in a holder, being clamped in such a way that the joint forms part of an electrical circuit. The girl who performs this operation then drops the whole into a tank containing benzine, and by means of an adjustable resistance passes just sufficient current through the joint as to make it incandescent in the liquid. This results in a deposit of pure carbon on the joints, which are now finished.

Flashing is the next step, and the filament is placed in a bell jar filled with a hydro-carbon gas and incandesced, this process being continued until it is ascertained that the correct resistance has been arrived at. It is now ready for sealing in, a process which is conducted on the tube seal

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principle—that is, the filament is first sealed into a small glass, which is then melted into the neck of the bulb. The exhaustion of the lamp follows, this being effected by ordinary mechanical pumps and finished by special pumps with pistons working in oil and giving a very high degree of vacuum. Tests of candle-power, electrical pressure, and current consumption are now made, and such lamps as do not come up to the standard are rejected, the remainder being passed on to the capping department, where the lamp is completed.

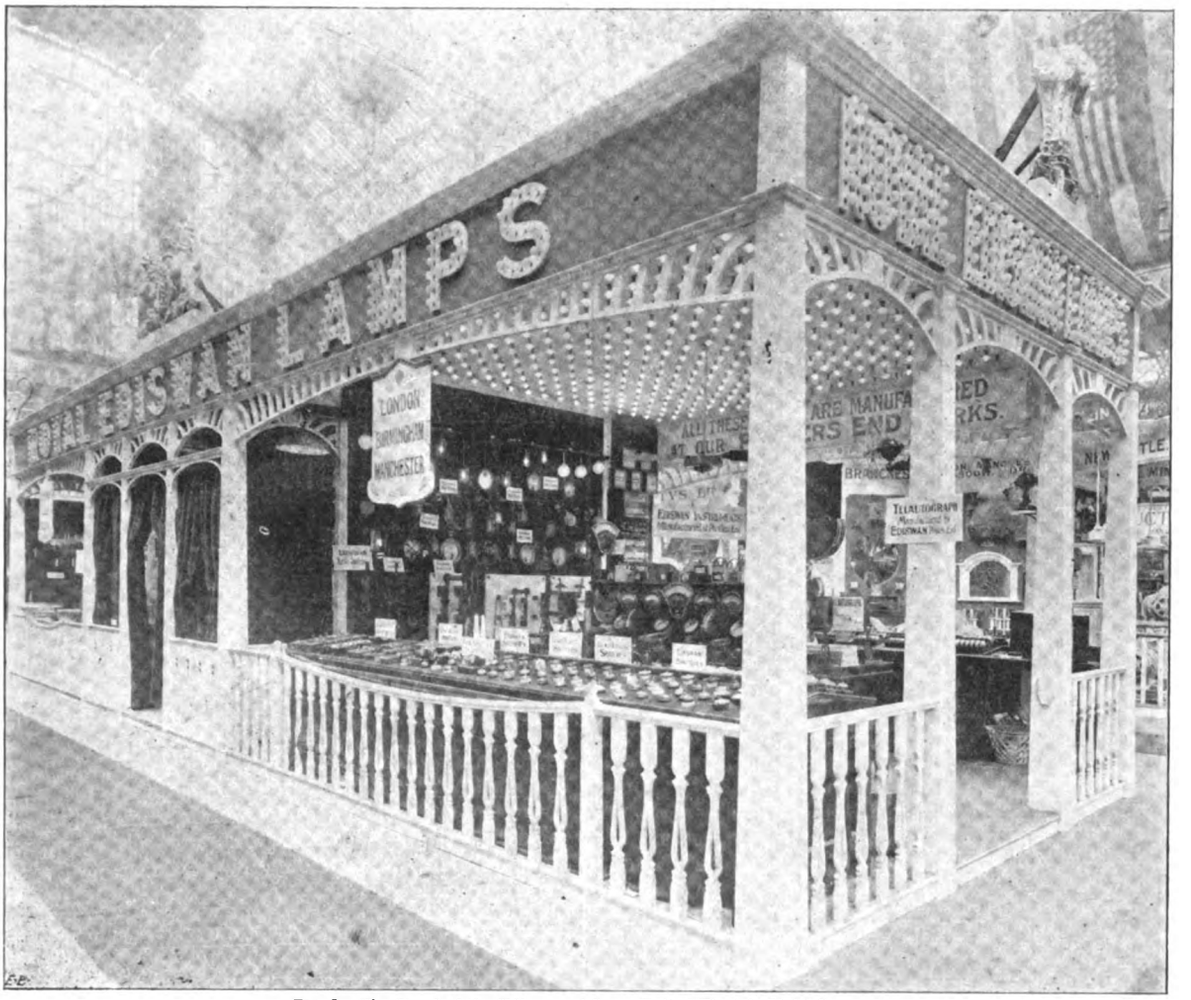

FIG. 5.—The Stand of the Edison and Swan United Electric Light Company.

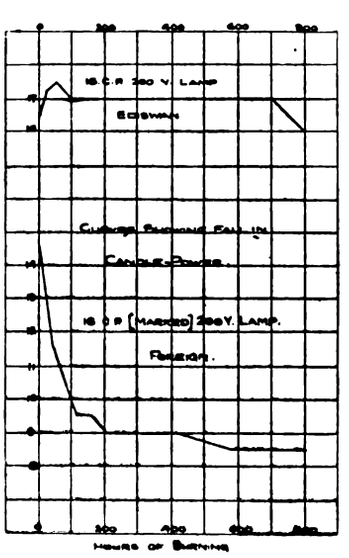

FIG. 6.

In all the above processes the most modern machinery and the greatest care are employed, both being necessary to maintain the high standard of the Ediswan lamp. Interesting comparisons of Royal Ediswan lamps with others of foreign manufacture are given in Figs. 6 and 7, which are self-explanatory. The tests upon which these curves are based were carried out by the Ediswan Company, who assure the writer that the contrast as shown in the curves is by no means extraordinary, but quite representative of the wide difference between the two classes of lamps. The latest product of the company is the lamp known as the Radiolite. It has a large spherical globe, the greater part of which is frosted in order to diffuse the light. The upper portion of the globe is clear, and above this is fixed an opal reflector which serves to throw downwards the light emitted from this part. The result is a largely increased downward candle-power and a soft diffused light. This class of lamp is both highly efficient and pleasing in appearance, and by virtue of such characteristics should command a good sale.

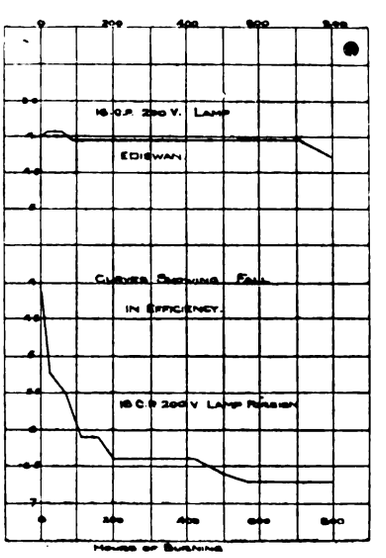

FIG. 7.

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In a prominent part of the stall is an exhibit which demonstrates that, although not customary, it is possible to make a carbon-filament lamp with an efficiency equal, if not superior, to that of the tantalum lamp mentioned in a former section of this article. Two instruments, placed in circuit with tantalum and Ediswan high-efficiency lamps of equal candle-power, show by the aid of needles rotating over their respective dials that such a lamp is quite possible, and it is contended that, although the life is necessarily short, the wide difference in the prices of the two lamps counterbalances this, placing the carbon lamp on an equally economical basis as the tantalum. Whether such a contention is justifiable commercially can only be determined by exhaustive tests on high-efficiency lamps of this class, and in the absence of these it is impossible to look on the demonstration as conclusive.

Turning now from the modern to the ancient side of the Ediswan exhibit, one is confronted with some most interesting relics of the early days of electric lighting. The first Swan lamp, dating back to 1879, is shown, followed by examples of each successive stage of improvement and development. There are various forms of sockets and holders which will recall the past most vividly to many; and other exhibits, such as the first tumler switch, are equally as reminiscent. This part of the stand affords an excellent object lesson of what time and perseverance will do. Surrounded on every side by the latest improvements in incandescent lighting, the relics certainly have a somewhat shabby appearance, not to mention an old-world look. But their value is considerable both as relics and as moral examples, and the Ediswan Company are to be congratulated upon the possession of such a complete and interesting collection.

Before leaving the stand of the Ediswan Company some mention should be made of the interesting assortment of instruments there on view. They are particularly noticeable for their fine finish and for the obvious care which has been spent on their manufacture. The voltmeters and ammeters of the dead-beat moving-coil class are worth inspection, as they have some excellent features, including perfect screening and a high degree of accuracy. These instruments have no soldered joints, and are claimed to be entirely free from thermo-electric effects or contact E M F.'s, prolific although little recognised sources of error.

The Robertson lamp factory (Fig. 8) forms one of the chief attractions of the exhibition, a great part of the manufacture of these well-known lamps being carried out before an audience always large and appreciative. In 1893—a year after the Crystal Palace Exhibition—the Robertson Lamp Company started in quite a small way at Brook Green, Hammersmith, and by the early part of 1895 had succeeded in turning out *one* marketable lamp. This was the first and most important stage. It was essentially one of experiment; and small though the immediate results were, so satisfactory did these experiments prove that a lamp was evolved which admittedly stands in the highest rank, and is now being turned out from the greatly enlarged works at the rate of four millions per annum. The growth of the business from such small beginnings to its present size is due entirely to the care which is taken in every operation to produce a first-class article. This is obvious even at Olympia, where, naturally, conditions are not the most favourable, but at the works themselves it is even more apparent, the thoroughness with which every operation is carried out being particularly evident. A Robertson lamp in its making passes through 45 successive stages, a large percentage of which are tests of vacuum, efficiency, etc., carried out in order to make quite sure of the finished product. Starting from the purest of cotton wool, the filament passes through the usual stages. It is turned into cellulose by the action of chloride of zinc of a special gravity and temperature; it is squirted into a thread which is hardened by steeping in alcohol for three or four days; it is further treated for several hours with another solution of alcohol and acid in order to remove the last traces of the zinc chloride; and it is next washed for 24 hours in cold running water so

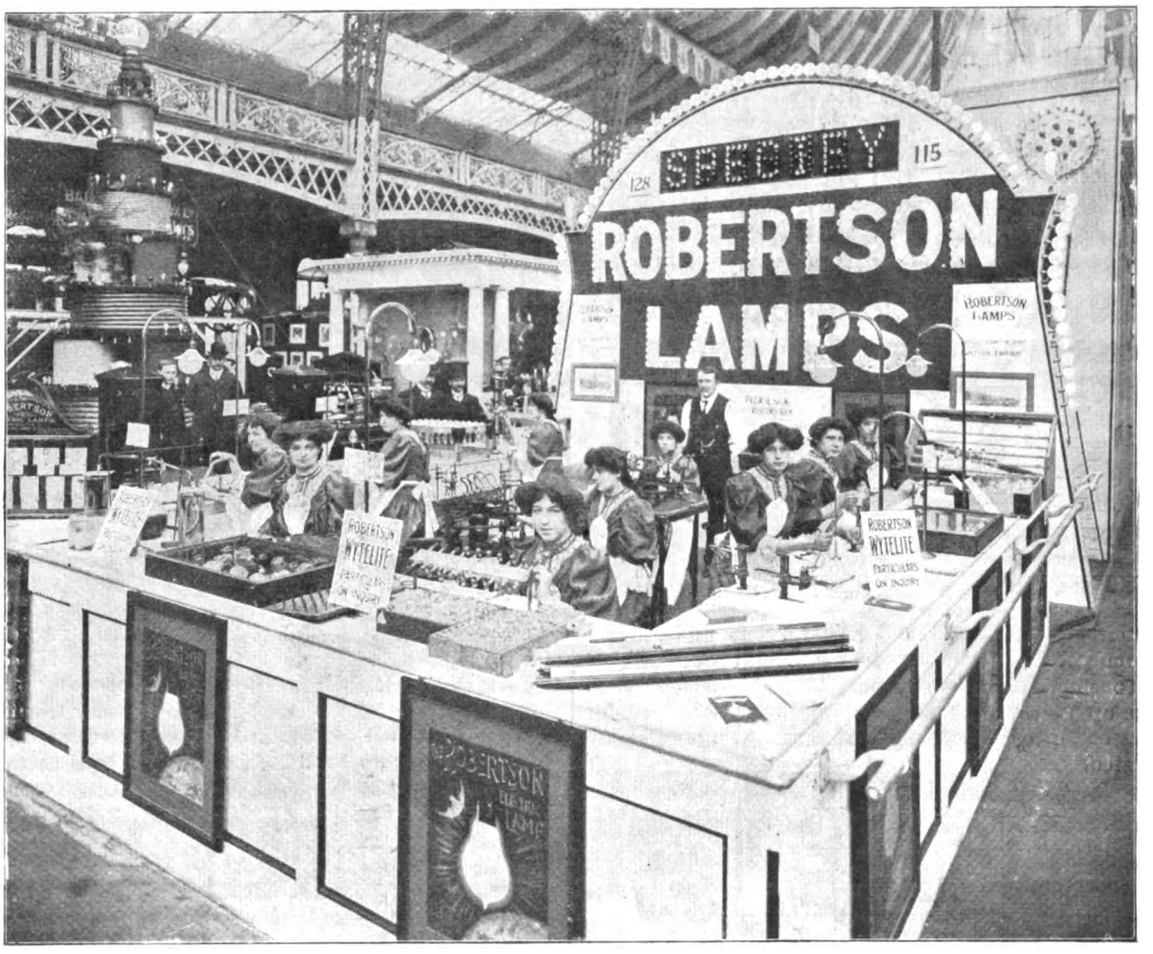

FIG. 8.—View of the Robertson Electric Lamp Company's Exhibit, showing Lamps in course of Manufacture.

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that the last of the impurities may be carried away. Drying is done, as usual, in heated rooms on large drums which will carry half a mile of filament, and this is followed by carbonising in furnaces, the thread being wound on carbon formers. These are placed in plumbago pots, which are then subjected to gradually increasing heat for about 24 hours, the operation being completed by the removal of the pots to a still hotter furnace, where they remain until the fire has died down. The filaments are now cut, allowance being made for varying diameters, and the next process is that of mounting on the platinum leading-in wires, which is carried out in the usual manner, the joint being made both mechanically and electrically. Flashing in a thin hydro-carbon vapour derived from benzine follows, and this is continued until a Wheatstone bridge test discloses the fact that the filament is of the right resistance. By another system in use at the Robertson Works the regulation of the flashing current is effected automatically, being cut off in the same manner when the correct resistance has been attained.

This completes the filament, and the next step is to secure it in the globe. Both the "tube" and "pinch" seal methods are used, the latter exclusively for low voltages and the former for both high and low. In making a "pinch seal" great care is taken to secure perfect contact between the leading-in wires and the surrounding glass so that the vacuum shall not suffer, and a ridge with two crossed pieces is formed in order to secure the cap firmly. This latter device entirely overcomes the trouble of twisted-off caps, so prevalent with cheap foreign lamps. The filament being enclosed in the bulb, the exhaustion of the latter follows, being performed by a mechanical pump until what would ordinarily pass for a good vacuum is obtained. "Good," however, is not good enough, and the exhaustion is completed by Sprengel mercury pumps, with which it is possible to attain a very high degree of vacuum in about 20 minutes. Besides the mercury pump, another system of completing exhaustion is used, being nearly always applied to high-voltage lamps. After the mechanical pump has done all it can, the connection is sealed off and the filament is incandesced to a high degree. The heat evolved serves to disintegrate a certain chemical substance which has previously been placed in the connecting tube, causing it to turn into gas and rise into the globe, mixing with the residual air. It combines with this, and the two form a solid which sinks into the connecting tube, and it now only remains to melt the latter and detach it from the lamp. Even after this there are still some occluded gases in the filament and wires, and to ensure a perfect vacuum these too must be got rid of. This is done by what is termed "over-running"—that is to say, the filament is subjected to more than its right voltage, and the resulting extreme incandescence attains the desired end of getting rid of the occluded gases.

The important process of testing the quality of the vacuum is next carried out on the glow method by aid of an induction coil. If when the high-tension current is applied the bulb glows, the vacuum is bad and the lamp is thrown away. If, on the other hand, the exhaustion is satisfactory, the filament is then over-run to the extent of 50 per cent., with the express purpose of burning it out if weak, and should it survive, the lamp is again tested for vacuum. Then follows a long series of photometric and other tests, and whatever voltage the lamp is found to be suited for is at the same time marked on the bulb. Capping, by aid of a special cement, which when dry resembles marble, is the next step, and after still further tests for vacuum power to resist over-voltage, and general symmetry of shape, the lamp is cleaned, packed, and sent off. Approximately 33 per cent. of the lamps are rejected in the course of manufacture—a high figure, but one that speaks well for the thoroughness of the testing methods employed.

In common with other lampmakers, the Robertson Company are now manufacturing the partially-frosted reflector lamp which is becoming so popular. It is termed by them the "Wytelite," a name which is entirely justified by the excellent quality of the light obtained. The spherical bulb being devoid of the usual pip at the point where it is sealed off, the lamp does not cast shadows; and the correct placing of the filament, combined with the frosted globe and the opal reflector, results in a light which in whiteness and diffusion is much ahead of the ordinary incandescent lamp. The current consumption is the same as that of an ordinary 16-c.p. lamp, but the light obtained in the downward direction, where it is usually most needed, is equal to 25 c.p. The globe being spacious, does not blacken; and in many other ways the "Wytelite" lamp is an improvement over its more familiar predecessor. The back of the Robertson stand is lit by a large bank of these lamps, and the effect is very striking.

The osmium lamp and some of its general features were mentioned in a former section of this series. Further particulars are now to hand as to the manner in which the General Electric Company are applying them to practical use. The lamp they are showing in the gallery of the exhibition is termed the "Osmi," and this demonstration of its possibilities is well worth a visit and close inspection. The favourable points claimed as compared with the carbon-filament lamp are: approximately 56 per cent. saving of current and 56 per cent. less heat; longer life; minimum sensitiveness to voltage fluctuations; a white light; and inappreciable blackening of the globes. The average life of the "Osmi" lamp is given as not less than 500 hours, but, as before stated, this is often exceeded by a very large amount. Voltage fluctuations of as much as 5 per cent. or even 10 per cent. are hardly noticeable in the light, and the candle-power remains very steady throughout the whole life. It has been shown that these lamps at present can only be made for comparatively low pressures, and a 75-volt lamp is the highest that is being shown at Olympia. To overcome the difficulty, the General Electric Company are supplying adaptors which consist of two, three, four, or five lampholders fixed together and wired in series, and by this means the osmium lamp is made a commercial possibility where a high candle-power light from one point is required. The filaments of the higher-pressure lamps are naturally very long, and for this reason are supported at their lower extremities by wires sealed into the globe. The construction of the filament and its nature also prohibit the burning of the lamp in anything but a vertical hanging position, but it is conceivable that this difficulty will ultimately be got over.

The General Electric Company are making a very determined attempt to popularise the "Osmi" lamp, and have already booked several important orders, particularly for street-lighting. The lamp certainly has its limitations; it is comparatively dear and obviously unsuitable for many situations. On the other hand, for such work as street or hall lighting it would appear to possess very valuable features, and developments in this and similar directions may be confidently looked for.

In conclusion, the writer begs to acknowledge his indebtedness and express his thanks to the various firms who have supplied him with information for these articles.

CABLES FOR ELECTRIC DISTRIBUTION AT OLYMPIA.

[SPECIALLY CONTRIBUTED.]

(Continued from page 490.)

A list of the very numerous exhibits of insulated cables at Olympia would convey little information to our readers. The names, however, of the exhibiting firms remind the engineers used to cable work of the special points of the cables made by the firms in question. It is pleasing to note in this direction that the old-established cablemakers hold their own, and succeed in getting regular orders from those users who have proved the worth of their manufactures. Thus, on the stand of Messrs. Siemens Bros., which is on the left-hand side as one enters the exhibition, there are shown samples of the high-tension cables which have been supplied by the firm exclusively to the Bristol Corporation from 1893 to the present date. The Hull Corporation, again, have bought their high-tension cables from the firm from 1897 up to now. After such evidence it would be a bold engineer who would on general experience only dictate to Messrs. Siemens Bros. as to how they should vary their standard

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design of high-tension cables. Of course, there are such bold engineers to be found, but the united efforts of the Cablemakers' Association tend to prevent them from doing much harm.

With the increase of pressure required for long-distance transmission the dielectric strength of the insulation has to be increased, and this has been successfuly accomplished. Cables for 10,000 volts working pressure, or samples of the same, are to be seen upon the stands of Messrs. Siemens Bros., the Callender Cable and Construction Company, Messrs. W. T. Glover and Co., Messrs. W. T. Henley's Telegraph Works Company, Limited, etc. This latter firm show a drum of 11,000-volt cable which has successfully withstood a testing pressure of 30,000, and supplied to the District Railway Company and the London United Tramways Company. The Western Electric Company show samples of the extra high-tension three-core cables supplied by them for the Baker-street and Waterloo Railway. With this high voltage the insulation on the cable itself has ceased to give experienced manufacturers any trouble. The insulation, however, of the joints where required, and of the ends, needs most careful attention. The joint boxes and accessories for end connections shown at Olympia are worthy of special study. Those shown on the stand of Messrs. W. T. Glover and Co. are specially designed to suit the extra high voltage above mentioned, and to provide against leakage of current over the surfaces of the insulation where a three-core cable is split up.

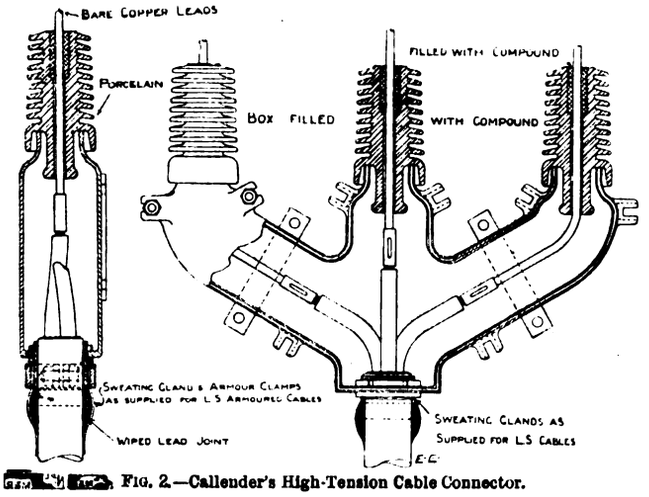

FIG. 2.—Callender's High-Tension Cable Connector.

In the accompanying illustration (Fig. 2) we show a three-way dividing box as made by the Callender Company for extra high-tension transmission work, in which a three-core cable has to be divided out into bare conductors at the generating or sub-station. One of the special features of this box is the design of insulator, which not only can be used for bare copper work, but, owing to the countersunk portion at the top, will take rubber or lead sheathed cables if the type of box is required to be used for this class of cable instead of bare copper. In such a case it would not be necessary to insure such a good porcelain insulation of the terminals, but it is useful to have a porcelain that is adaptable to any class of single conductor. This box, when jointed up, is filled with high insulation compound, and it will be noticed that when the box is filled the porcelain can be squeezed down into position without any mechanical joint, and yet with the assurance that, owing to the design of the bottom of the porcelain, the joint will be absolutely waterproof. This box is also made with an extra length attached to the bottom, so that in the event of circumstance requiring the box to be suitable for twisting the cores in any direction ample space is provided.

The same firm also show on their stand one of the pillars (Fig. 3) as supplied for the Tucuman system of overhead lighting and power distribution. At the top of the pole there are 12 sets of insulators, each set being for the three-wire system of overhead mains feeding out four ways from a street corner. Also, at the top of the pole, holes are drilled into which are inserted porcelain bushes, and through these holes rubber-covered cables are drawn up and connected to the bare overhead mains; the other ends of these rubbers are connected through porcelain bushed holes at the bottom of the pole to Callender-Ward fuse gear mounted on the double porcelain insulation principle. There are in the base of the pole four choking coils and four fuses, the arrangement being that the fuse controlling one of the outers of the three-wire overhead mains is placed in series with a choking coil, and this coil is arranged on porcelains at the back of the fuse. In the illustration reproduced only two ways of the overhead wiring were utilised, and, therefore, four fuses were required, but when the extension of the other two overhead ways is put into operation, the extra amount of gear will be shipped out and placed in position, as everything in the pillar designs is now so arranged that an extension can be made, when required, without the slightest difficulty by means of adding certain accessory pieces, the fixtures for

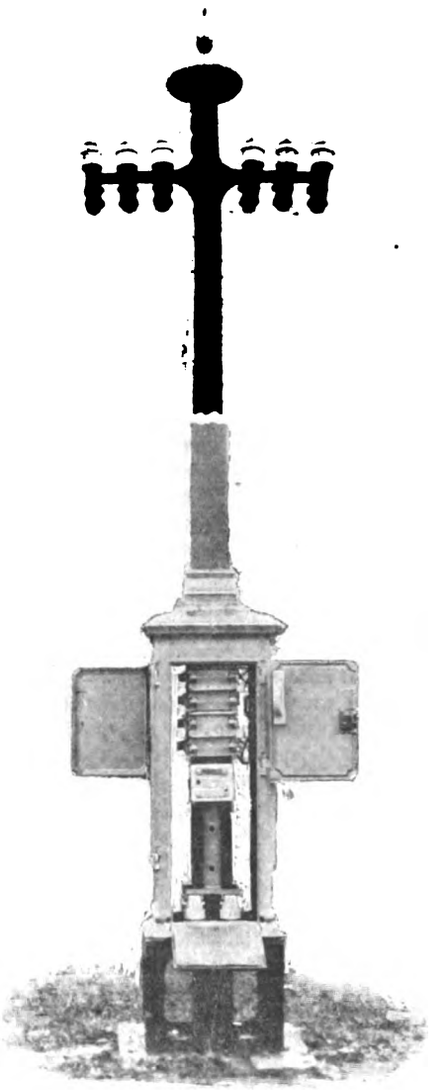

FIG. 3.—Connecting Box for Overhead High-Tension System.

which have been properly provided for in the first instance. There are also eight lightning arresters of the Wurtz type arranged for on the closed sides of the pillars, each arrester being attached to one of the choking coils.

Quite apart from the ordinary cables for laying in the streets, there has arisen a demand for special cables capable of withstanding special conditions. Amongst these is the fireproof class of cable, which is much needed in central stations where the bunching of each range of cable is sometimes unavoidable. Messrs. W. T. Henley exhibit numerous examples of such fire-resisting cables, and Messrs. W. T. Glover's have arranged a special test to show the efficacy of their fireproof coverings. This firm advocate the use of the cable in question for all fiery mines, and have also standardised a leather braided cable, which is specially valuable as a flexible connection in colliery work.

Of the plain indiarubber-covered wires for house wiring it is difficult to say much, as nearly all the large electrical

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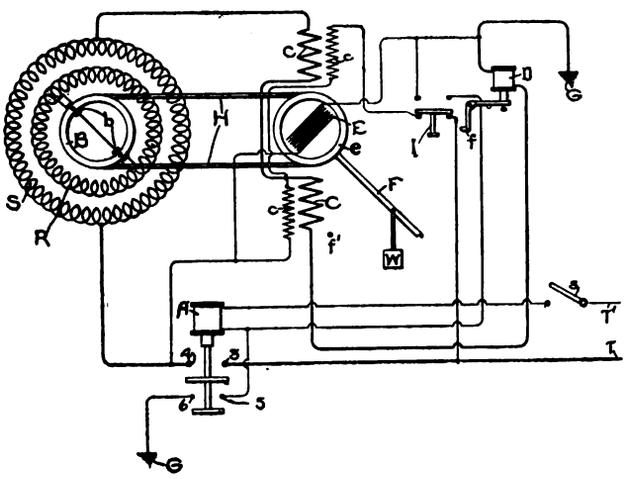
supply houses exhibit this useful commodity, without which electric lighting cannot be carried out in this country. The General Electric Company, Messrs. I. Frankenburg and Sons, Limited, Messrs. Falk, Stadelmann, and Co., Limited, and a number of other firms are showing extensively their standard insulated wires. There is a wide choice of good firms from which to purchase a reliable article. Unfortunately, there are also inferior cables on the market, which the new wiring contractors are tempted to patronise. They find in time that all is not indiarubber which bears the name, and, unfortunately, the consumer has to bear the brunt of their want of experience. In electric cables for any purpose whatever the best is cheapest, and the Olympia Exhibition clearly shows what a wide range of choice this maxim leaves to electrical engineers.

AUTOMATIC REGULATOR FOR ALTERNATING-CURRENT MOTORS.

A patent has been granted in the United States to Mr. G. H. Hill, of Schenectady, N.Y., for the purpose of automatically regulating the speed of a repulsion motor from stationary to full speed. It is noticeable that the torque of this type of motor may be varied by shifting the brushes which short-circuit the armature or rotor winding, and it will be seen from the accompanying diagram which we reproduce from the *American Electrician* that the inventor utilises this feature to accomplish his object. The stator winding is represented by S and the



rotor winding by R; the rotor winding is connected to a commutator in the usual way, but for simplicity this is omitted, and the brushes, *b*, are shown in direct contact with the winding. These brushes are mounted in a brush-holder ring, B, which is adjustable around the axis of the machine and is connected to a similar ring, *e*, by means of a belt, H, so that when the ring, *e*, is rotated the brush ring, B, follows its movement. The controlling ring, *e*, carries a coil, E, which is arranged in inductive relation to stationary coils, C C, the latter being in series with the stator winding. The polarities of the two sets of coils are such that when they are energised the coil, E, tends to turn counter-clockwise, which tendency is opposed by the weight, W, attached to the arm, F. The drawing shows the equipment as arranged for use on an electric car, so that the ground connections, G G, represent one terminal of the supply system; the main terminal of opposite polarity is the wire, T. When the apparatus is in position of rest, the arm, F, is raised to its horizontal position, where it is held by the latch, *f*; in this position it raises the bridge, I, and closes the circuit from the upper ground terminal through the solenoid A to supply source, T (when the switch, *s*, is closed), which is of the same polarity as the main supply terminal, T, but not necessarily of the same voltage. The switch, *s*, being closed under these conditions, current will flow through the solenoid A and the brush, I, to the ground connection, which is a common return for both supply sources. The solenoid A will then raise its plunger and bridge the contacts 3, 4, and 5, 6. The contacts 3, 4 close the torque circuit to the stator of the machine, and the contacts, 5 6 close the return connection between the solenoid A and the ground, so as to make the solenoid independent of the bridge, I. With the arm, F, horizontal the short-circuiting brushes on the rotor commutator are in the position of zero torque, and the motor, of course, does not start up. The magnetised current, however, through the stator winding passes through the solenoid D, which releases the latch, *f*, and allows the lever, F, to be drawn down by the weight. A shunt current passes from the main terminal, T, through the movable coil, E, to the ground, and this restricts the downward motion of the arm, F, and, consequently, the circular motion of the brush ring, B. When the arm, F, falls to a position where the magnetic pull of the coil, E, balances the weight, W, the brushes will have reached a position where the motor has sufficient torque to start up. As the motor speeds up and the counter E.M.F. in the stator winding increases, the current in the coils, C C, will decrease, allowing the weight, W, to pull the arm, F, still further down, carrying the brushes further around toward the point of maximum torque and increasing the speed of the motor still further. This will continue until the motor is running at full speed and the opposing forces in the regulator are in equilibrium. From the foregoing it will be evident that the regulators operate to produce practically a constant current flow through the stator winding of the motor. The regulator is provided with an auxiliary set of stationary coils, *c*, *c*, which are short-circuited when the plunger of the solenoid A goes up. When the switch, *s*, is open to shut the motor down the solenoid A is de-energised, of course, and drops its plunger, opening the two paths of contact. This removes the short-circuit around the auxiliary coils, *c*, *c*, and they then receive current from the main terminal, T, and through the bridge piece, I, this current passing to ground through the movable coil, E. The auxiliary coils and the movable coil, E, rotate the ring, *e*, raising the lever, F, until it is held in a horizontal position by the latch, *f*. In this position the bridge, I, is lifted from its bottom contacts, opening the connection between the main terminal, T, and the auxiliary coils, *c*, *c*.

FORTHCOMING EVENTS.

FRIDAY, OCT. 20.

Electro-Harmonic Society.—At 8 p.m., first smoking concert of the season in the King's Hall, Holborn Restaurant.

Institution of Mechanical Engineers.—At 8 p.m., "The Manufacture of Cartridge Cases for Quick-Firing Guns," by Colonel Leandro Cubillo.

WEDNESDAY, OCT. 25.

Tramways and Light Railways Association.—At 8 p.m., "Roller Bearings," by Mr. T. W. How.

FRIDAY, OCT. 27.

Institution of Electrical Engineers (Glasgow Section).—Fourth annual dinner at the Grosvenor Hotel, Glasgow.

Junior Institution of Engineers.—At 8 p.m. (at the Westminster Palace Hotel). annual general meeting and first meeting of the Incorporated Institution.

Institution of Civil Engineers.—Nov. 7, at 8 p.m., inaugural address by Sir Alexander Binnie and presentation of awards.

Rontgen Society.—Nov. 2, at 8.15 p.m., "Ruhmkorff Coil," by Prof. Wertheim Salomonson (of Amsterdam).

Birmingham Electric Club.—Nov. 4, at 7.30 p.m., "Electric Furnaces," by Mr. J. H. Stansbie.

New Publication. — "A Guide to the Electrical Examinations," by F. H. Taylor (London: Percival Marshall and Co. 1s. and 1s. 6d.). This handbook will be found useful to students, lecturers, etc, containing, as it does, a collection of information upon the electrical examinations of the City and Guilds of London Institute and the Board of Education, with a selection of examination papers and answers.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EXHIBITIONS AGAIN.

Almost as soon as these lines are in print the 1905 exhibition will be closed. As far as we can gather, it has been pre-eminently successful, and the thanks of the profession should be given in no grudging spirit to the organising managers (Messrs. Bridges and Smith) and to the executive committee, but especially to the former, who have borne the burden and the heat of the responsibility, and perhaps to these we might add the names of the consulting engineers who have been assiduous in their efforts to make satisfactory arrangements for everyone. If we were disposed to attempt a classification of electrical exhibitions, we should place them under one or other of three categories, the present exhibition forming the single example under one head. There are exhibitions of an international character, in which educational purposes are put in the foreground, and business is openly tabooed; there are exhibitions of a local character to induce local support to local operations; and there is this last, incepted by manufacturers and organised for the general good of the industry. One of the greatest aims of every exhibition, whatever may be said to the contrary, is education—the education of people in the matter of progress. One of the most difficult things in the world is to educate the general public as to the value of new departures. Neither descriptive, illustrated articles, nor glaring advertisements will do as much as the seeing of a thing at work or in use. The world is very conservative. All the discoveries made within the last century were ridiculed and treated with contempt by our forefathers, yet we are equally prejudiced and hostile to all those improvements proposed to us which will in all probability be adopted by our children. A striking example of these statements is seen in the history of mechanical road traction. Proposed and tested three-quarters of a century ago, it was rejected till a half-century elapsed, when the idea was resuscitated, and is going along to success, notwithstanding the foolishly insane opposition to it even in these so-called enlightened days. Of course, there are some people who never learn. According to their own ideas, their knowledge is infinite and their actions perfect. They are really like the man who wanted to know how he looked when asleep, so sat before a mirror with his eyes shut; or the one who hoped to convince a possible purchaser of the value of his house by showing him one brick as a sample. The business man has at least three objects in life: first, he wants to know all about competitors' goods; he wants to produce something that will compete favourably with the products of his opponents; and, lastly, he wants to make as much money as he can out of his business. Properly organised exhibitions help him, directly or indirectly, in a position to provide for these wants. Business is not conducted for the pleasure of the thing, but with the very definite object of obtaining an income. Hence, while the aim is to obtain business, and as much as possible, it is quite as necessary to guard against excessive cost of obtaining it. The exhibitor at an exhibition is quite sure of the costliness of his proceedings, so he must try to minimise the cost and expand the return. At the meeting of manufacturers this week this point was discussed, and it was determined to minimise their costs at the many minor exhibitions held for local education. It is proposed that if promoters want exhibits, they must be prepared at least to pay the expense of carriage to and from the factory. This is quite fair, as, although business may result, it is by no means certain that the business will go to the exhibitor. The profession can now number in its ranks men of mature age and experience. In earlier days

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youth held the helm, and scepticism has ever been the bugbear of youthful vanity. Even now—as ever—youth considers it knowing to quarrel with existing institutions and established truths, and this is well, because it means that things are more closely examined, and if experience guides and controls, the declamatory attitude leads to good. Thus the manufacturers in the plenitude of their wisdom organised the exhibition about to close, and have made it successful. They now recognise that this success will prompt others to repeat the exhibition for private gain, and have agreed not to support any such attempt. Their conclusions generally in the matter of exhibitions should be supported, in that they must for their own purposes have closely examined the *pros* and *cons.* of the case.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HASTINGS TRAMWAYS.

SIR,—We observe in your issue of the 13th inst. that in your review of the Hastings power station you refer on p. 516 to the apparatus employed for purifying the condense water. You state, "a filter of the Wilson automatic self-cleansing type as supplied by Messrs. Masson, Scott, and Co." We consider this statement very misleading, as the filter in question was actually made and erected by ourselves (Wilskemp Limited, St. Ann's Engineering Works, St. Ann's-hill, Wandsworth, S.W.) to the order of Messrs. Davis-Perrett, Limited, 13, Fenchurch-avenue, E.C. We should be much obliged if you could see your way to insert a corrective paragraph to the above effect in an early issue of your journal.—Yours, etc.,

(For Wilskemp Limited) JAMES J. JACOB.

BOURNEMOUTH TRAMWAYS.

The completion of the tramways extensions connecting Bournemouth, Christchurch, and Poole was celebrated on Tuesday last, when Messrs. J. G. White and Co., Limited, the principal contractors, entertained the mayors of the three towns and numerous other guests at dinner. The combination of the conduit and trolley systems remains the most interesting feature of the completed scheme. Full details of this were given in our issues for Jan. 9, 16, and 23, 1903, about which time the central portion of the system was opened. The extension to Christchurch is on the overhead trolley system, the route length being 3½ miles and the total length of single track about 5½ miles. This is of entirely new construction, whereas the extension to Poole consists of a line recently purchased from a local company, except for a short section of new track linking this line with the Bournemouth system. The names of the various contractors for the original scheme need not be repeated here. Suffice it to say the British Electric Equipment Company, Limited, have carried out the overhead work for the extension lines; Callender's Cable and Construction Company supplied and laid the feeder cables; Messrs. J. G. White and Co., Limited, constructed the permanent way; and the Acme Flooring and Paving Company, Limited, did the wood paving. It is noteworthy in connection with the overhead work that a grooved trolley wire is used, whereby extra smooth running is ensured at the points of suspension. These extensions incidentally show what can be accomplished by co-operation between neighbouring authorities to provide facilities for intercommunication, and may portend further developments of a like nature. Now to Tuesday's doings. Several gaily-dressed cars were run through from Bournemouth to Christchurch in the early afternoon, and, the weather being of the district's best, the outing proved most enjoyable. Later on a reception was held by the Mayor of Bournemouth, Alderman J. Elmes Beale, in the Winter Gardens. Then came the principal event of the day—namely, the banquet, at which Mr. J. G. White presided. This was given at the Grand Hotel, and was quite Carltonian in style. The work of Messrs. J. G. White and Co., as principal contractors, could scarcely have been more highly eulogised than it was during the subsequent speeches. Mr. J. H. Rider, in proposing "The County Borough of Bournemouth and the Tramways Undertaking," struck the keynote by an apt reference to the excellent work carried out by this company for the London County Council. Referring to the working of the Bournemouth tramways, Mr. Rider said the receipt of 1s. per car mile run signified one of two things—either that too few cars were employed, or that the residents used the cars to an extraordinary extent. He believed the former explanation to be the true one. The Mayor of Bournemouth and the chairman of the Tramways Committee (Alderman Lawson) both responded to this toast. They were equally insistent on the praise due to Messrs. J. G. White and Co., Limited, both for the excellent quality of their work and the expedition with which it had been carried out. Incidentally the Mayor remarked upon the esteem in which the company's employés were held by the residents along the Christchurch route. He also referred to the splendid services rendered by the borough engineer, Mr. F. W. Lacey, and the resident electrical engineer, Mr. Bulfin, in connection with the undertaking. The toast of "The Other Contractors" was proposed by Mr. A. N. Connett, and responded to by Mr. T. Callender.

It must be remembered, in adjudging the value of the complimentary remarks made on this occasion, that the central and by far the larger portion of the Bournemouth system of tramways has now been in operation for nearly three years, during which time the quality of the work has been proved under service conditions. The success of the conduit in Bournemouth is, of course, primarily due to Mr. A. N. Connett, who was responsible for the details, and is all the more noteworthy because the town was the first in this country to adopt a mixed trolley and conduit system. It must be acknowledged that Messrs. J. G. White and Co. have established a standard for work in this and other countries which for downright thoroughness need fear no comparison.

THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.

BY ALFRED STILL, M.I.E.E., A.M.I.C.E.

(Continued from page 492.)

In comparing three-phase with single-phase transmission *on the basis of the same maximum potential difference between wires*, we have for the total three-phase power

$$W = \sqrt{3}\, E \times C,$$

which for equal power single-phase would be written

$$W = E \times (\sqrt{3}\, C).$$

Let r = the resistance of each conductor on the three-phase system, and

r_1 = the resistance of each conductor on the single phase system,

then *weight of copper, single-phase* $\propto 2 \times \frac{1}{r_1}$,

and *weight of copper, three phase* $\propto 3 \times \frac{1}{r}$,

and the ratio $\frac{\text{weight of copper, single-phase}}{\text{weight of copper, three-phase}}$ may be written

$$\frac{2\,r}{3\,r_1},$$

but for equal line losses we have

$$3\,C^2 r = 2\,(\sqrt{3}\,C)^2 r_1,$$

which gives us $r = 2\,r_1$.

Hence the relative weights of copper are as 4 : 3, showing a saving of 25 per cent. in favour of the three-phase system.

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Effect of Inductive Load on Line Losses.—We shall still neglect the capacity or self-induction of the lines, but briefly consider the effect of an inductive load on the vector diagrams. In Fig. 20 the diagram has been drawn for the condition of a power factor of unity.

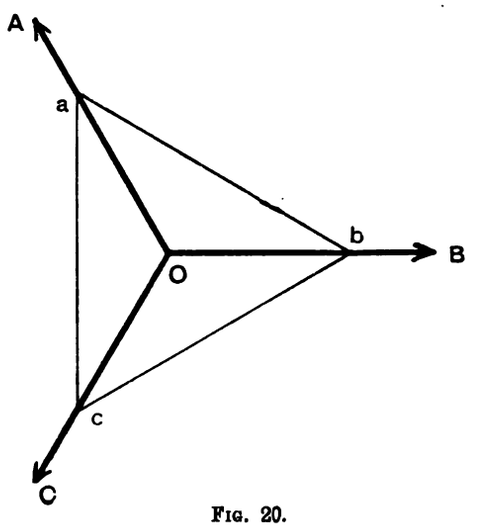

FIG. 20.

Here O A, O B, and O C are the three current vectors. The potential difference between wires is $a\,b = b\,c = c\,a = E$.

The length $O\,a = O\,b = O\,c = e = \frac{E}{\sqrt{3}}$.

The total power is: $W = \sqrt{3}\ E \times C$

$= 3\,e \times C$

$= 3\,(O\,A \times O\,a)$.

In Fig. 21 the diagram has been drawn for an inductive load. Here there is a certain displacement of the current phases relatively to the E.M.F. phases. It will be noticed that the vertices of the E.M.F. triangle no longer lie on the current lines as in the previous diagram. The three current vectors still make the same angle of 120deg. with each other, but they have been moved bodily round (in the direction of retardation) through an angle θ. The

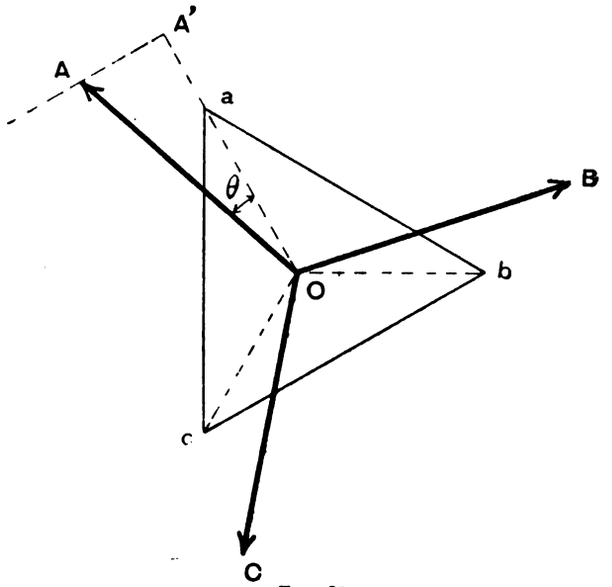

FIG. 21

total power is, evidently, no longer equal to three times $O\,A \times O\,a$, but to $3\,O\,A' \times O\,a$, where O A' is the projection of O A on O a; and cos θ is the power factor of the three-phase circuit.

It was explained in connection with single-phase currents that, for a given total power to be transmitted at a definite pressure, the weight of the conductors—if the $C^2\,r$ losses are to remain constant—must vary inversely as the square of the power factor. This rule necessarily applies equally to the case of three-phase transmission. Thus, in Fig. 21, the power factor, cos θ, is expressed by the ratio $\frac{O\,A'}{O\,A}$, but, if the *power* and *pressure* are constant, the length O A' will not alter, whatever may be the power factor. Hence O A (the current in any one of the wires) will vary inversely as the power factor, and—for a given loss in the line—the cross-section of the conductor must vary as the square of the current—*i.e.*, *inversely* as the square of the power factor.

It is not necessary to complicate the diagram Fig. 21 by drawing the vectors showing the effect of the resistance drop in displacing the E.M.F. phases at the receiving end relatively to those at the transmitting end. The construction is exceedingly simple, and can be carried out for each phase exactly as in the case of Fig. 2. We have merely to bear in mind that O A and O a in Fig. 21 correspond with O C and O E' in Fig. 2. The result will be an E.M.F. triangle representing the necessary pressures at generating end, which will be similar to but somewhat larger than $a\ b\ c$, and of which the phase displacement angle, ϕ relatively to the current vectors will be *smaller* than the angle, θ, at receiving end. In fact, the conclusions drawn from Fig. 2 as applying to single-phase transmission will apply equally to the case of three-phase transmission—that

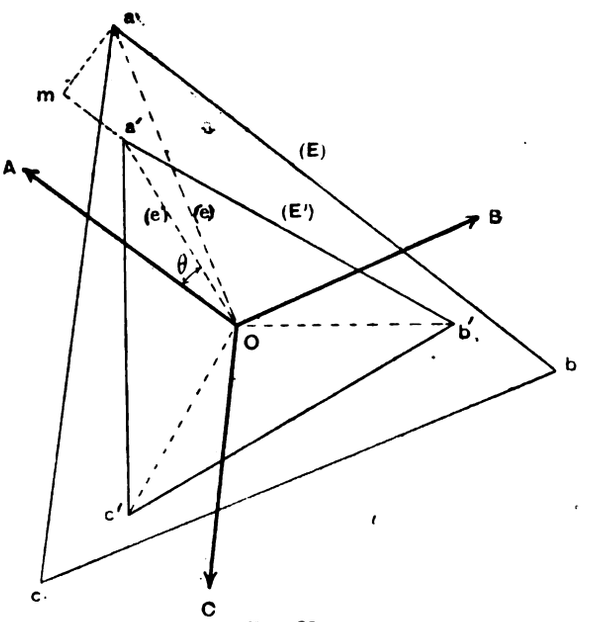

FIG. 22.

is to say (1) the power factor at generating end is greater than at receiving end; (2) *for a definite percentage $C^2\,r$ loss in the conductors*, the arithmetical difference in the pressures at the two ends of the line will *diminish* as the load becomes more inductive. It must not be forgotten that these conclusions refer to a line of negligible self-induction and capacity.

Self-Induction of Three-Phase Lines.—The arrangement of three-phase overhead lines is generally such that the wires occupy the vertices of an equilateral triangle. Under such a condition, it is evident that the magnetic flux due to one of the wires will neither increase nor decrease the amount of the induction through the loop formed by the other two wires. As a matter of fact, if the three wires are arranged in any other practical manner, the effect of the induction due to any one wire on the loop formed by the other two wires will be found to be negligible.

It will be remembered that, when dealing with two-phase transmission with common return, it was shown how the total induction in any one loop may be considered as the resultant of two separate fields—one due to the current in the common return, and the other due to the current in the outer wire—combined at an angle of 45deg. In a three-phase circuit the currents in the three wires are equal, but they differ in phase by 120deg. If, therefore, we calculate, by the help of the curve (Fig. 4), the induced E.M.F. on the assumption that each wire produces its own flux of magnetism independently of the other wires, we have merely to combine two such E.M.F.'s in the manner

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previously indicated (see Fig. 19) to obtain the total E M.F. in any one of the three loops. This is evidently $\sqrt{3}$ times as great as the induced E.M.F. calculated for the current in one of the wires only.

By far the simplest way of constructing the vector diagrams for three-phase circuits is to consider the three phases independently, and Fig. 22 shows the effect of taking into account the self-induction and ohmic resistance of the lines. Here A, B, and C are the current vectors, and a' b' c' is the E.M.F. triangle for the receiving end, the angle of lag being θ. Consider O A and O a' as being the current and E M F. vectors of a single-phase circuit. Draw a' m parallel to O A to represent the ohmic drop due to the resistance of one conductor, and m a, at right angles to O A, to represent the necessary impressed voltage to balance the E.M.F. of self-induction, on the assumption that the magnetic field is due solely to the current, O A, in one conductor. Join O a, and note that, so far, the construction is exactly similar to that adopted in Fig. 3 for a single-phase circuit. We have merely to suppose the same construction to be followed in the case of the other two phases, and the result is the triangle a b c, which represents the necessary three-phase applied E.M.F. at the generating end.

The conclusions drawn from the diagram Fig. 3 when treating of single-phase currents are equally applicable to the case of three-phase transmission. Assuming the distance between the wires to be the same for a three-phase as for a single-phase transmission, let us see whether either system has an advantage over the other from the point of view of inductive drop. In the first place, the total power delivered on the three-phase system (see diagram Fig. 22) is

$$3 \text{ O A} \times \text{O } a' \times \cos\theta$$
$$= 3 \text{ C} \times e' \times \cos\theta$$
$$= \sqrt{3} \text{ C} \times \text{E}' \times \cos\theta$$

where C = the current in any one conductor, and

E′ = the pressure between wires at receiving end.

In a single-phase system supplying the same power at the same pressure between wires, the current is, therefore, $\sqrt{3}$ times as great. The inductive drop in one of the three-phase *loops* is proportional to C × $\sqrt{3}$, and exactly equal to the inductive drop due to each of the single-phase *wires*; hence if the diameter of the wires were the same in

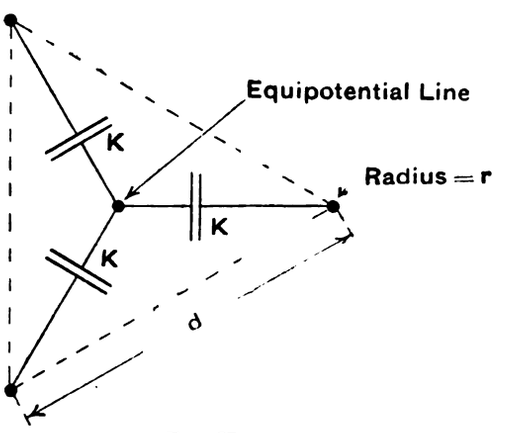

FIG. 23.

both cases, the inductive drop in a three-phase line would be only *half* that in an equivalent single-phase line. As a matter of fact, the diameter of the conductors in the single-phase line would be greater on account of the larger current, and has the effect of *reducing* the self-induction on the single-phase line by something under 10 per cent.

Capacity in Three-Phase Transmission Lines.—In their paper read before the American Institution of Electrical Engineers in 1900, Messrs. Perrine and Baum showed that the capacity of a three-phase line with the wires arranged in the form of an equilateral triangle may be considered as being made up of three equal capacities, all measured between any one wire and the line of zero potential, which may be taken as a line passing through the centre of the triangle. The three capacities are shown diagrammatically in Fig. 23. The capacity of each of the three imaginary condensers shown in the diagram is given as

$$\text{K} = \frac{\cdot 0388}{\log_{10}\frac{d}{r}}$$

where K = the capacity *per mile* in microfarads

d = the distance between wires;

r = the radius of any one wire.

It follows that the capacity current per conductor can readily be calculated exactly as explained in connection with single-phase transmission, the condenser E M.F. being taken as the pressure between the wire and neutral line, which is equal to $\frac{1}{\sqrt{3}}$ times the pressure between wires. This method of calculating the capacity effects on a three-phase line is very simple and convenient; it is evidently based on the assumption that the influence of the earth may be neglected, and this assumption is probably justified if the distance between the wires is small as compared with their height above ground.

The effects of capacity are not usually very great on overhead lines, but, in the case of long lines, transmission at light loads may become difficult, if not impossible, and if this should be the case some means of neutralising the capacity may have to be adopted. Suitable choking coils might be connected between the wires at intervals along the line, or, if power is supplied through induction motors at intermediate stations, there may be no need of any special appliances to introduce additional self-induction.

The formulæ for the capacity of three-core cables with lead coverings are not so simple as for overhead wires, and information regarding the amount of the capacity current to be expected in a given type of cable should be obtained from the maker.

(To be continued.)

THE RELATION BETWEEN CURRENT AND VOLTAGE IN THE ALTERNATING ARC.*

It is usual to consider the behaviour of a conductor carrying a current as characterised by a constant relation,

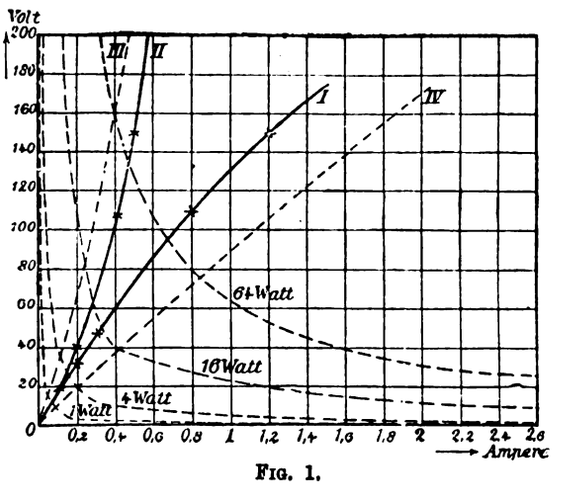

FIG. 1.

called the resistance, between the voltage applied and the current flowing, or, in the form of Ohm's law, $i \times r = e$. The simplicity of such a consideration has led to its application in cases where its value and even its meaning are more or less lost. This has been especially the case in connection with recent advances, and it has gradually become clear that for many cases Ohm's law must be considered as only an interpolation formula holding within certain limits, and that for the complete definition of the behaviour of a conductor its experimentally determined characteristic curve connecting current and applied voltage is required. In some special cases this curve can be

* Abstract of an article by H. T. Simon in the *Physikalische Zeitschrift* and in *Elektrotechnische Zeitschrift* Aug. 31, 1905, and Sept. 7, 1905.

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expressed by a simple formula such as Ohm's law, and in these cases the usual analytical treatment is best, but more generally the curve is a complicated function of the current. Characteristic curves have long been employed for dynamos and accumulators because these first showed the insufficiency of Ohm's law, and more recently the passage of currents through gases, and through carbon-filament, tantalum, and Nernst lamps, has been successfully treated by means of such curves. Thus, in Fig. 1, Curve I. is the characteristic of a carbon-filament lamp, and Curve II. that of a tantalum lamp. By adding the ordinates of these two curves at various currents Curve III. is obtained, which is, therefore, the characteristic curve of the two lamps in series. By adding the abscissæ of the two curves together at various voltages, Curve IV. is obtained as the characteristic of the two lamps connected in parallel. It will be seen that Curve IV. is practically a straight line from the origin, and, therefore, represents a combination whose resistance is independent of the current.

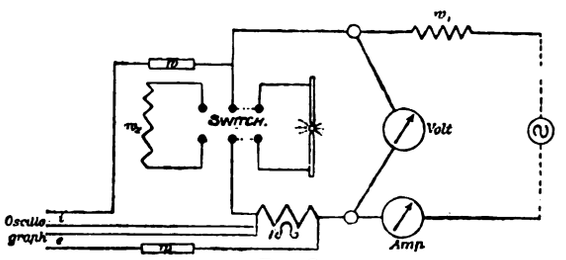

FIG. 2.

By suitably varying the lengths of filament in the two lamps the series characteristic (Curve III.) could be made a straight line. The dotted hyperbolas shown in Fig. 1 indicate the total watt consumption at each point. In the same way such curves can be made to indicate whether a given combination is stable under given conditions, and many other interesting points.

They are especially useful, however, in connection with the electric arc. The behaviour of the arc depends on a large number of variables, such as the length of the arc, the material of the electrodes, nature, temperature, and pressure of the surrounding gas, the heat conductivity of the electrodes and of surrounding objects, etc. Mrs. Ayrton and other observers have determined what may be called the "static characteristic" of the arc by step by step measurements of voltage and current, the voltage being gradually adjusted by means of a regulating resistance, and have shown that it obeys the law $e \times i = a + b\,i$ for currents varying from two amperes upwards, a and b being experimental constants. The action at very small currents has not been investigated. The data at present available

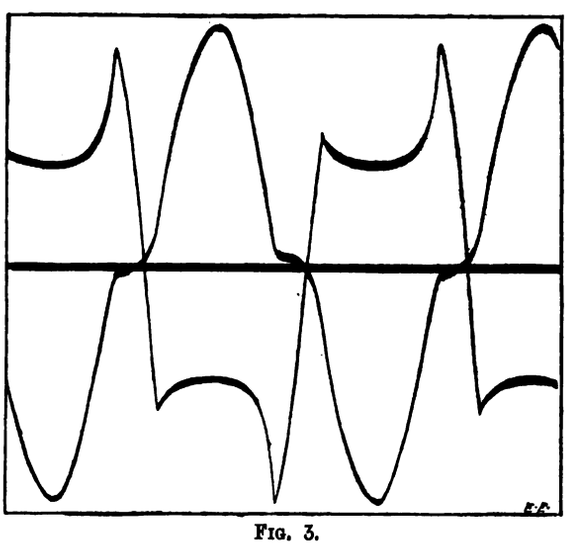

FIG. 3.

would seem to indicate that the temperature of the electrodes, especially of the negative electrode, has an all-important effect on the behaviour of the arc, so that the higher this temperature the greater is the current flowing at a given volage. The nature of the electrodes, as well as the quality of the surrounding gas, would, however, seem to have an additional independent effect.

A method which lends itself especially to the study of the electric arc consists in taking what may be called its "dynamic characteristic"—*i.e.*, taking simultaneous instantaneous values of voltage and current when the current is varying periodically. Voltage and current curves of an alternate-current arc have often been taken—*e g*, by Blondel and by Duddell—but the results do not appear to have been used systematically for the construction of the characteristic curve. The present writer has made some interesting experiments in this direction on the alternate-

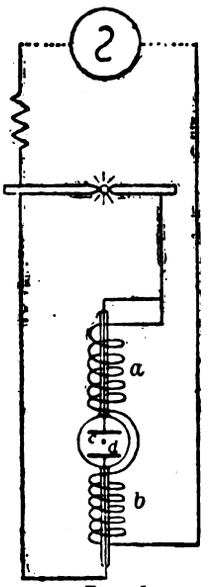

FIG. 4.

current arc, and has employed two distinct methods for the purpose: (1) The curves of current and voltage of the arc are taken simultaneously by a double-strip oscillograph, connected as in Fig. 2. By means of the reversing switch shown the arc can be replaced by a known resistance, w_2, for the purpose of

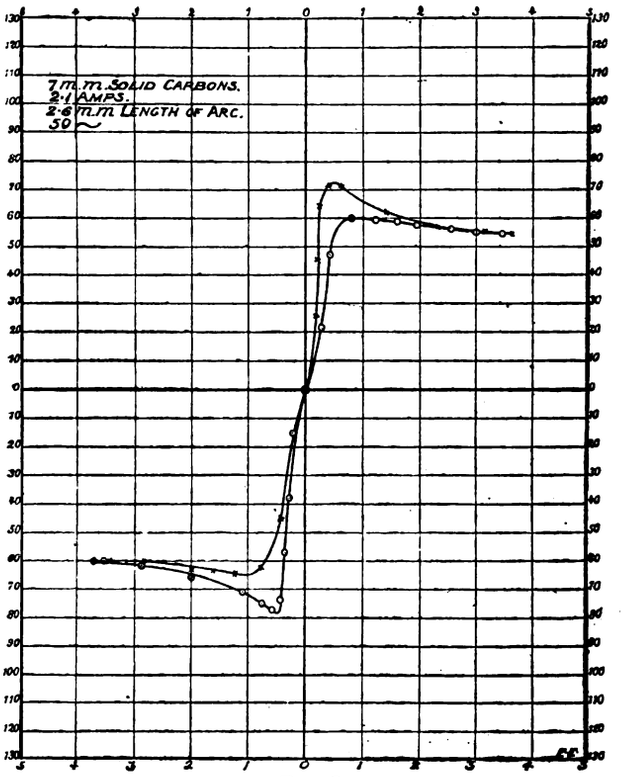

FIG. 5.

checking the oscillograph calibration. Curves of the type shown in Fig. 3 were thus recorded on squared paper, and from the corresponding values of volts and amperes the characteristic curve was deduced. (2) The second method consisted in drawing the dynamic characteristic direct on a

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fluorescent screen by means of a Braun cathode tube. The tube was arranged as in Fig. 4, the current of the arc being sent through the coils, *a b*, producing a horizontal deflection of the cathode rays proportional to the current, whilst the electrodes, *c d*, were connected across the arc and produced a vertical deflection proportional to the voltage. In this way the cathode stream occupies a point on the dynamic characteristic at every instant, and, if the periodicity is

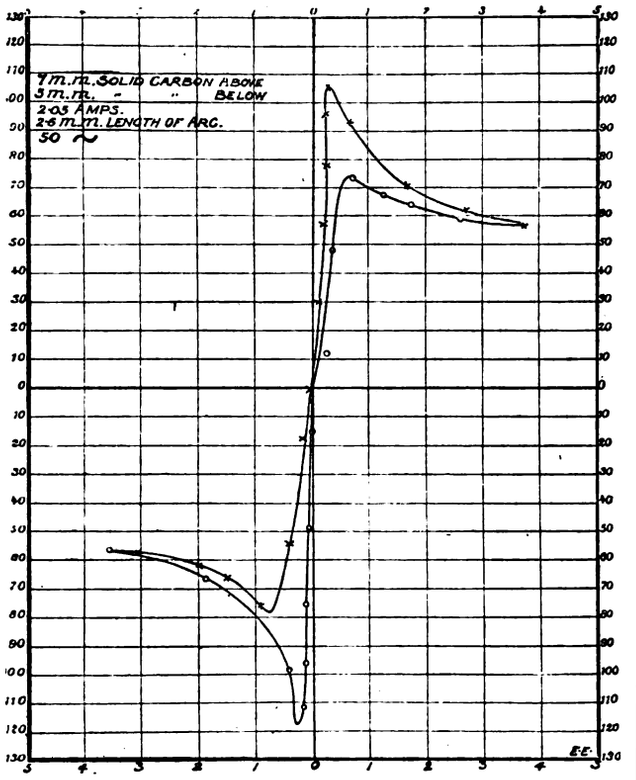

Fig. 6.

high enough, the whole curve appears fixed on the fluorescent screen. This latter method is not confined to low frequencies, as in the case of the oscillograph, and so can be employed in determining the characteristics of electrical resonance discharges and the like.

The type of curve obtained from an arc is shown in Figs. 5, 6, and 7. The crosses represent the curves for rising currents and the circles the curves with falling currents. These two curves are always different, and the cause of this difference the writer proposes to call the hysteresis of the arc. The analogy between the results and the effect of magnetisation in iron is, in fact, very close, and the action of the arc circuit is very similar to that of a magnetic circuit containing an air-gap. Whether

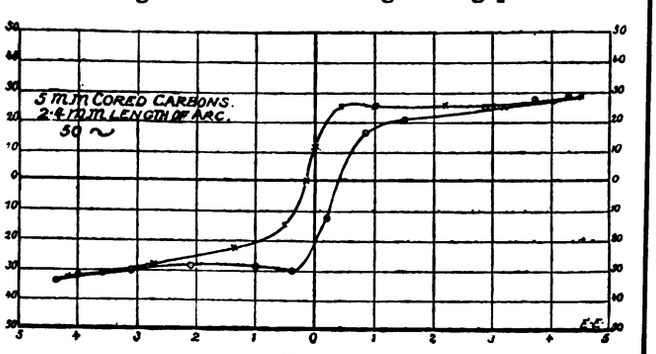

Fig. 7.

the quantities corresponding to residual magnetism and to coercive force actually exist, or are only due to experimental errors (which would reach their maximum values just at those parts of the curve), the writer hopes to decide definitely by further experiment. It is possible that the effect corresponding to residual magnetism—*i.e.*, the fact that an E.M.F. exists when the current is zero—may be a thermo-electric effect due to differences of temperature between the two electrodes, such as occur with vertical carbons due to the rising streams of hot gases. The dynamic characteristic curves are affected by the length of arc, quality of electrodes, and all the other variables which affect the static characteristic. Thus the five characteristics in Fig. 9 (calculated from the volt and ampere curves in Fig 8) show the effect of increasing the length of the arc with a constant supply voltage (maximum instantaneous value = 200), constant steadying resistance, and constant periodicity. The sloping straight lines are the steadying resistance lines—*i e*, the tangent of the angle they make with the horizontal is equal to the amount of the steadying resistance in ohms, so that heights from the 200-volt line to this resistance line represent the volts lost in the steadying resistance at each value of the current. It will be seen that for very short arcs (*a* and *b*) the falling branch of the characteristic is above the rising branch. This is probably due to the influence of the air currents which, in Mrs. Ayrton's tests, were found to produce a hissing arc under the same conditions.

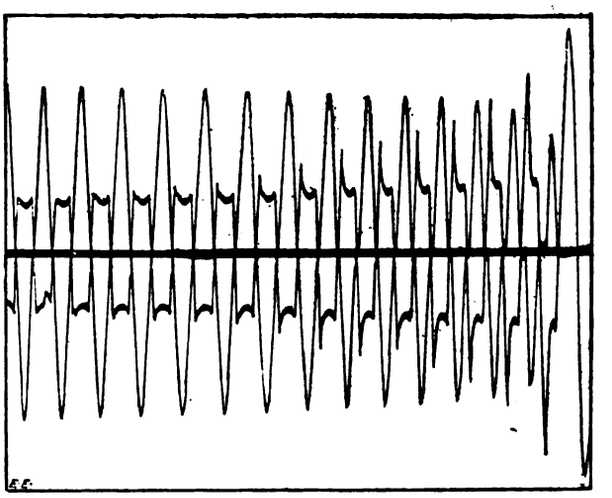

Fig. 8.

The effect of varying the steadying resistance is shown in Fig. 10. The four curves are obtained from a test made with a constant length of arc of 3mm. and a voltage whose maximum value was 200, the steadying resistance being rapidly increased whilst the oscillograph record of volts and amperes was being taken on a moving film. It will be seen that as the maximum current falls—*i e.*, as the steadying resistance rises—the maxima of both rising and falling characteristics increase, but the rising curve much more rapidly than the falling one. The maxima also occur at smaller and smaller current values. The hysteresis rises with falling maximum current value. Extinction of the arc occurs as soon as the maximum of the rising characteristic reaches above the resistance line. Tests were also made with a falling frequency, and showed that both rising and falling characteristics increase their voltage maxima with falling frequency, but the former more rapidly than the latter, so that the hysteresis increases with falling periodicity. The currents at which the maximum voltages occur get smaller as the periodicity falls, and extinction of

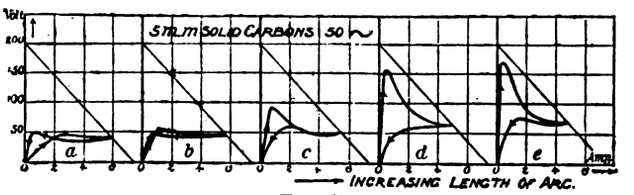

Fig. 9.

the arc again occurs as soon as the rising characteristic exceeds the resistance line.

On the basis of the ordinary ionic theory of discharges in gases, the following explanation of the electric arc may be given: In the ordinary state of the surrounding gas only a few ions are present, so that even with a high applied voltage a very small current only can pass. As the voltage is increased a value is eventually reached at which the existing ions attain so great a kinetic energy that they are able to ionise the neutral molecules by colliding with

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them. The conductivity and the current accordingly increase whilst the voltage falls, and what is known as the glow discharge takes place. Up to this point it is only the ions of the gas itself which carry the discharge. With increasing current the gas path as well as the tips or craters of the electrodes warm up to a degree sufficient to produce a balance between heat energy supplied and heat energy emitted. Eventually glowing of the electrodes occurs, and the negative electrode begins to set an appreciable number of electrons free. These give increased ionisation and increased current at lower voltage, so that evaporation of the electrodes commences, and this vapour then carries the discharge. The increasing current finally becomes limited by the steadying resistance in use. When the discharge takes place in the electrode vapour, the ordinary conditions of the electric arc exist.

Of the energy used in the arc (volts × amperes), by far the greater part is used at the positive and negative electrode surfaces. This energy determines the temperature and the surface of the two craters, whilst, on the other hand, the crater surface and the length of the arc determine the voltage required for any particular current value. As soon as the point is reached at which the negative electrode commences to vaporise, as described above, increase of current no longer increases the temperature, but only the surface of the negative crater. So long as the negative crater is small, a small increase in current produces a large percentage change, and it is on this account that the characteristic falls away so suddenly after the voltage maximum, when the negative electrode is white hot. The positive crater has a similar though much smaller effect, for this crater, owing to the greater fall of potential at the anode, has a greater surface than the negative crater even at small currents. The difference in the effect of the two craters is further accentuated by the important action of the negative crater as the source of the ionising cathode stream.

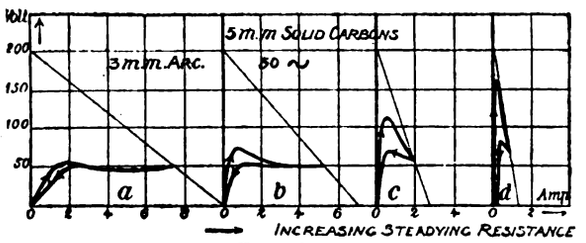

Fig. 10.

From the above considerations it is clear that the principal determining factor for the voltage required for a given current may be considered as the product, T F, of the temperature, T, and surface, F, of the negative crater. All the other factors, such as drop of potential at anode, surface of positive crater, fall of potential in the gas column, etc., are included in this product T F. It is immaterial how the value of this product is produced—*i.e.*, whether by the passage of the current itself or through externally applied heat. At ordinary atmospheric temperatures a considerable voltage must be applied before a sufficiently high T F is reached to set free an appreciable number of electrons. When once this point is reached, a comparatively low voltage is sufficient to give the high value of T F required for the maintenance of the arc. The value of T F does not depend simply on the product of volts and amperes, but also on the relation between the energy supply and the energy dissipation through conduction, convection, and radiation. Of these, the dissipation through conduction is by far the most important. The current develops a heat energy equal to $e \times i$ in unit time, while a certain amount of energy, W, is dissipated per unit of T F in unit time. These two amounts must be equal, so that $e \times i = W\ T\ F$ or $T\ F = \frac{e\ i}{W}$. For a given amount of energy supplied, T F becomes lower the quicker the heat is dissipated from the crater surface, so that in the case of the static characteristic of the arc the voltages are higher, and the maximum voltage occurs at a higher current, the greater the facilities for heat dissipation.

When the supply of energy is variable instead of constant, there is an alternate storing up and giving out of energy by objects surrounding the arc—these objects acting as a secondary source of energy. The equation for this case may be stated as

$$e\,i = (W\ T\ F)_t + L\left[\frac{d\,(T\ F)}{d\,t}\right]_t,$$

where L is a constant depending on the density, specific heat, and heat conductivity of the electrodes and the surrounding air. The index t indicates that the instantaneous values of the various quantities are used. By the aid of this expression the writer determines the dynamic characteristics for various practical cases from the known or assumed static characteristic, and shows that the calculated effects of changes of steadying resistance or of periodicity on the characteristic agree well with the experimental results. He is further able to give simple explanations of other well-known effects, such as the valve action of a carbon-metal arc, the difficulty of maintaining an alternating arc between metal electrodes, the difficulty of measuring the "true resistance" of a direct-current arc by superposing an alternating current through it unless excessively high frequencies are used (Duddell, *Proc.* Roy. Soc., 68, p. 512, 1901), etc.

An important bearing of the arc "hysteresis" on the production of Duddell's singing arc is also pointed out, and the writer hopes shortly to publish a theory of this phenomenon based on oscillographic experiments.

PERSONAL.

Mr. A. J. Fraser, electrical engineer to the Nelson Corporation, has resigned.

The Doncaster Town Council have increased the salary of the electrical engineer, Mr. Rayner, by £50.

Mr. Charles E. Gray has been appointed electrical engineer to the Ross Electric Light and Power Co., Ross, in place of Mr. A. P. Lumsden.

The Heywood Town Council have granted the electrical engineer, Mr. James Scott, a sum of 50s. to distribute for extra work performed by his staff.

It has been decided to appoint Prof. Fitzgerald electrical inspector for the city of Belfast from June 16 last at a salary to be named by the Board of Trade.

Mr. N. Gunz has resigned his position of secretary of the General Electric Co., and has established himself as manufacturers' agent at 46, Queen Victoria-street, E.C.

THE INFLUENCE OF ELECTRICITY ON POWER ENGINEERING.*

BY W. B. ESSON, M.I.C.E., M.I.E.E.

(*Concluded from page 532.*)

Up to the present I have referred to hydro-electric plants only, and it is not easy to estimate the total of the water power which has been utilised all over the world by their erection. The tribute under which Niagara River has been laid for power supply has been already cited, and I believe I am well within the mark in placing the total capacity of the hydro-electric power-houses at work and under construction on the American continent alone at a million horse-power. In Italy, Lombardy alone accounts for 88,000 h.p. in hydro-electric power-houses at work and under construction, while Switzerland, the home of hydro-electrics, accounts for 220,000 h.p. Taking the whole world, the water power utilised in the hydro-electric stations must lie somewhere between a million and a half and two millions of horse-power—a vast force the greater part of which might have run to waste for all time had it not been for the invention of the dynamo.

All these schemes cannot be placed in the same category. Cases are numerous in which electricity is employed merely as a means whereby the power of water can be conveniently parcelled out to various industrial undertakings in the immediate neighbourhood. Such cases furnish an example of power distribution rather than of power transmission. The work is brought to the power, and the enterprise is of a kind differing entirely from those in which the power must be transmitted over a considerable distance, and in

* Presidential address to the Civil and Mechanical Engineers' Society, delivered Oct. 5, 1905.

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which by no possibility could the work ever be brought to its source. As furnishing a case of the former kind Niagara may be cited. The supply of cheap electrically distributed power has been the means of founding a most important industrial district and of increasing land values to a large extent. There is no doubt that here, though distance does not come in so much, electricity furnishes by far the best means of power distribution, but several other means have been proposed, and an altogether different problem is that of transmitting power to a distant region practically inaccessible so far as fuel is concerned on account of the enormous cost of transit. The works in the immediate neighbourhood of Niagara use about 60,000 h p, and their demand continues all the year round without ceasing, the greater portion of the power being used for metallurgical and electro chemical processes in the form in which it is received. The Niagara industries present the case of Mahomet going to the mountain, but amongst the cases of the mountain taking itself to Mahomet the transmission to the Kolar goldfield at Mysore already referred to furnishes a very good example. For years prior to 1899 the project of utilising the falls was discussed, but as often was it abandoned because of there being no local market for the power and no prospect of any industries being tempted to the district. But the falls were there with their huge power running to waste, and the Kolar goldfield was but 92 miles distant. Fuel in the mines was excessively dear, while the possibility of transmitting the power economically to great distances had been demonstrated in the case of other undertakings. The problem of utilising the power was in 1900 again taken up with all the knowledge which had been gained elsewhere brought to bear on it, and an enterprise is in full swing to-day by which 4,000 h.p. is delivered to 10 mining companies in the Kolar fields, the revenues from which are sufficient to recoup the Mysore Government for the whole of its capital outlay in six years.

It is difficult to realise what electricity has done for the mining industry. I am not thinking of its use for power distribution in and about coal mines, though on the Continent this has now attained gigantic proportions, but of the reduction in operating cost effected by the utilisation of distant water power through the medium of electricity. Mines which under the old regime could not have been made to pay have been opened up, whilst those that previously had just been clearing expenses have been enabled to pay dividends. It is estimated that the Sheba mine saved £10,000 per annum by introducing electric transmission, owing to the ore being then crushed in the mine instead of transported by aerial ropeway to a mill on the bank of a river 2¾ miles away. At the Burma ruby mines, before the installation of the electrical transmission plant the cost of fuel for power and lighting was £500 per month. The hydro-electric plant saved all this—£6,000 per annum—and enabled the company to begin paying dividends. By the installation of their three-phase plant, the first in the Rocky Mountain regions, the Silver Lake group of mines looked to save £7,200 per annum. These are a few instances out of many. The same tale is told in all cases.

The carrying out of power schemes in this country does not demand a fraction of the resource and originality demanded of engineers carrying out power schemes in some of the American States. Here a trench is made in the ground, an insulated cable is put in with or without bitumen around it, and so the transmission line is laid. Nothing could be simpler, but it is a very different matter carrying a pole line over the mountains in Colorado. There the engineer meets Nature in her most aggressive mood. Wind, snow, sleet, and lightning storms have to be faced, and through all the line must stand intact. Crossing canyons with spans of over 1,000ft.; climbing divides at an altitude of 13,000ft., in winter inaccessible and swept by frequent snow slides; carrying a pipe line to work under a head of 1,400ft. almost perpendicularly down the face of a bluff; making a 6ft. wooden pipe to stand a head of 450ft.—these are a few of the many problems which have to be solved by power engineers abroad. The construction of the pole line often presents much difficulty though many points of interest. Until recently wooden poles only had been used, but it is evident that iron and steel, being many times stronger than wood, and capable of economical disposition with regard to the strains, properly designed structures of this material would enable spans to be greatly increased. Such structures have been used in special cases and where long spans are necessary for crossing rivers or spanning ravines, but there is a growing tendency to employ for high pressures a steel pole construction with the spans made intentionally long so as to reduce the number of points of support. The number of insulators is, of course, reduced to correspond with the increased spans, and it is argued that a construction of this kind, by diminishing these weak points, gives a line less liable to interruption than one in which wood poles are used. Steel poles certainly give a construction more in accordance with engineering ideas, and though the bulk of the work may be still carried out in wood, it is probable that for main lines, whenever the magnitude of the enterprise will justify the larger investment, the more solid and permanent construction will be employed. With proper care steel piles should last at least four times as long as wooden ones, so that the sum to be set aside for renewal is much reduced, while the maintenance is also less. But against this there may, in many cases, have to be set the cost of freight and haulage to an almost inaccessible region where timber may be obtained for the cost of felling. In this instance the difference in capital outlay would be considerable, while in an iron-working district, on the other hand, it might be negligible. We shall very likely use steel poles for our power lines in this country because we produce, not wood, but steel, and have a preference for things solid and lasting. But we have easy country to negotiate compared with some of the country over which power lines run abroad—a factor which is of considerable importance.

A good example of steel construction is presented by the line of the Guanajuato Power and Electric Company in Mexico. There steel towers about 12 to the mile are used instead of wood poles, which are generally spaced 40 to the mile. In Italy iron pole work has been developed to a considerable extent. After Paderno, which was the first line to adopt an all-iron construction, the Cenischia line was erected with a similar design of pole and with spans up to 260ft. Then came the Brembo line with specially constructed spans up to 920ft. to transmit the power over the mountains. Mr. Semenza, who has done a large amount of important work in connection with this subject, informs me that amongst others at present under construction are two new lines with spans of 360ft., one of them to carry six wires, the other to carry 12. The first iron poles were unnecessarily heavy and had equal stiffness across the line and parallel to the line. Mr. Semenza has quite rightly contended that as in a straight line with equal spans the only strain to be borne by the line is exerted by the wind, it is unnecessary to employ poles of equal resistance in all directions, and he has accordingly designed a pole which presents great resistance in the direction of the wind, but low resistance in the direction of the line. This pole is elastic and can deflect over 16in. without exceeding the limit of elasticity, the consequence being that if one or two of the wires break the two nearest poles will bend, which will relieve the strain on the spans following, so that as a whole the line will stand, and no damage be done to the supports. The two new lines mentioned above as under construction have poles of this kind, as well as the Brembo line.

Several important undertakings depend only on one transmission circuit, amongst which may be mentioned the Electra-San Francisco transmission, 154 miles long; the Shawinigan Falls-Montreal transmission, 85 miles long; and the Welland Canal-Hamilton transmission, 30 miles long. There is considerable economy in having only one set of conductors, and whether the risk of breakdown on a line constructed in the manner just described is, by using two circuits, reduced to such an extent as will justify the extra cost, must always be a matter for the engineer, guided by local circumstances, to decide. When two circuits are employed the individual conductors are smaller, so that there is not necessarily a greater total weight of copper, but for high pressures a pole line for each circuit is advisable, and this with its complement of cross-arms and insulators considerably increases the outlay. Only

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when the pressure does not exceed 25,000 volts, and where in consequence the risk of shut down is immeasurably less than when pressures of 40,000 to 60,000 volts are used, is it wise to adopt a construction whereby two circuits are carried on one set of poles.

Needless to say, turbine construction has been influenced to a very large extent by electric power development. Apart from the enormous amount of hydraulic engineering work represented by the utilisation of something between one and a half and two million horse-power, the improvement in the efficiency of the turbine from the date of the Francis wheel must be credited directly to the great stimulus electric power work gave to turbine manufacture While in 1870 the average power of each wheel made by one of the leading turbine firms was 70 h.p., in 1903 it was over 700 h p, and the annual output in horse-power had increased from 10,000 to 130,000. Twenty-five years ago the construction of a turbine giving 500 h p. was something of an achievement, to-day turbines are at work of 10,000 h.p. In all modern installations the electric generators are coupled direct to the turbine shafts. When it is possible, a horizontal shaft arrangement is chosen, though it is noteworthy that up to the present, owing to the special conditions to be met, the largest turbines have had vertical shafts. Generally the full-load turbine efficiency is about 80 per cent., though higher figures have been obtained, but the power of the wheel, the speed, and the fall all influence the useful return. The design of turbines has not received much study in this country, possibly because here the sphere of their usefulness is comparatively narrow. On the other hand, the subject has been studied exhaustively on the Continent, and it is to books written in another language that we must go for our information.

But if we are backward with respect to water-turbines, we make up for this as regards the steam-turbine, for if Britain is not exactly the birthplace of the latter it is the country which has seen its greatest development. The Parsons turbine was first designed in conjunction with a dynamo to form a complete generating unit, and, born in 1884, in the present year the turbo-generator attains its majority. At the time of its advent but little attention was paid to it, and it was regarded mostly as an interesting scientific toy. To-day there are 600,000 h.p. of turbines of the Parsons type at work, and in 21 years the machine has grown from a 10-h.p. infant to a 10,000-h.p. giant. The turbine is gradually being recognised as the simplest and best form of steam-engine for alternator driving, and to be preferred to reciprocating engines in every case when the generator output is over 1,000 kw., and there is available plenty of condensing water. Surely this is a wonderful example of the influence of electricity on power engineering, and when it is remembered that the great success of the turbine has been due to the ability, energy, and enthusiasm of one man, it is felt that he deserves the greatest and the best rewards that engineering has to offer.

The influence of electricity on the design of steam-engines other than the turbine is undoubted. When the dynamo first made its appearance there was no high-speed engine in the market, and it was the persistent call of electrical engineers for an engine to which their machines could be coupled direct, thus dispensing with belts or ropes and the loss of power inseparable from them, that led the late Mr. Willans to persevere and achieve such remarkable results. The dynamo gave the engineer an appliance which enabled him to ascertain to a nicety the efficiency of his engine. With carefully calibrated instruments it was extremely easy to locate and measure the losses at different loads and under various conditions, and the researches in this direction described in the classical papers of Willans are a standing tribute to his ability as an engineer and his patience as an investigator. Many have followed in Willans's footsteps, with the result that high-speed engine design has about reached its highest level. With high efficiency there has ever gone a cry for efficiencies still higher, and electricity as demanding engines of the high-speed class and providing an easy method of testing their performance has been the main factor to which the progress has been due.

I have dealt in this address at some length with the great water-power utilisations—a branch of power engineering which owes its very existence to the agency of electricity. But the influence of electricity has been apparent not only in giving birth to these undertakings, but in modifying the manner and method of power engineering in every direction. The way in which this influence has been exerted in the case of the steam-engine has been referred to, and its effect on the design of gas-engines has also been marked. Dowson, by his introduction of a heat gas, did much in the early eighties to encourage the use of gas-engines, and considerable progress resulted from his work. On account of the demand for engines to drive dynamos a large number of competitive designs came into the market, and improvement was greatly stimulated thereby. But it was not till 1896 that blast-furnace gas was used in a gas-engine, an experiment being made in that year on a very small scale at the Wishaw works of the Glasgow Iron and Steel Company. When the possibility of burning blast-furnace gas direct in the cylinder of an engine and the economy resulting therefrom were realised, a great impetus was given to gas-engine construction. But, alas, from this date the sphere of the greatest activity was shifted to the Continent, and it is there that the great business in large gas-engines has been done. It was left for the newer iron and steel works on the Continent to take advantage of the opportunities which the working with blast-furnace gas afforded. In such works the blowing, of course, comes first, and engines of 1,200 h.p. have been constructed for this. Nevertheless, a large number of engines are coupled direct to electric generators which serve to operate motors for cranes, rail straighteners, shears, pumps, and all the auxiliary machinery to be found in an iron and steel works. At the present time there are probably not less than 100 engines of over 500 h.p. working with cheap power gas to drive electric generators, and more large engines are made for this purpose than for any other. Already engines of 2,500 h.p. have been constructed for electrical work, and I understand that the designs are completed for the 5,000-h.p. size. Undoubtedly engines using gas produced from cheap bituminous coal will figure largely in the electric power stations of the future.

On the Continent a number of installations have been erected in which the by-product gas from coke ovens is utilised to drive gas-engines. In the Ruhr coke-making district in Germany there is an aggregate of no less than 6,000 h p. produced by the utilisation of waste gases from the ovens. There are coked in this country annually about 50,000,000 tons of coal, and the gas from the coke ovens is capable of yielding in gas-engines 1,000,000 h.p. continuously. In Germany and Sweden there are several works in operation producing power gas from peat. For the production of this gas the peat can contain as much as 45 to 50 per cent. of water, and it is not unlikely that there may be an opening here for the establishment of power stations near peat moors remote from coalfields. I have heard of a peat moor about 1¾ miles square capable of supplying enough gas to generate 10,000 h.p. for 60 years. This may or may not be an exaggeration, but it is certain that there is enormous industrial waste in this country, and that true co-operation in the widest sense of the term between different industries would result in large savings.

I have not touched upon that department of power engineering which concerns itself with railways. The influence of electricity has wrought revolutionary changes here, but I have already occupied your attention too long, and in dealing with a subject so vast something has to go. It is only 24 years since the first commercial electric rail way was laid down, and to-day the capital invested in street railway undertakings is something in the vicinity of 200 million sterling. In this country there are about 1,800 miles of electric tramways and about 280 miles of electric railways, of which in London alone 150 miles are opened or under construction. These figures indicate great progress, but there are many fields of enterprise as yet untilled, and in closing I feel that I have but touched the fringe of a great subject. In the application of electricity to power work, engineering finds its mission of civilisation as well as its greatest triumph, and the power lines disappearing in the jungle, climbing to the mountain tops, spanning the torrent, and descending to the fertile valleys,

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bear to distant points, no less than telegraph and telephone, a message of peace and progress.

THE LIVERPOOL-SOUTHPORT ACCIDENT.

Board of Trade Report.

The Board of Trade have now issued the report of Lieut.-Colonel E. Druitt, R.E., upon the fatal collision which occurred on July 27 on the Liverpool-to-Southport line. It will be remembered that an express passenger train to Southport ran into an empty train standing on the middle line at the Hall-road Station. We reported the accident at the time, and it will be remembered that 20 passengers in the leading car were killed. Colonel Druitt reports that the collision was solely due to inadvertence in leaving the siding points in the wrong position, and then to disregard of rules on the part of Boote, the signalman at Hall-road Station box, and to disregard of rules and reckless driving on the part of Rimner, motorman of the express. The only lesson to be learnt from this calamity is the very old one—namely, of the necessity at all times of complying exactly with all rules and regulations, and that punctuality and fast running must always give way to safety. In the report Colonel Druitt also deals with the many points raised in the Press and elsewhere as to the collision in question. This part of his report reads as follows:

1. The alleged greater danger of facing points as compared with trailing points on a line on which express trains run. This danger does not exist with the safeguards especially introduced, which have been described above, to prevent a signal being lowered to the safety position unless the points are first accurately in position for the line to which the signal refers. In this case both the signalman and the driver broke important rules regarding the manner in which trains are to pass signals which are defective or out of order, and in consequence a collision occurred; but a worse collision can be brought about at trailing points on the supposition that signalmen and drivers may break rules, as then two trains running at speed could be brought into collision when converging on to a single line. Facing points are being brought more and more into use for leading on to loop lines, and for platform lines at stations while the lines for express trains run between the loop or platform lines. Their great advantage is that slow trains preceding an express can be quickly run off the fast line on to the slow or loop line or into a siding, without first running forward the whole length of the train, stopping, and then backing slowly in through trailing points, a lengthy operation, and one which keeps the fast line occupied much longer than necessary. Given the conditions of traffic at Hall-road Station, the facing connections are in my opinion the simplest and quickest way of getting the turnback trains off the down road clear of following trains, and, therefore, the safest. No doubt an ideal system would be to have separate pairs of lines for fast and slow traffic, and when the traffic warrants such a doubling no doubt it will be made, but at present the existing arrangements need only be considered.

2. Whether the open corridor type of car used on this railway fitted for electric traction is more liable to be telescoped, should a collision occur, than the ordinary pattern with separate compartments? These open cars have very strong and heavy underframes, and the tops are light and independent of the frame, being secured to it by a few bolts. It may be pointed out that the open corridor carriage is coming into use on many railways where steam locomotives are used, and, judging by the damage to the cars forming the express train behind the first motorcar, which was very slight indeed, there would appear to be no extra danger with this type of car. It must be remembered that this collision was a very violent one, the express running at a high speed into a train weighing 170 tons standing with the brakes hard on. The rear end of the first car of the standing train jumped up, and so the heavy underframe of the leading car of the express slid along under that of the first car of the standing train, and the top woodwork was all torn away, and the two cars completely telescoped one inside the other. The standing train was driven back a distance of 50 yards with the wheels not revolving, but skidding, so that some telescoping was certain to occur whatever type of vehicle was in use. Two years ago a passenger train of ordinary coaches ran into the buffer stops at a terminal station at a speed of about 12 miles an hour. The locomotive was hardly damaged, but the rear ends of the carriages next the engine were thrown upwards, and the underframe of the second carriage from the engine was thrust under that of the first carriage and was completely telescoped, and 16 of the passengers in it were killed. This collision also raises the old question of always having an empty carriage next the engine where no luggage compartment is so placed, especially as there is no locomotive on these trains to act as a buffer. The motorcars at each end of these trains have, first, a motorman's compartment, then a luggage compartment, and then a vestibule with the entrance and exit doors at the sides, amounting in all to a space of 14ft. between the front and the first portion of the car used for passenger accommodation. I do not consider it practicable to require the motorcars at each end of the train to be run empty. End-on collisions are as likely to occur as head-on collisions, so the same precaution would be necessary at the tail as at the head of the train. Much greater security can be obtained by strict observance of rules, and the fact that one driver has recklessly run past a stop signal in the danger position at a very high speed cannot be regarded as one requiring the very onerous conditions to be imposed which would result if no passengers were allowed in the motorcars. Such conditions would quite prevent the use of single steam motorcars, which are now being used in great numbers by several railway companies.

3. With regard to the danger from fire, it may be pointed out that on this occasion as soon as the collision occurred a short-circuit was set up between the live rail and running rail, probably through a bar falling across them, and so a very large arc was formed at once, and this blew the section circuit breakers at the Formby sub-station, but not those at the Seaforth sub-station, which were much further away from Hall-road, but the sub-station attendant at Seaforth records a heavy overload at the moment of the collision. This arcing caused by the short-circuit soon ceased, either from the bar being fused through or something being moved, and then the current fed to the third rail from Seaforth was normal, showing that no short-circuit existed. When the circuit breakers at Formby sub-station blew, the switchman on duty there telephoned to Seaforth sub-station and also to Formby signal box to know if anything was wrong, and being informed all was well there, he, thinking the circuit breakers had blown through overload, restored them and found there was a load of 600 amperes (less than the normal load), and this shows that there was no longer a short-circuit, and, therefore, no arcing taking place. As soon as he had restored the circuit breakers the Hall-road stationmaster rang him up to cut off the current, which was done at once both at Formby and Seaforth sub-stations, and the third rail rendered dead for that section of the line. About four minutes had then elapsed since the collision had occurred. On subsequent examination it was found that there were no signs of fire on any of the cars, except a slight charring of the woodwork underneath the first car of the standing train, and signs of short-circuiting between the broken conductors and the ironwork under the car, which caused a certain amount of smoke, but there was no actual fire in any of the carriages, and no one in them could have received any electric shock. It may be mentioned that iron bars are supplied to stationmasters, and are also carried on the trains, for setting up a short circuit and thereby blowing out the circuit breakers at the sub-stations in case of emergency. On the occasion in question the stationmaster should have telephoned at once to have the current cut off, as he saw the large flame of the arc, instead of first going to the scene of the collision. It may be remembered that in a bad end-on collision last winter the derailed coaches of an express train, driven by steam, caught fire and several were totally destroyed. So far as can be gathered from the results of the first bad collision on a railway worked by electric traction in this country, there would appear to be no extra danger of fire occurring among derailed coaches than on a railway worked by steam.

4. It may also be mentioned that, though there is only one motorman on each electric train, the guards are instructed as to how to stop a train in case of emergency should the motorman be suddenly incapacitated. On electric express trains there is one guard, with instructions, as soon as the train starts, to walk through the train from end to end, count the passengers, and then stand behind the motorman for the remainder of the journey. On electric stopping trains there are two guards, one of whom is always standing behind the motorman when the train is running. Looking at the facts connected with the collision, the two most striking results are, first, the absence of any fire among the derailed coaches, the danger from fire being one regarded as especially liable to occur on railways using electric traction; and, secondly, the very small amount of damage done to the cars, with the exception of the leading one of each train, due, no doubt, to the very heavy and stiff underframes. Probably the collision would not have been so severe if steam locomotives had been in use, as under the same conditions the acceleration of the express would not have been so rapid; that on the electric trains is stated to be such that a speed of 30 miles an hour can be obtained from rest in a period of 30 seconds, but this and the quick stopping due to the very powerful brakes in use form the great advantages of electric traction for a fast and frequent passenger service of trains, and no danger need result therefrom if the ordinary rules for working trains are adhered to.

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LEGAL INTELLIGENCE.

TRAMWAY ACCIDENT.

An action was heard by Judge Mansel Jones at the Sheffield County Court on Wednesday, when Mrs. Elizabeth Prior sued the Sheffield Corporation for £25 damages for personal injuries.

Plaintiff's case was that she was crossing the road, when a number of people—who were being refused admission to a tramcar which had not reached a stopping-place—were flung back, and some of them falling against the plaintiff, she fell to the ground. The Corporation repudiating liability for an accident which they contended was caused by the improper attempt of passengers to board it before it reached its proper stopping-place.

His Honour said the witnesses for the defence had contradicted themselves, and held that plaintiff had made out a good claim, and gave judgment in her favour for the amount claimed.

TRAMWAY CLEANER'S INJURY.

At Cardiff County Court last week, John Lethbridge, a car cleaner in the employ of the Corporation, sued the latter for damages for injuries under the Workmen's Compensation Act.

The case for the plaintiff was that whilst engaged on repairing cars in the car-shed he went to grind a tiebar at the emery wheel, when his hand was caught by the wheel and the top of one of his fingers was torn off, and his left hand otherwise injured. He had not worked for 18 weeks as a consequence, and his hand was not right yet. After the accident a notice was put up forbidding the use of the wheel.

For the Corporation it was contended that no one but a machinist had a right to use the emery wheel in the way plaintiff had used it. It was his duty to take the tiebar to the foreman, and the accident was due to the fact that, as an unskilled man, he was trying to do something that only a skilled mechanic ought to do.

His Honour believed that the accident was due to a defect in the wheel, and gave judgment for plaintiff for £60, with costs.

COMPANIES' MEETINGS AND REPORTS

CUBA SUBMARINE TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held on Wednesday under the chairmanship of Mr. C. W. Parish.

The CHAIRMAN stated that the traffic receipts for the last six months had amounted to £14,811, as against £16,526 for the corresponding period last year. This difference was due to the fact that last year the French cable had not been down part of the time, and this was the means of bringing extra traffic which usually did not come to them. To their traffic receipts had to be added an amount of £1,450, being interest on investments, making, with transfer fees, a total of £16,272. Their expenses were £6,334, and the preference dividend for the half-year amounted to £3,000, making altogether £9,334, which enabled them to declare a dividend on the ordinary shares at the rate of 5 per cent., leaving £2,938 to be carried forward. The reserve fund now stood at £85,181. It was a matter of great satisfaction to them to know that they were able to meet all demands for fresh cables and repairs and still have a satisfactory reserve. Their appeal to the law courts of Cuba for the subsidy due to them for cost of cables had not yet come up for judgment.

The report was adopted without discussion.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The ninth ordinary general meeting of this Company was held under the chairmanship of Mr. R. M. Horne-Payne. Full particulars of the report appeared in our last week's issue.

The Chairman reviewed the position generally, after which the report and accounts were unanimously adopted, as also was the following resolution: "That the payment of the dividend on the cumulative perpetual preference stock and preferred ordinary stock and the payment of the interim dividend at the rate of £3 per cent. on the deferred ordinary stock, paid in April, 1905, be approved, and that a balance dividend on the deferred ordinary stock at the rate of £3 per cent., making a total dividend of £6 per cent. (free of income tax) for the year ending June 30, 1905, be declared."

NORWICH ELECTRIC TRAMWAYS.

The ordinary general meeting of this Company was held last week, Baron E. B. d'Erlanger presiding.

The directors' report stated that there was a gross profit for the year of £10,838. 6s. 9d. Out of this amount the 4 per cent. interest on the Company's mortgage bonds for the year—viz., £2,640—has been paid, and £1,000 placed to reserve fund account (which now stands at £4,196. 17s. 1d.), leaving £7,198. 6s. 9d. to be dealt with. The directors recommended that a dividend of 2½ per cent. be paid on the shares of the Company for the year ended June 30, 1905, absorbing £6,600, and that the balance of £598. 6s. 9d. be carried forward. The revenue shows a decrease of £81. 6s. 7d., and the expenses an increase of £680. 13s. 11d., consequently there is a decrease in the profits of £762. 0s. 6d. The directors would, however, point out that exceptional outlay has been made on maintenance and repairs, including the renewal of several important junctions and a number of crossings, etc., these several items aggregating an amount of about £1,300. If the exceptional expenditure referred to above is deducted from the total expenses for the year, a decrease of some £620 would be shown in the ordinary operating and maintenance expenses. The average working cost per car mile was 5·30d., as against 5·24d. in 1904. The average receipts per car mile were 7·76d., against 7·74d. the previous year. The number of passengers carried was 7,409,126, and the number of car miles run was 1,083,055.

The report was adopted.

INDIAN ELECTRIC SUPPLY AND TRACTION.

The first ordinary general meeting of this Company was held last week, Sir W. D. Lawrence presiding.

The CHAIRMAN stated that the first shipment of cables had been made, and the contractors were of opinion that they would be able to supply current in March next for lighting and fan purposes. In Cawnpore the canvassing indicated that their customers would be exceedingly numerous. Every help was being received from the authorities. In addition to Cawnpore, the directors contemplated developing electric traction in other large towns in India, though they would not extend their operations until the success of their initial experiment was fully assured. At the present moment, of £125,000 stock, £100,040 had been paid up, and the remainder would fall due in September next. The report was adopted.

SWANSEA IMPROVEMENTS AND TRAMWAYS.

The half-yearly report of this Company shows that the gross receipts amount to £16,751. 9s. 11d., being an increase of £2,920. 11s. 9d. upon the corresponding period of last year, and the expenses (including debenture and other interest, and provision for amount payable to the Swansea Corporation in respect of lines to be leased) to £12,542. 19s. 4d., an increase of £2,557. 13s. 2d. The profit on the half-year's working is £4,298. 10s. 7d., which, added to the balance of £1,987. 10s. 4d. brought forward, makes a total of £6,286. 0s. 11d. at the credit of profit and loss account. Of this sum it is proposed to place £1,000 to the reserve account, £1,299 will absorb the dividends on the preference shares, and £3,935. 6s. 11d. is to be carried forward. Referring to the new tramway extensions, the directors say the yearly amount payable to the Corporation in respect of the lines, which is to be based upon the capital properly expended by the Corporation in their construction, has not yet been determined, and the amount set aside in the profit and loss account as payable up to June 30 is calculated upon an estimate furnished by the Corporation. The working of the Mumbles section, as usual in the first half of the year, shows a deficiency of £3,052. 8s. 4d., and the net loss on the improvements undertaking for the half-year amounts to £352. 9s. 11d., of which £309. 5s. 5d. is represented by accrued interest on mortgages. The detailed accounts show in regard to the tramways undertaking that the capital issued amounts to £206,250, and that the amount received for sale to the Swansea Corporation of the electrical equipment of the Morriston section of the Company's lines £6,640, and that £392 were the expenses of opposing the Corporation Bill of 1905. The traffic receipts for the half-year amounted to £16,333. 18s. 4d. The route miles now opened for traffic are 11·40, and the number of passengers carried was 3,018,701, as compared with 2,555,287 for the corresponding half-year of 1904, whilst the average receipts per passenger had gone up ·3d., and the expenditure decreased by ·1d. The total sum provided to date by the British Electric Traction Co. for capital expenditure, working deficiencies, and for first quarter's rent of lines amounts to £43,014. 2s. 9d.

NEW COMPANIES REGISTERED.

Consolidated Supply Co., Limited.—Capital, £50,000. Object: to acquire and extend the works and business of the Consolidated Electrical Co. The price to be paid by the Supply Company for such premises and business has been agreed at the amount representing the same in the last balance-sheet, and is to be paid and satisfied partly in cash and partly by the allotment to the old company of 15,000 of the preference shares of the new company, credited as fully paid, and in addition thereto a further sum in cash which will be more than sufficient to defray the administration expenses incurred since March 31. The directors have, under the terms of the agreement, secured to the shareholders the right to subscribe for 6 per cent. preference shares in the Supply Company, to a total amount of not exceeding £5,000. Registered address: Broad-street House, E.C.

Radia Motor Co., Limited.—Capital, £75,000. Object: to adopt an agreement with Jules Roth, of 36, Rue Taitbout, Paris, to establish in England, France, or elsewhere factories and workshops for the construction of motors and motor machinery driven by electricity or other agency. Registered office: 1, Broad-street-place, E.C.

Liens Registered.

Electromobile Company, Limited, Lambeth, S.E.—Mortgage dated Aug. 10, 1904, stamped to cover £10,000, was on Oct. 5, 1905, stamped to cover a further £10,000. Mortgagees: North of England Trustee, Debenture, and Assets Corporation, Limited, of Manchester, charged on a certain percentage of all moneys payable under contracts for sale, garage, or supply of electricity.

South Metropolitan Electric Light and Power Co., Limited.—Issue on Sept. 29 of a debenture for £10,000, part of a series created

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by resolutions of July 3, 1900, and May 6, 1904, to secure a sum not exceeding the amount of the share capital issued and paid up for the time being charged on the company's undertaking and property, present and future, including uncalled capital. The debentures are issued to the trustees for further securing debenture stock, created by trust deed of Aug. 3, 1900, supplemented by trust deed of June 3, 1904. Trustees: Mr. H. R. Beeton, 18, Austinfriars, E.C.; and Mr. W. R. Davies, 10, Moorgate-street, E.C. Total amount previously issued of same series, £200,000.

APPOINTMENTS VACANT.

Premium Pupil, Electricity Works, Canterbury. See advertisement.

Tramway Constructional Engineer for the Far East. Apply Box R 7, *Electrical Engineer* Office. See advertisement.

Electrician, Poplar and Stepney Sick Asylum, Devon's-road, Bromley-by-Bow, E. Applications to the Clerk by Oct. 21.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sells Advertising Offices, London, E.C.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office. See advertisement.

Resident Engineer, commencing salary £300, rising to £400 per annum; Sub-station Superintendent, salary to commence at £250, rising to £350 per annum; and Shift Engineer, salary to commence at £150, rising to £250 per annum; Birmingham Corporation. Applications by Oct. 30. Full particulars in advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Bermondsey.—Tenders for new plant will shortly be advertised for.

Wimbledon.—We understand that tenders will be called shortly for electric pumps for the sewage works.

Edinburgh.—The Corporation require tenders for arc lamps and arc lamp-posts. Tenders by Oct. 23. See advertisement.

Stoke-upon-Trent.—The Guardians invite tenders for (1) rewiring a portion of the workhouse and cottage homes, and (2) replating the battery. Tenders by 9 a.m. on Nov. 1.

Madrid.—The Public Works Department require designs for a scheme of electric tramways in the town. Particulars from Direccion General de Obras Publicas, Madrid. Tenders by Nov. 27.

Edinburgh.—The Parish Council invite tenders for an installation of intercommunication telephone system throughout the offices, Castle-terrace, Edinburgh. Tenders to the Clerk by 10 a.m. on Nov. 7.

Utrecht.—The Government Railways require tenders for Contracts 215-219—for steel plates, tirefonds, bolts, etc. Specification (1s.) from the Chief of Works and Stores, Morcelse Park, Utrecht. Tenders by Oct. 24.

Brisbane.—The Postmaster-General invites tenders for 150 branching system table telephones. Tenders by Dec. 1. Particulars may be obtained from the Postmasters-General at Sydney, Melbourne, Brisbane, and Adelaide.

London, S.W.—The London County Council invite tenders for wiring and fittings for the electric lighting of the bandstand in the Villiers-street section of the Victoria-embankment Gardens. Tenders by 10 a.m. on Oct. 25.

Greenwich.—The Guardians invite tenders for repairs to the batteries at their installation at Grove Park Workhouse, Lee, S.E., and also for maintenance of same. Full particulars can be obtained and the installation inspected on application to the Master. Replies before Oct. 24.

Dundee.—The Dundee Harbour Trustees invite tenders for the supply and erection at the Craig Pier of three electric arc lamps and three electric incandescent cluster lights, with the necessary wiring, switches, etc. Tenders to Mr. J. Thompson, harbour engineer, Dundee, by 10 a.m. on Oct. 25.

Barrow-in-Furness.—The Corporation invites tenders for the supply and erection of a 500-kw. combined steam-engine and generator, balancer booster, switchboard, water-tube boiler, mechanical stoker, economiser, travelling crane, cooling tower, pipes, etc. Tenders by 12 noon on Nov. 13. See advertisement.

Netherlands.—The Board of Trade have been notified by the acting British consul at Amsterdam (Mr. F. A. Chambers) that the Zuid-Hollandsche Electrische Spoorweg-Maatschappij (South Holland Electric Railway Co.) will be prepared to receive tenders for the making of ground works, engineering, and additional works between the Ceintuurbaan and "piket 120 by 70" (in connection with the works of Contract No. 14), the laying of rails and switches, and the supply and use of gravel ballast, as well as some works in connection with the railway, in accordance with Contract No. 17. The estimated cost of the work is 936,000fl. (£78,000). On Oct. 25, at 10.30 a.m., an explanation will be given, meeting place Café, "Plaats Lommerrijk," on the Bergweg, near Hillegersberg. Copies of the contract, with drawings, may be obtained from Messrs. Beversen and Van Hoorn Heerengracht, 38, The Hague, at a cost of 12·20fl. (£1. 0s. 4d.). Tenders should be written on stamped paper, and received before 1 15 p.m. on Nov. 2.

RESULTS OF TENDERS.

Bombay.—The Brush Electrical Engineering Co. have obtained the contract for an 80-kw. dynamo for the Jubilee Technical Institute.

Hammersmith.—The Council have accepted the tender of J. and A. Law, of Glasgow, at £57. 10s., for extension of the handrail around the main switchboard.

Birmingham.—The Corporation have accepted the tender of T. Lowe and Sons, Burton-on-Trent, at £22,220, for erection of a tramway depot in Moseley-road.

Hampstead.—The Lighting Committee of the Borough Council have accepted the tender of Rickett, Cockerell, and Co. for the supply of steam coal to the electric lighting station for 12 months.

Mansfield.—The Brush Electrical Engineering Co. have obtained the contract for the Mansfield Light Railways Co. (through J. G. White and Co.) for a car to be used for watering and cleaning the track.

Private Plant.—Messrs. Dougill's Engineering Co., Leeds, report an order from the Masborough Co-operative Society for the supplying and erecting of a four-cylinder vertical gas-engine of 140 b.h.p. coupled direct to a 67-kw. generator, the plant running at 250 r.p.m.

Stoke Newington.—The Borough Council have awarded the contracts for sub-station plant as follows: Electrical Power Storage Co., at £998. 10s., for 244 P 11 cells; Ferranti Limited, for switchgear. The rest of the contract has been placed with Bruce Peebles and Co., Edinburgh.

Shanghai.—Messrs. Bruce Peebles and Co., Edinburgh, have received the complete contract for the construction of electric tramways, including 30 miles of track, overhead work and cables, power station plant, and 100 cars and equipments, the total value of the contract being £377,000.

Watford.—The Urban District Council have received the following tenders for supply and erection of a steel chimney at their electric lighting works:

J. Fraser and Son, Millwall, E. (accepted)	£131	0	0
Ashmore, Benson, Pease, and Co., 47, Victoria-street	132	10	0
Norton Hardy Engineering Co., Great Bridge, Tipton	138	0	0
T. Pigott and Co., Spring-hill, Birmingham	143	10	0
J. Thompson, 49, Queen Victoria-street	205	15	0
Teeside and Bridge Engineering Co., 39, Lime-street, E.C.	182	10	0
Heenan and Froude, Newton Heath, Manchester	192	10	0
Willans and Robinson, Ferry Works, Queen's Ferry	189	0	0

London, S.E.—The Metropolitan Asylums Board have received the following tenders for electric lighting, power distribution, fire-alarms, and telephone installation, etc., at the South-Eastern Hospital and Ambulance Station:

Bromley and Batstone, 24-26, Holborn, E.C.*	£4,894	0	0
Buchanan and Curwen, 64, Victoria-street, S.W.	5,495	0	0
Foote and Milne, 66, Victoria-street, S.W.	5,535	0	0
Wenham and Waters, Croydon	5 974	0	0
Alliance Electrical Co., 23, Grafton-street, W.	6,026	12	0
F. A. Glover and Co., Vine-street, Clerkenwell, E.C.	6,500	0	0
Drake and Gorham, 66, Victoria-street, S.W.	6,590	0	0
Belshaw and Co., 53, Victoria-street, S.W.	6,894	0	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Geneva Tramways Co.—The receipts for September were £9,265, being an increase over the corresponding period of last year of £605.

Heywood.—The running of the steam tramcars has ceased in consequence of the reconstruction necessitated by the adoption of the electric system.

Batley.—The work of electrifying the Bradford-road tramway system is nearing completion, and it is believed that trams will be running next month.

Manchester.—The Tramways Committee have promised to consider the application of the ratepayers of Chorlton-cum-Hardy for an improved omnibus service.

Hastings.—An extensive correspondence is proceeding in the local Press as to whether there shall be a Sunday service, opinions being apparently divided on the point.

Bombay.—In reference to our previous note on this matter, it is stated that the action of Mr. Bingham against the Corporation has been dismissed in the Indian courts.

Paddington.—A correspondent writes in the local journal advocating the adoption of the electric tram system in Edgware-road, and produces ample evidence in support of his view.

Bournemouth.—Public meetings are being held in the Branksome ward both in favour of and against Sunday trams, the general consensus of opinion being apparently against them.

Perth.—An animated discussion occurred at a special meeting of the County Council on Monday on the question of Sunday running. Eventually a resolution was carried against a Sunday service.

Brighton.—In view of the reduced number of passengers travelling on the trams during the winter months, the Corporation have decided to somewhat reduce the service, so as to secure economical working.

Paisley.—Speaking at a meeting of the Town Council, Provost R. K. Bell remarked that the advent of electric tramways was one of the most important events which had taken place since his connection with the Council.

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Cardiff.—The Tramways Committee have agreed to accept contractor's reduced tender for the supply of tickets, the price being 15s. per bunch instead of 18s., which is expected to result in an economy of £60 per annum.

Charing Cross, etc., Railway.—The London County Council have disapproved the plans submitted by the company for the Oxford-street station, on the ground that staircase exits leading from public footways are a source of danger to pedestrians.

Maidstone.—It is reported that the Board of Trade has informed the Urban District Council that Upper Stone-street is not included in the recent order for extensions. The Board declines to give any reason, and the matter is expected to be reconsidered by the Council at an early date.

Belfast.—The work of training the drivers and conductors in the management of the new electric cars is proceeding. The Town Council have decided to place the tramway advertising contract with Mr. Courtney on the following terms: £1,400 for the first two years and £2,500 for each of the additional five years.

Spain.—A company has been formed at Barcelona with a capital of 3,000,000 pesetas subscribed capital to construct tramways in the Baleares. Application has been made to the Public Works Department, Paris, by Don José San Roman, of Oviedo, for a concession to construct, in three sections, an electric tramway near Oviedo.

Halifax.—The Corporation have not yet obtained the necessary parliamentary powers for an extension of the tramway system to Bailiffe Bridge, and as the Board of Trade declines to grant a provisional order for an extension beyond the city boundary, the matter will remain in abeyance until the Corporation apply for another Act of Parliament.

Croydon.—The division of the ratepayers who favour the complete municipalisation of the tramways have opened a campaign with a view to securing their object. At last week's meeting of the Corporation the plans submitted by the British Electric Traction Co., showing the route along which it is proposed to lay underground cables in connection with the Mitcham-road, etc., extensions, were approved.

London United Tramways Co.—At a meeting of the Hammersmith Borough Council on Wednesday the Works Committee, having considered the borough surveyor's report, recommended that notice be served on the company requiring them to repair the wood paving along Uxbridge-road, Goldhawk-road, Glenthorne-road, Beadon-road, Studland-street, and King-street, between the Broadway and Young's-corner.

Whitworth.—At a meeting of the District Council it was reported that the Rochdale Corporation were unable to secure power to construct tramways in Whitworth under a provisional order, but that if Whitworth obtained the necessary powers, Rochdale would be prepared to work the tramways on terms to be arranged. The Council resolved to fall in with the Rochdale Corporation's offer provided that the terms mentioned were satisfactory.

Leith.—Owing to the current on the Leith Walk section running to earth, there was a delay in resuming the service. The cause of the stoppage was due to the bell connected with the circuit breaker on the car failing to ring, when the motor equipment went out of order. The defect was soon remedied. This is the first hitch since the opening of the system. It is stated that the portions of the new electric system still under construction will be opened on Friday, Nov. 3.

Bolton.—We have received a copy of the accounts presented to the Borough Council for year ended March 31, from which we see that the income totalled £95,766, being an average of 10·634d. per car mile, while the expenditure amounted to £55,202, representing an average of 6·13d. per car mile, leaving a gross surplus of £40,564. Interest and sinking fund absorb £13,014 and £12,278 respectively. After placing to the reserve the substantial sum of £11,600, the Corporation were able to assign nearly £4,000 to the relief of rates.

Dundee.—Considerable progress is being made with the construction of the tramway between Dundee and Monifieth, and it is anticipated that cars will be running before Christmas. A slight deviation has been made from the original plans at the point where the system will leave Craigie estate and enter upon property of the Earl of Home. Instead of encountering a pretty stiff gradient, arrangements have been made for the new roadway which has been made to the north of Stannergate Station, running through a corner of the Earl of Home's estate, and thereby saving the climb.

Aberdeen.—From the report of the Tramways Committee for the year ended May 31 we learn that the total income amounted to £70,430, averaging 10·46d. per car mile, and the general working expenses totalled £42,393, leaving a net balance of £28,037, out of which interest and sinking fund absorbed £10,882 and £2,858 respectively. The amount carried forward to renewal account reached £10,562, whilst £2 846 was written off for depreciation. The total length of single track is about 27½ miles, and the mileage covered during the year covered by the report reached 1,617,525, whilst the number of passengers carried amounted to 17,142,896.

Southend-Colchester Light Railway.—The light railways order, as modified and confirmed by the Board of Trade, authorising the construction of light railways from Southend to Colchester has now been published, giving exact details as to the powers granted and the reservations provided for. The proposed railways form a series of five, making a fairly direct line from Colchester to Southend with a hiatus between West Mersea and Bradwell, where the estuary of the Blackwater intervenes. The gauge is 4ft. 8½in. The length of the line is to be 9½ miles. The motive power authorised for the company includes electricity as well as steam power. The capital of the company is to be £300,000 in 30,000 shares of £10 each.

Manchester-Ashton.—Negotiations are proceeding between the Manchester and Ashton Corporations for alternate through running of the two authorities' cars. Under the agreement between the two Corporations Ashton should have commenced running cars to and from Droylsden on Sept. 30, and six new cars were obtained. Manchester did not, however, favour the break in the through journey, and a deputation from the Ashton Tramways Committee recently waited upon them, and proposed as an alternative that the Ashton cars should run through to and from Manchester, each authority to take the receipts in its own district and pay to the other the working expenses. The proposal is at present under consideration.

Lincoln.—The work of electrifying the tramways is approaching completion. The length of the track is a mile and three-quarters, the same distance as was covered by the old tramways, and the course occupies the High-street between Lincoln and Bracebridge. Penny fares are to be the rule for adults, and it is possible children will be charged half-price. As our readers will recall, the "G. B." surface-contact system is being employed. Messrs. Griffiths and Co., engineers, of London, have been entrusted with the work, the contract price being nearly £20,000. There is a clause in the agreement between the engineers and the Corporation that if the undertaking does not answer within a certain period, they will convert the tramways into an overhead trolley system free of cost.

Ramsgate.—The Board of Trade inquiry into the accident on the East Cliff on Aug. 3, when a tramcar went over the cliff and seven persons were injured, was resumed last week. The inquiry had been adjourned for the attendance of the driver, Lewin William Lloyd, who had been suffering from the effects of the accident. The driver now stated that before reaching the hill where the accident occurred he had no difficulty in controlling the car, but when he got on the hill the car skidded. He released the power brake and worked the sand pedal, but no sand came. Witness complained that the upper part of the hill was not kept well sanded by the company. He denied that he applied the brake suddenly. Before he reached the scene of the accident he found the sand pedal in good order, and could not explain why it went wrong. He knew the bunkers were full of sand when he took over the car. After further evidence the inquiry was closed.

Birmingham.—Considerable progress has been made during the past few weeks in connection with the tramway extension scheme. It is expected that one of the sections will be completed at the end of this month. Estimates are being prepared in connection with 14 miles of additional tramlines to be constructed early next year in other parts of the city. The Electric Supply Committee of the City Council propose that the charges to the Tram Committee for tramways inside the city boundary in future be for the first four million units per annum 1½d. per unit net, for the second four million units per annum 1¼d. per unit net, for any quantity taken in excess of eight million units per annum 1d. per unit net. When the tramway leases fall in next year, and when the new lines which are being constructed by the Corporation are being worked by the Tram Committee, it is estimated that the quantity of electricity required for traction purposes will exceed 8½ million units per annum, the cost of which on the scale suggested will work out at 1·34d. per unit on the average. When, however, the Bristol-road route comes under the control of the Corporation in 1911 this average will be reduced somewhat, inasmuch as the quantity of electricity required for local tram purposes per annum, it is estimated, will then be over 12 million units.

Southend.—A meeting under the auspices of the Cab Trade Association was held to protest against the proposed extensions of the trams down High-street, and it was resolved to petition the Corporation against the proposal. With reference to our notice last week, that it had been decided to extend the tramway system to Shoeburyness, detailed estimates are now set forth showing the total expenditure as being £67,250, including £24,500 for the new road and wall to Halfway House, Undercliff road, etc. From this amount was to be deducted Colonel Burges's contribution of £6,000. It is proposed to raise a loan for the purpose of public improvements along the beach of £10,000, and this amount to be deducted from the £24,000 mentioned above, leaving a net total chargeable to the light railways department of £51,250. In regard to the High-street and Marine-parade sections, the following estimates were approved: the annual expenditure was estimated at £1,989 (working expenses, 43,000 car miles at 8d. per car mile, £1,433, and loan charges, £556), and the income at £3,108 (43,000 car miles at 1s. 2d. per car mile £2,508, 2½ per cent. increase on other lines on present income £500, advertising £100). The surveyor reported engineering difficulties in connection with the latter scheme, and made certain suggestions for remedying them. It was decided to refer this matter to a committee.

Portsmouth.—An accident occurred last week, when two ladies, in the act of crossing the road, were knocked down and injured by an approaching tramcar. Fortunately the cowcatcher acted with great efficiency, and prevented more serious consequences. Supplementing the note contained in our issue of Sept. 22, the car miles covered during the year ended March 31 totalled 1,974,996, over which 19,625,329 passengers were carried, averaging 9·94 passengers per car mile. The traffic receipts during the same period amounted to £95,699, which is equivalent to an average of 11·63d. per car mile, and 1·17d. per passenger carried. The gross receipts reached £102 452, and the percentage of working expenses to total receipts averaged 43·74d. The report of the resident engineer shows that the station equipment is in a satisfactory condition, and practically the same as when first put down. The condensing plant is now too small for the requirements, and during the forthcoming year it will be necessary to instal larger plant so as to deal with the increasing load. The overhead line has been kept up-to-date, and repairs, where necessary, have been effected. The low-tension cables are in a satisfactory condition, and have given no trouble whatever. As regards permanent way, the track may be considered satisfactory, most of the points and crossings having been renewed. The cars are showing signs of wear and tear, and a further increase in the cost of their maintenance is anticipated during the coming year. The workshops are complete, and the

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machinery installed has assisted considerably in the efficient maintenance of the rolling stock.

Leeds.—The revenue returns for the financial half-year from March 25 to Sept. 30 show that the gross receipts amounted to £165,226. 2s. 9d., an increase of £4,136. 16s. 11d. as compared with the gross receipts of £161,089. 5s. 10d. for the corresponding half of last year. The actual traffic receipts amounted to £163,286. 17s. 2d., as against £159 053. 2s. 5d. taken on the cars in the same months of 1904, the increase being £4,233. 14s. 9d. With improvements in the service, the car mileage is a constantly increasing quantity, and during the half-year it reached a grand total of 3,674,307 miles, as compared with 3,608,736 miles, an increase of 65,571 miles. For this increased amount of running the extra cost of working is only £593. 7s. 4d., the total working expenses being £86,154. 0s. 8d. Thus the gross profit for the half-year is £79,072. 2s. 1d., showing an increase of £3,543. 9s. 7d. over the gross profit for the corresponding half of 1904. The increase in the number of passengers carried, again comparing the same two half-years, was no less than 2,264,993, or more than five times the entire population of the city. In the previous half-year the number of passengers carried was 34,108,522, and this grew until, in the half-year just closed, the enormous total of 36,373,515, which means that the entire population of the city was carried 80 times. The 1d. passengers are in a very large majority, numbering 26,663 863, or 73·22 per cent. of the whole. Halfpenny stages come next with a total of 4,031,188, or 11·9 per cent.; and they are followed by the buyers of 2d. tickets, numbering 3,180,037, or 8·74 of the total. Three-halfpenny fares are only found on a few routes, and these total 791,803; while the 3d. tickets issued numbered 553,400. Workmen's tickets and exchange tickets issued to workmen making their return journey in the evening are pretty evenly balanced, and together reach a total of 1,183,224, or 3·25 per cent. The receipts for the half-year work out at 10·66d. per car mile run, which is a slight increase of ·08d. over the average car-mile receipts of 10·58d. last year. The average fare paid during the half year was 1·08d.

London County Council.—The extensions referred to in our issue of last week, which are estimated to involve a total expenditure of £411,460, have been approved. Street widening improvements consequent upon these schemes were also sanctioned, subject to the usual conditions of consent of the local authorities concerned, and their agreeing to contribute to the cost. In the case of the Tooting line the Improvements Committee recommended that the Wandsworth Borough Council should be asked to contribute a third of the cost, the remaining two-thirds to be charged to the account of the improvement. An amendment was carried to the effect that the point whether part of the cost should not be charged to the account of the tramway should be left for the Council's subsequent decision. It was decided that 1d. fares should be charged on the Council's northern tramways between Aldwych and Holborn Town Hall, and between Holborn Town Hall and the Angel, Islington, the fare between Aldwych and the Angel to be 1½d. At Tuesday's meeting of the Council the Highways Committee recommended that £5,300 be voted for additional high-tension feeder cables for the Elephant and Castle sub-station. They also recommend that the construction of the track work for a through route between the Strand and Islington be transferred from the Council's Works Committee to Messrs. J. Mowlem and Co., the estimated cost of the work being about £1,780. The committee also recommended that permission be accorded the Metropolitan Water Board, the Gaslight and Coke Co., and the London Hydraulic Power Co. to lay mains along the Council's subway upon the usual terms of user. The receipts for the week ending 7th inst. amounted to £14,624, against £13,048 last year, whilst for the period from April 1 to Oct. 7 the revenue totalled £412,834, against £350,602 for the corresponding period of last year. At Wednesday's meeting of the Fulham Borough Council the Law and Parliamentary Committee presented a long report containing a summary of the correspondence with the County Council relative to street improvements in connection with the projected tramway from Putney to Harlesden. The attitude of the Borough Council is indicated by the following resolution: "That the London County Council be informed that this Council regrets and deprecates the payment out of the rates of the sum of £64,000 for the acquisition of the respective interests affected by the proposed widening of High-street, in front of the King's Head public-house, and which has not resulted in the extinction of the license in respect of such premises, though land has been acquired at a cost of more than £228 per square yard, equalling the enormous rate of £1,106,285 per acre."

LIGHTING AND GENERAL.

Falmouth.—Electric light cables are now being laid in the town.

Llandilo.—The revenue of the electric lighting for the quarter was £122.

Gelligaer.—The District Council have decided to apply for an electric lighting provisional order.

Oriental Telephone and Electric Co.—The directors have declared an interim dividend of 5 per cent. on the ordinary shares.

Yarmouth.—The Guardians have decided upon the electric lighting of the new lodge entrance and the long avenue leading up to the workhouse.

Whitehaven.—It is proposed that separate committees be appointed to have charge of the water and electric lighting undertakings of the Corporation.

Oriental Telephone and Electric Co.—The directors have declared an interim dividend of 5 per cent. on the ordinary shares free of income tax.

Edinburgh.—Councillors Stevenson and Cunningham and the resident electrical engineer have been appointed to visit the Electrical Exhibition at Olympia.

Todmorden.—The new electricity works were formally opened last week.

Torquay.—An inquiry is to be held into the application of the Corporation for a loan of £9,500 for the proposed extension of the existing electricity works.

Hayward's Heath.—The Urban District Council have been approached by the promoters of a company with regard to the introduction of electric lighting.

The Ceuta Cable.—A Reuter telegram from Almeria states that the steamship "Buccaneer" has begun repairing the cable connecting Alhucemas, Melilla, and Ceuta.

Smallwood (Cheshire).—The electric light has been installed in the village, which only contains a population of 300, by Messrs. Samuel Jackson, builders and contractors.

Consolidated Electrical Co.—The directors have decided to pay off the arrears of dividends on their preference shares for the period from Nov. 30, 1903, to May 31, 1905.

Elgin.—The minute of agreement between the Council and the Duke of Richmond and Gordon as to laying electric mains along public roads in Fochabers has been signed.

St. Mellon's.—The District Council have appointed a committee to meet the promoters of the scheme for electrically lighting the Rhymney Valley in the area of this council's district.

Hammersmith.—The premises of 29 additional consumers, representing a maximum of 652 8 c.p. lamps, have been connected to the mains, the present number of consumers taking current being 1,690.

Heywood.—The electrical engineer in his last report stated that the consumption of electricity for the month of August was 3,971 units, as against 3,199 units for the corresponding period of last year, showing an increase of 772 units.

Electric Furnaces.—Messrs. Marryat and Place, 28, Hatton-garden, E.C., inform us that the 1,000-ampere electric furnace they are exhibiting at the Olympia Exhibition has been purchased by the National Physical Laboratory, Teddington.

Goole.—The Goole branch of the Amalgamated Society of Railway Servants are urging upon the Council the necessity of taking prompt measures to ensure the proposed electric lighting scheme being worked for the town and for the benefit of the townspeople.

Stanley (Yorkshire).—The Urban District Council have approved of the proposed lighting scheme recommended by the Lighting Committee. This will involve an outlay of £1,175 and an annual expenditure of £642. About 14½ miles of roads will be lighted.

Battersea.—Owing to the failure of the armature of the turbine generator, the district was plunged in darkness for some time between 9 and 10 last Saturday. The supply was soon started again, section by section, but not before the pickpockets had secured a rich harvest.

Clydebank Dock.—At Clydebank Dean of Guild Court on Tuesday permission was granted to the Clyde Navigation Trustees to erect an electricity generating station for the working and lighting of Clydebank Dock. The main building will be 109ft. by 120ft., and the chimney stack will be 150ft. high.

Wisbech.—The Council, whose first electric lighting provisional order has expired, propose to apply in the ensuing session of Parliament for a further provisional order. Negotiations are to be opened with some company for the supply of electric energy within the borough providing terms can be agreed upon.

Harrow.—The Council have received an application from the Post Office for permission to make a telegraph extension from Sudbury to Harrow road. It appears that the land in question belongs to the freeholders on either side of the road, and the matter has been referred to the Works Committee to investigate.

Stepney.—The London County Council recently sanctioned the borrowing of £57,000 for the extension of the power-house at Osborn-street, and the purchase of additional steam and electricity generating plant. A further instalment of £10,000 is to be borrowed in order to meet capital commitments to the end of the financial year.

Callender's Cable and Construction Co.—The directors have decided to pay an interim dividend on the ordinary shares of this company on Nov. 1 next of 5s. per share, being at the rate of 10 per cent. per annum. The books are closed to the 31st inclusive for the purpose of preparing this dividend.

Western Telegraph Co.—The directors recommend a final dividend of 3s. per share, making a total dividend of 6 per cent. for the year ended June 30 last, and also the payment of a bonus of 2s. per share, both free of income tax. The sum of £60,000 has been transferred to the general reserve fund, and £5,000 to the maintenance ships' reserve fund.

Western Telegraph Co.—The directors have, after transferring £60,000 to the general reserve fund and £5,000 to the maintenance ship's reserve fund, decided to recommend a final dividend of 3s. per share, making with previous distributions a total of 6 per cent. for the year ended June 30, 1905. They also recommend a bonus of 2s. per share.

Willington.—The County of Durham Electric Power Distribution Co. have written to the Urban District Council regretting the Council thought the time inopportune to consent to their application, and asking them to reconsider the question. We expect nothing further is to be done at present, as the clerk has been directed merely to acknowledge the receipt of the letter.

Morecambe.—At the last Council meeting it was decided that the best thanks of the committee be accorded to Mr. W. H. Hall, the electrical engineer, for the efficient result of the year's working. Last year there was an increase in the gross profit from £1,798 to £2,155. There has been a reduction of 14 per cent. in the general works cost, from 3·31d. to 2·85d. per unit sold.

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Bo'ness.—The question of the difference between bank interest on principal deposited and interest paid to the lenders through the instalments of the loan not being taken up as anticipated, and also the matter of supervising engineer to act for the Council at a yearly inspection of the electric lighting works, was again discussed at the last Council meeting and further adjourned.

Liverpool.—During the past year the equivalent number of 16-c.p. lamps connected to the electric supply mains has increased from 277,767 to 310 562, and the number of consumers from 5,345 to 6 821. The amount of electrical energy supplied for lighting and power shows an increase of about 6 per cent. over last year, and 5·75 per cent. increase in electrical energy supplied for tramways.

The Seychelles.—The Colonial Office report for 1904 on the Seychelles Islands refers to the projected improvement in the supply of water to the town of Victoria, and states that a high-level reservoir at 600ft. above the town might be further utilised by means of a Pelton wheel or turbine to generate sufficient horse-power to light the town by electricity and supply mechanical power to the public works yards.

Walsall.—The last report of the Electricity Committee shows that the total number of consumers supplied on Sept. 30 last was 432. During the past month the total units generated at the station was 135,525. The total output from the main generators was 131,004 units, and that from the transformers 101,686 (estimated). The machinery was run for 707 hours. The wages paid amounted to £130.

Croydon.—Further consideration of the report on street-lighting has been adjourned to a future meeting of the Council, and in order that the matter may be fairly considered the Lighting and Electricity Committee have been requested to obtain from the Croydon Gas Co. and from the South Suburban Gas Co. respectively offers for the efficient lighting of the borough, and to submit such offers to the Council.

Stock Exchange.—Application has been made to the Stock Exchange Committee to allow Lisbon Electric Tramway' 500,000 ordinary shares of £1 each, fully paid, Nos. 1 to 500,000, 425,553 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 425.553, and £500 000 5 per cent. mortgage debentures of £100 each, Nos. 1 to 5 000 (registered, renewed special application), to be quoted in the official list.

St. Marylebone.—The costs incurred and paid up to the present—£681. 12s. 8d.—in opposing the various electric companies' Bills have been transferred from the electricity to the general account. A further loan is required on capital account of the electricity undertaking, and application will be made to the London County Council for an advance of £90,405. being the balance of the amount of £340,455, the borrowing of which has been sanctioned for 42 years.

Bermondsey.—The last report of the Electric Lighting Committee gives the number of lamps now connected as 51,383 lamps for private consumers and the equivalent of 4 622 lamps for public lighting, a total of 56,005 lamps. The following extension of plant has been recommended: steam dynamo of 500 kw. capacity, £2,950; switchboard extensions and connections, £325; boiler capable of evaporating 12 000lb. water per hour, £1,800; steam-pipe and exhaust connections, £215; contingencies, £100—total, £5,390.

Our Navy and our Army.—Mr. Alfred J. West on the 16th inst. commenced his eighth annual series of the popular entertainments illustrating "Life in our Navy and our Army" at the Polytechnic, Regent-street. The programme for the current season will be entirely new to London, though it has been given with very great success in the provinces, particularly on the occasion of the recent visit of the French fleet to Portsmouth, when a special matinée was arranged for the officers and men.

Grimsby.—The Corporation Lighting Committee have agreed to an application from a would-be consumer of electricity, who asked the Corporation to supply him with current to drive a motor used, amongst other purposes, for driving the small dynamo of his own private electricity installation. The engineer thought that they were creating a dangerous precedent, but the committee granted the application on the ground that, the premises being wired for 100 volts, the applicant could not take the Corporation lighting current at 230 volts without rewiring his works.

Finchley.—At the last Urban District Council meeting a statement was made regarding the electric light revenue account, which shows at the moment a debit of £1,858. This is accounted for by the fact that the consumers' accounts for the quarter ending September are all outstanding. The accounts are now being issued, and, when paid, will more than cover the amount of the debit balance. There are the three accounts in debit. On the other side there are 16 accounts in credit to the amount of £8,208, so it must be admitted that the bank balances are in a satisfactory condition.

Maxim Electrical Co.—We have been asked to point out that this company is no way connected with the old company, bearing a similar name, and that the Maxim arc lamp has been exclusively adopted for all the stations of the Underground Electric Railway Co., after an extended trial in competition with others. The company have been working overtime for some weeks on account of repeat orders from the Underground. These lamps have also been installed at the L.S.W. Railway Station at Waterloo. The firm's incandescent lamps has been adopted at Glasgow and other places in preference to others.

Greenock.—Application is to be made shortly for further borrowing powers for the electricity department. The electricity generated during August amounted to 200,662 units, an increase of 73,921 as compared with the corresponding month of last year. With regard to a proposed supply of electricity to the new cottage hospital about to be erected in Port Glasgow, the Corporation have declined to furnish a supply, but if the applicants approach the Corporation of Port Glasgow for a general supply to that burgh they thought arrangements might be made for giving such on terms to be arranged by the Corporation.

London Gazette.—The partnership between Newman Wilkinson and Horace Francis Simon, electrical engineers, 43, Mincing-lane, London, has been dissolved by mutual consent. A receiving order has been made out on debtor's petition in the estate of Thomas Hill, electrical engineer, 24 Vicarage-road, Wolverhampton. The partnership between Percy Joseph Driscoll and Charles Balbiani, electrical engineers, 33. Portland-street, Wardour-street, London, has been dissolved by mutual consent. The last day for receiving proofs in the estate of Fred Shaw, electrical contractor, Hessle-road, Kingston-upon-Hull, is Nov. 2.

Switchboard Panels.—Manufacturing electrical engineers visiting the Olympia Exhibition would do well to look at the slate and marble switchboard panels which have been made by Messrs. Congden and Powell, of Bravington-road Works, Harrow-road, W. The firm are not themselves exhibiting, but their material is used on the switchboards shown by Messrs. Ferranti, J. E. Spagnoletti and Co., Crompton and Co., etc. The workmanship on these slabs will be appreciated, but, unfortunately, a casual glance does not reveal that uniformity which is the great feature claimed for the panels either of slate or marble supplied by this firm.

Changes of Address.—We are informed that in future the business address of Mr. C. C. F. Monckton, M.I.E.E., electrical engineer to the Government of Trinidad, will be 53, Victoria-street, Westminster. The Glasgow office of the Union Electric Co. has been transferred to 12, Waterloo-street, Glasgow, and is in charge of Mr. Alexander Morrison, who is the company's representative for Scotland. Mr. Morrison has had very considerable experience in the heavier lines of electrical engineering, having served his time with Messrs. Mavor and Coulson, after which he was in the employment of Messrs. Haddow and Co., the Glasgow contractors, and in the tramways department of the Glasgow Corporation.

Ferranti Limited.—A trip was arranged for the employés of Messrs. Ferranti to visit Olympia Electrical Exhibition on Saturday last, a party of 170 men leaving Manchester at midnight on Friday by the Great Central Railway. Messrs. Ferranti contributed towards the general expenses of the trip, provided breakfast on arrival in London and a luncheon in the restaurant of the exhibition, at which the directors of the company were present. Each man was furthermore supplied with a pass to the exhibition. Some of the party returned on Saturday evening, while others deferred their departure until the following day. The trip was eminently successful, and will, it is hoped, prove to be of educational advantage to the employés of the firm.

Blackpool.—The electrical engineer (Mr. C. Furness) has reported that the returns for the month of September showed an increase in the total works output over the corresponding month of last year of 15,152 units, made up as follows: private lighting, 136,678 (increase, 8 180); public lighting, 19,491 (decrease, 492); Corporation trams, 119,774 (increase, 6 253); Lytham and St. Annes trams, 10,191 (increase, 1,211)—total for month, 286,154 (net increase, 15,152). For the half-year ending Sept. 30, 1905, as compared with the output for the corresponding half-year in 1904, the figures are as under: private lighting, 560,072 (increase, 23,545); public lighting, 80 069 (decrease, 4,347); Corporation trams, 705,076 (increase, 48,285); Lytham and St. Annes trams, 59,426 (decrease, 451)—total for half-year, 1,404,643 (net increase, 67,132); new consumers (half-year), 42.

London County Council.—On Tuesday tenders were received for the supply and delivery of steel girder tramway rails, with fastenings, required in connection with the reconstruction for electrical traction of certain of the Council's tramways. It was agreed to lend the St. Pancras Borough Council £1,874 for electric lighting, and the Woolwich Borough Council £16,275 for electric lighting purposes. The proposal with regard to free wiring has now been put into the following form: "That application be made to Parliament in the session of 1906 for powers to enable local authorities in London who have now, or may hereafter obtain, powers to supply electrical energy, to wire and fit consumers' premises for the use of electrical energy, and to obtain loans for this purpose. The following inspectors have been appointed under the Woolwich Electric Lighting Order, 1905, and the Act confirming that order: T. P. Gunyon, H. W. Ridley, A. Champion, W. T. Hodgson, A. H. Sears, and T. W. Graves. Additional high-tension feeder cables, estimated to cost £5,300, are required for the Elephant and Castle tramways sub-station.

Birmingham.—The Electric Supply Committee have decided to recommend to the City Council the following new rates of charges for lighting and private power supply: Lighting—for the first 300 units per quarter, 5d. per unit; any quantity used in excess of this per quarter, 3½d. per unit. Power—for the first 300 units per quarter, 2d. per unit; for any quantity used in excess up to 3,000 units per quarter, 1½d. per unit; for any quantity used in excess of 300 units if more than 3,000 units are consumed during the quarter, 1½d. per unit. The charges per unit for an all-day supply for lighting purposes will remain as at present—viz., 3d. per unit for the first 300 units per quarter, and 2d. per unit for any quantity used in excess, subject to a guarantee of 25s. per 16-c.p. lamp per annum for a minimum number of 12 16-c.p. lamps installed. A special discount of 3 per cent. off all the above charges is allowed if the account is paid within a specified time. These recommendations will be submitted by the committee in their report to the City Council at the December meeting. The charges proposed by the committee for the supply of the tramways inside the city boundary have been approved by the Tramways Committee. Under the scale agreed upon the charge for the first 4,000,000 units per annum is to be 1½d. per unit net, for the second 4,000,000 units per annum 1½d. per unit net, and for any quantity taken in excess of 8,000,000 units per annum 1d. per unit net. A proposal to supply electric motors on hire is also under consideration.

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Bolton.—The electric supply fund account for the year ending March 31, 1905, shows a total expenditure of £34,827, an income of £38,975 and a net profit transferred of £4,148. The expenditure includes the following: generation of electricity, £11,718; distribution of electricity, £285; rents, rates, and taxes, £1 412; management expenses, £1 420; interest account, £7,283; depreciation account, £12.708. The separate section income is: sale of electricity, £37,390, which sum includes £14,588 for tramway traction at 1·1d. per Board of Trade unit; rental of hired meters, £339; rental of hired motors, £715; and electric fittings trade, £529.

Caversham.—The Highways and Lighting Committee, after meeting the representatives of the Reading Electric Supply Co. on the subject of the supply of electrical energy in Caversham, have recommended the Council to adhere to their resolution to take such steps as may be necessary to obtain a provisional order from the Board of Trade authorising them to supply electricity for any public or private purposes within the urban district of Caversham. This has been confirmed. The principal reason for this decision was, we hear, the fact that at the end of nine years the Reading Corporation have the option of buying up the Reading Electric Supply Co.'s undertaking, and they might then force the hands of the Caversham authority in the matter. Six more lamps are to be erected in the Woodcote-road.

Handsworth.—The new electric light and power station at Piers-road which is to supply Handsworth with illumination and motive power was formally opened last week by Councillor F. Tibbitts, chairman of the Electric Supply Committee. The scheme has cost between £49 000 and £50,000, and future extensions have been taken into account. The present provision is for three watertube boilers, each capable of evaporating 6,000lb. of water per hour at a pressure of 200 lb per square inch. There is room in the present boiler-house for four more similar boilers. The engine room is ample for a 1,700-h.p. plant. At present there are installed four high-speed engines—two of 200 h.p. each and two of 150 h.p. each. Each of the smaller engines drives two dynamos, while the large engines each drive a single dynamo. The large dynamos are compound-wound. A large number of arc lamps has been provided for the public lighting of the main thoroughfares; each pillar carries two incandescent lamps on brackets for after midnight lighting. Sir Alexander B. W. Kennedy was the consulting engineer, and Messrs. Henman and Cooper the architects.

Hampstead.—At the meeting of the Borough Council last week the Lighting Committee reported that they had carefully considered the reference from the Council to inquire into the charges and system of charges to the public for electric light, and also the question of reducing the charges for current for private lighting. The committee had received reports on the subject from Mr. G. H. Cottam, the chief electrical engineer, and Mr. C. E. Moon, the borough accountant. They found that the present method of charge for current is by the demand indicator system, and is at the rate of 6d. per unit for one hour's average maximum consumption per day per half-year, and 2½d. per unit for all units beyond that quantity consumed during the half-year, the average maximum demand being the average of the readings of the indicator during the three dark months of the half-year. The profit upon the electric lighting undertaking for the year ended March 31 last, after deducting the sum of £2,000 contributed in aid of the rates, was approximately £7,000. They considered, from the figures placed before them, that the Council would be justified in making a reduction in the charges for current for lighting to private consumers, and they had considered several methods of so doing—viz., continuing the demand indicator system at reduced charges, charging a flat rate for current, and reducing or abolishing the meter rents. They had caused inquiries to be made as to the methods of charge for electrical energy by other metropolitan borough councils, and they found that the same were as follows: Poplar—maximum demand system; Stepney—maximum demand system for lighting, flat rate for power, heating, etc.; Battersea and Fulham—flat rate only; Bermondsey, Islington, St. Pancras, Shoreditch, and Southwark—optional flat rate; Hackney—recently changed to maximum demand system, but optional flat rate to old consumers; Hammersmith—maximum demand system to Sept. 30, 1905, then abolished and flat rate substituted. The committee were of opinion that it would be advisable to afford private lighting consumers the option of being charged on the maximum demand system or at a flat rate, and, therefore, they recommended that after consumers' meters have been read in December next, and the accounts rendered thereon at the rates now in force, consumers be given the option of declaring upon which of the following systems they will be charged for current for private lighting: Maximum demand system—during the two winter quarters, October-December and January March, at 6d. per unit for the first two hours' maximum per day, and 1½d. per unit for all current consumed beyond that quantity during each winter quarter; all current consumed during the two summer quarters, April-June and July-September, to be charged at the uniform rate of 1½d. per unit. Flat rate system—for all units consumed for private lighting at the uniform rate of 4d. per unit. The committee further recommended that no alteration be made in the charges for current for heat and for power, or in the charges for public lamps, and that the question of making any alteration in the meter rents do stand over for the present. The recommendations were adopted. The following is an explanation of the maximum demand system proposed: For each winter quarter the ordinary meter will be read and the total number of units consumed during the quarter noted. The demand indicator records the maximum rate at which current is consumed at any moment during the quarter, this being equivalent to the maximum number of lamps on at one time. The number of units which would have been consumed had this maximum demand been maintained for two hours during each day of the quarter—that is, for 182 hours per quarter—will be charged at 6d. per unit. The balance of the number of units recorded by the ordinary meter will be charged at 1½d per unit. During the two summer quarters the demand indicator will be disregarded, the ordinary meter only being read. With regard to wiring of consumers' premises, it was agreed not to support the clauses proposed by the London County Council should another attempt be made to obtain the powers referred to. At the same time the Council are prepared to support a clause making it lawful for borough councils to expend money upon wiring consumers' premises, provided that the work be done through a contractor. The agreement with the General Post Office for an additional exchange line with internal extensions at the town hall in the place of the National Telephone Co.'s line and extensions has been signed.

Camberwell.—Last evening the mayor opened the new swimming, slipper, Turkish, and Russian baths erected by the Borough Council in the Old Kent-road at a cost of about £56,000. Mr. E. H. Payne was the architect, and Mr. A. N. Coles the contractor for the building. The whole of the engineering work was designed by Mr. W. M. Binny, A.M.I.C.E., of Teddington, who acted as consulting engineer for the architect, and also supervised the erecting of the machinery. In arranging this scheme of engineering it has been sought to arrange it, as far as practicable, in such a manner that the success of one operation shall not be altogether contingent upon another, and for alternative machinery to be brought into use when it is necessary to clean or repair any particular machine. Advantage has also been fully taken of making use of the by-products or exhaust steam from the electric light and laundry engines, air compressors, pumps, etc., for the purpose of heating the water used in the baths, wash-houses, and laundries, as the greatest part of the steam required to be generated by the boilers is ultimately used for the purpose of heating water, etc. By first using the live steam in driving the various engines and pumps, and afterwards utilising the exhaust steam for heating, the cost of fuel for generating power is practically nil. The public wash-house and ironing room are situated on the ground floor, and under them on the basement floor are the engine and boiler rooms, workshop, and establishment laundry, containing all the principal parts of the machinery very compactly arranged for generating power, so that the engineer and his assistants can easily supervise the working of the plant without leaving their special quarters. The engineering work has been divided up into various sections, the contracts for which have been let in each case to firms who make a speciality of that particular branch, and without the intervention of a general engineering contractor. In the boiler-room are three boilers of the Lancashire type, each 7ft. 6in. diameter, constructed of steel, for a working pressure of 100lb. per square inch, two of which would be in use at the same time, the third being laid off when required for cleaning and repairs. These boilers were supplied by Messrs. Galloways, Manchester. The feed water for the boilers is softened and freed from scale-forming matter by means of a water softener situated on the roof. This was supplied and fixed by Messrs. Lassen and Hjort, Queen Victoria-street, and is capable of treating 2 000 gallons of feed water per hour. The feed water after being softened is pumped into the boilers by means of two vertical duplex type feed pumps, one of which is alone capable of doing the work, the other being available as a stand-by. These pumps were supplied by Messrs. Carruthers, Glasgow. In the engine-room is situated the laundry engine for driving all the shafting in the premises, and is of the vertical enclosed type, fitted with a system of forced lubrication for automatically oiling all the working parts while running. This engine was supplied and fixed by Messrs. Allen, Son, and Co., Bedford, who also supplied and fixed the electric light engine and dynamo of 30 kw. capacity, capable of lighting the whole of the premises. The working parts of both the laundry and electric light engines are specially arranged so as to be interchangeable, thus simplifying repairs and working. There are also arrangements made for changing over the electricity supply from the electric light engine to the company's supply, so as to conform with the London County Council's requirements for licensed premises, and also to enable the electric light to be used after the machinery is stopped for the night. The wiring and fittings of the electric lighting have been specially arranged in separate circuits to conform to the London County Council's requirements for licensed premises, and are arranged so that alternative use can be made of the steam-engine and dynamo in the engine-room, or from two sources of supply on the company's mains. Change-over switches are provided, so that the whole or any part of the premises can be lighted from either the company's supply or from the engine and dynamo, or a part from each. The wiring and fittings of the electric light have been arranged in the slipper baths and other places so as to be well out of the reach of the bathers, so as to prevent any possibility of accidents. The main controlling arrangements and switchboards are situated in a special room in the basement, out of the reach of unauthorised persons, and consist of three main panels, each fitted with a voltmeter and ammeter, main switches, fuses, etc. These panels are supplied with current either by the company or from the engine-room switchboard. From the switchroom the principal sub-circuits are carried to sub-distribution boards in various parts of the building. The contractors for the electric wiring and fittings were Messrs. H. M. Leaf, 47, Victoria-street, Westminster. The specification of the wiring was prepared by Mr. Morgan Williams, M.I.C.E., 39, Victoria-street, Westminster, who collaborated with the consulting engineer.

PROVISIONAL PATENTS, 1905.

OCT. 9.

20330. Improvements in arc lamp electrodes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricität s-Gesellschaft, Germany.)

20335. Improvements in protective devices for use in the distribution of electricity by overhead wires. James Robson, 3, Devonshire-place, Selly Park, Manchester.

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20347. Apparatus for mechanically and electrically controlling the working of overhead and rail points on electric railways and tramways. Adolf Lutgarten and John Griffith Jones, 577, Stretford-road, Old Trafford, Manchester.

20368. Improvements in or relating to single-phase commutator motors. Valere Alfred Fynn, 70, Chancery-lane, London.

20371. Improved apparatus for sound transmission by means of electrically-produced light and heat rays. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

20392. Improvements in or relating to electric motors Alphonse Ferdinand Pieper, 111, Hatton-garden, London. (Complete specification.)

OCT. 10.

20402. Improvements in direct-current dynamo-electric machines and motors. Albert Henry Midgley and Benjamin Reed, 128, Southwark-street, London.

20435. Improvements in flame carbon arc lamps. Veritys Limited and Frederick Stanhope Worsley, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

20441. Improvements in inclined carbon arc lamps Veritys, Limited, and Frederick Stanhope Worsley, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

20467. Improved signalling apparatus for single-line sections of electric railways and tramways. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

20496. Improvements in or relating to telephones and telephone systems. Alfred Julius Boult, 111, Hatton-garden, London. (Charles E. Egan, United States.) (Complete specification.)

20500. Improvements in mercury electrolytes. Henry Stafford Hatfield and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

20512. Improvements in or connected with the caps and contacts of electric incandescent lamps. Matthew Favero, 40, Chancery-lane, London.

20515. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

OCT. 11.

20542. Improvements in electric cooking apparatus. Henry Bevis and Charles Herbert Archer, Peel Works, Adelphi, Salford, Manchester.

20547. Improvements in a system for the transmission of electric currents. Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

20548. Improvements in the transmission of intelligence with the aid of electric energy. Isidor Kitsee 18, Fulham-place, Paddington, London. (Complete specification.)

20593. Improvements in annunciators for telephones Alfred Laurentius Peterson, 6, Lord-street, Liverpool. (Complete specification.)

20595. Improvements in and relating to electric switch fuses. Claude William Atkinson and Edmund Garside, 1, Queen Victoria-street, London.

20599. Improvements in and relating to electric switches or cut-outs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

20609. Improvements in electric arc lamps. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

OCT. 12.

20657. New or improved duplex telegraphy. Alfred Minkley and Walter John Bakewell, 89, Clarence-road, Derby.

20666. Improvements in electrical distribution systems. George Croydon Marks, 18, Southampton-buildings, London. (John Roberts, Cape Colony.)

20687. Improvements in safety devices for overhead electric conductors. Emile Giraud, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 31, 1904, being date of application in France.) (Complete specification.)

20690. Improvements in electrical block signalling apparatus. James McIlwain and Charles Anderson Bennett, 53, Chancery-lane, London.

OCT. 13.

20728. Improved means for facilitating the erection of telegraph poles and the like. John Ridsall Brown, 55, Market-street, Manchester. (Complete specification.)

20737. Improvements in insulating materials for covering electric cables and the process for making same. Harris Markus and the Barnwell Machine Company, Limited, Droylsden Rubber Works, Droylsden, near Manchester.

20742. Improvements for hand-operated brakes on electrically-driven cars. Fitz-Roy Owen Jonathan Roose, 18, Vincent-square-mansions, Westminster, London.

20749. Improvements relating to overhead current collectors for electric railways and tramways. Siemens-Schuckertwerke G. m. b. H., 12, Queen Anne's-gate, Westminster, London. (Date applied for under Patents Act, 1901, Oct. 27, 1904, being date of application in Germany.) (Complete specification.)

20756. Improvements in or relating to the suspension of rotating apparatus and magnetic compasses. Hermann Anschutz-Kaempfe, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, March 25, 1904, being date of application in Germany.) (Complete specification.)

20769. An improvement in the application of alternating current to electro-metallurgy. Vladimir Mitkevitch, 10, St. George's-crescent, Liverpool. (Complete specification.)

20770. Improvements in cathodes. Henry Stafford Hatfield and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

20772. Improvements in alternating-current collector motors. Actien-Gesellschaft Brown, Boveri, et Cie., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 17, 1904, being date of application in Switzerland.) (Complete specification.)

OCT. 14.

20805. Improvements in or in connection with trolley poles of electric tramcars and like vehicles. Arthur Entwistle and Edwin Entwistle, 3, Brown-street, Market-street, Manchester.

20814. Improvements in the mariner's compass. James Kean, James Spiers, and Kelvin and James White, Limited, 154, St. Vincent-street, Glasgow.

20819. Improvements in and relating to the application of rotary electric motors to work certain to-and-fro movements, and in a gearing device and a pump and a fluid motor with which the same can be effected. George Hudleston Hurlstone Hardy, 35, Park-road, Twickenham, Middlesex.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 2.

1904.

17220. Starting and controlling alternating-current electric commutator motors particularly for use on electric railways. Union Electricitäts-Gesellschaft in liquidation. (Date applied for under International Convention, Aug. 8, 1903.)

21562. Electrolytic method and apparatus for the production of white lead. Koopman. (Townsend.)

21684. Alternating-current electric motors of the repulsion type Union Electricitäts-Gesellschaft. (Date applied for under International Convention, Oct. 9, 1905.)

21889. Electric alternating-current generators. Lindström. (Date applied for under International Convention, Oct. 16, 1903.)

22401. Automatic signalling apparatus for electric tramways. Jewell.

22832. Apparatus or means for automatically operating and controlling electric motor starters, particularly when used in connection with pumps which require to be automatically started and stopped. Tangye Tool and Electric Company, Limited, and Bate.

23765. Insulating material for electrotechnical purposes. Rudenick.

24915. Methods of insulating coils and the like, especially applicable to the construction of high-tension electrical machinery. Highfield.

25041. Trolley heads in connection with electrical tramways on the overhead wire system. Kneen.

25801. Reversing controllers for use in connection with electromotors. Electric and Ordnance Accessories Company, Limited, Hall, and Garner.

25817. Electrical incubator alarm. James.

26172. Electric switches and the like. British Thomson-Houston Company, Limited. (General Electric Company.)

26194. Dynamo-electric generators and motors. Torda.

26306. Apparatus for the conversion of rotary motion into oscillatory motion. Young, Bergtheil, Bergtheil, and Young.

26475. Electric fire-alarms and thermo-indicators. McNeil.

26786. Means for rendering the insulation of electric conductors fireproof. Hardingham. (Felton und Guilleaume Carlswerk Act.-Ges.)

26789. Holders and contacts for electric incandescent lamps. Dear.

26906. Electric demand indicators. Dick, and Reason Manufacturing Company, Limited.

27160. Electric motor apparatus. Mavor and Coulson, Limited, and Mavor.

27479. Inverted arc electric lamps. Andrew and Johns.

28678. Cranes and other lifting machinery driven by electric motors. Reed, and Craven Bros., Limited.

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1905.

402. Fusible electric cut-outs. British Thomson-Houston Company, Limited. (General Electric Company.)

383. Electrical contact breakers and switches for igniting the explosive mixtures of petrol motors and other gas and oil engines. Jones.

2491. Thermal electric cut-outs or fuses. British Thomson-Houston Company, Limited. (General Electric Company.)

2394. Electric lampholder with locking device to prevent the withdrawal of a lamp therefrom. Hirst and Bevis.

3177. Control of electric motors. Geipel and Lange.

4131. Telephone cables. Whalley.

4166. Telephone apparatus. Bines.

4167. Induction coils. Bines.

4167A. Telephone systems. Bines. (Date applied for under Patents Rule 9, Feb. 28, 1905.)

7617. Electric cut-out switches. Frechette.

11442. Manufacture and production of bobbins for electrical measuring instruments. Hartmann und Braun Akt.-Ges. (Date applied for under International Convention, June 16, 1904.)

11770. Means by which electrical bells may be employed on high-tension circuits. Agaggio.

12914. Telegraphic receiving apparatus. Field.

13678. Signalling by electromagnetic waves. Fessenden.

13682. Method and apparatus for the manufacture of electrical condensers. Siemens Bros. and Co., Limited. (Siemens und Halske Akt.-Ges.)

14209. Apparatus for supplying electrical energy to a network by the aid of an auxiliary current generator and an auxiliary line wire. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	6¼-7
—— 6 per cent. Cum. Pref., 1-100,000	5	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	2⅞-3⅛
—— 4 per cent. Mortgage Debenture Stock	100	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	½-¾
—— Non. Cum., 6 per cent. Pref.	2	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100	91-94
—— 4½ per cent. 2nd Debenture Stock	100	78-81
Callender's Cable, Debentures	100	109-111
—— Ordinary	5	10¼-11½
—— 5 per cent. Pref.	5	5⅜-5¾
Crompton and Co.	3	1⅜-1⅝
—— 5 per cent. Debentures	100	95-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	1⅜-1⅝ xd
—— "A" Shares, 01-017,139	5	2-2⅛ xd
—— 5 per cent. Debentures	100	92 97
—— 4 per cent. Deb Stock, Red.	100	85-90
Electric Construction, Nos. 1 to 112,100	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	1⅛ ⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	96-100
W. T. Henley's Telegraph Works, Ordinary	5	12 13
—— 4½ per cent. Preference	5	5⅛ 5⅜
—— 4½ per cent. Debentures	100	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	15¼-16½
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	10-10¼
Telegraph Construction and Maintenance	12	34-36
—— 5 per cent. Bonds	100	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10	12¼-12⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	10-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	11-12
—— 4½ per cent. Debenture Stock, Red	100	106-108
Bromley (Kent) Electric Light and Power Co.	5	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	104-107
Brompton and Kensington, Ordinary	5	9⅜-10¼
—— 7 per cent. Preference	5	9¼-10
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	9-9¼
—— Nos. 60,001-80,000	5	9 9¼
Cambridge Electric Supply Company, £10 Ord.	8	12¼-13⅛
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	105-108
Charing Cross, West End, and City Electric Supply, Ord., 1-8,000	5	7⅞-8⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	4⅜-5
—— ditto (1905) 40,001-80,000	5	4⅜-5⅛
Chelsea Electricity Supply	5	5⅜ 6⅛
—— 4½ per cent Debentures	100	109 111
City of London, Ordinary	10	12¼-13¼
—— 6 per cent. Cumulative Pref.	10	13¼-14½
—— 5 per cent. Debenture Stock	100	124-128
—— 4½ per cent. 2nd Deb. Sts. Prov. Certs. (all pd.)	100	104 106
County of London Electric Supply, Ordinary	10	10-10½
—— 6 per cent. Cum. Pref	10	12⅜-12⅝
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	111-1 4
—— 4½ per cent 2nd Debentures Prov. Certs	100	103-105
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	5¾-6¼
—— 6 per cent. Cum. Pref.	5	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100	108-110
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	2¼-3
—— 5 per cent. Debenture Stock, Red.	100	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	99-102
Havana Electricity, 1-15,000	10	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	8-8⅜
Isle of Wight Elec Lt and Pwr., 4½ p c. Db. Stk. Red.	100	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	15/16-1 1/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	12-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	97-100
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	3	2-2⅛
—— 6 per cent Pref.	5	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	99- 02
Metropolitan Ordinary, 00,001-300,000	5	10 10⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	09 113
—— 4½ per cent. Cum Pref.	5	5⅜ ⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	98 100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5	7⅜ 8¼
—— do., 57,0 0-75,000	5	7⅜-⅛
—— 5 per cent. Pref., 1-57,00	5	6¼ 6⅜
—— do., 57,0 0-75,0 0	5	6¼-6⅜
Notting Hill Electric Lighting	10	14 15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	98 100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	6⅜ 6⅝
—— 4 per cent. Debenture Stock	100	100 102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ord 1-12,000	5	2¼ 2⅜
—— 4 per cent. Debenture Stock	100	76 0
South London, Ordinary	5	3⅜ 4¼
South Metropolitan Electric Light and Power, Ord.	1	13/16- 5/16
—— 7 per cent. Cum. Pref.	1	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	105-108
—— Ditto, June, 1904	—	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	14¼ 15¼
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	4⅜-4⅝
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5⅛
Westminster, Ordinary	5	12⅝ 13⅜
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6⅛-6⅜
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	5⅝-6¼
—— Ord.	5	8 5/16-8 9/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-106
Barcelona Tramways, Ord., 1-20,000	10	13⅜-14½
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	9 -10
—— 5 per cent. Deb., Red., 1-600	100	98-101
—— 4½ per cent. Red Deb. Stock	100	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	⅜-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	3⅜-4¼
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd.	100	96-98
British Columbia Electric Railway Co., Ord. Def.	100	126-129
—— Ord. Pref.	100	109-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	105-108
—— 4, per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	101-103 p.c. xd
—— 4½ per cent. Vancouver Power Deb.	100	9 -101
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	9⅜-9⅝
—— 6 per cent. Cm Pf., 30,001-60,000	10	11-11½
—— 5 per cent. Perpetual Debenture Stock	100	121-123
—— 4½ per cent. 2nd Deb Stock	100	99-101
Buenos Ayres and Belgrano Trams.	5	3 11/16 3 15/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	⅜-5⅛ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	⅜ ⅝ xd
—— 5 per cent. Deb. Stock, Red.	100	106 108
—— Prov. Cert., all paid	100	102 105
Buenos Ayres Electric Trams., 5 p c. Deb. Stk., Red.	100	98-100
Calcutta Tramways, 1-102,268	5	9-9⅜
—— 4 per cent. 1st Deb. Stock, Red.	100	107-109
Cape Electric Tramways, Nos. 1-480,000	1	1⅛ 1⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	3½ 4½
—— 4 per cent 1st Mortgage Deb., 1-3000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	13¼-14⅛
—— 6 per cent. Cum Pref.	10	15-16
—— 4 per cent. Debentures	100	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100	94-97
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4, per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	2¼-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	83-88
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	9⅜-10⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	100 103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	7/32 9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926. 1-5,500 and 7,001-8,000	$1,000	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	101-104
— — Sterling 4½ per cent. Deb., 1922, 601-2,000	100	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	⅛-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	12
—— 5 per cent Cum Pref	10	9½-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	104-107
Potteries Electric Traction, Ordinary, 20 001-40,000	10	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	9-9⅜
—— 4½ per cent Debenture Stock	100	101-104
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,1 2 6 per cent. Preference	1	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	100 p.c.
Electric Railways.—		
Central London, Ordinary	100	91-93
—— 4 per cent. Pref.	100	101-103
—— ,, ,, deferred	100	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99½-100¼
Waterloo and City, Ordinary	100	88-90

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	112-113
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅝
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 14	1,308	1,289	+ 18	— h	25½	20⅔	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 14	217	197	+ 20	—	8	8	,, 15	14,328	3,316,380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 15	971	1,015	— 44	— 581	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338 b	6·03
Birmingham Corporation	,, 14	367	328	+ 39	—	2	2	,, 31	17,133	4,709,738	266,526	·86	14·5	8,866	—
Blackburn Corporation	,, 11	934	869	+ 65	+ 958	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	,, 12	662	653	— 6	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 14	335	340	— 5	— 810	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 15	1,805	1,705	+ 100	+ 1,975	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 11	1,312	1,009	+ 303	—	16 82	16·82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 14	4,249	4,437	— 187	—	96	77	,, 31	230,085	47,108,000	5,053,392	1·172	10·927	2,396	—
Brighton Corporation	,, 15	887	919	— 52	+ 714	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 13	5,025	4,817	+ 208	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 7	1,218	1,140	+ 78	—	10 60	10·60	March 31	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 15	287	321	— 37	— 1,168	8¼	8¼	,, 31	17,950	3,878.269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	,, 7	1,945	1,924	+ 21	+ 254	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 14	131	131	—	— 509	8·5	8·5	Dec. 31	10,713	2,935,002	359,756	—	7·14	—	5·18
Central London Railway	,, 14	6,731	6,781	— 50	— 1,90	6	6	,, 31	347,588	44,875,547	1,281,214	1·86	65·10	57,931	35·80
City and South London Railway.	,, 15	2,578	2,536	+ 42	— 531	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	,, 12	471	479	— 8	+ 790	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	Sep. 1	250	251	— 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Oct. 13	123	131	— 8	+ 23h	6¾	6¾	Dec. 3.	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 13	4,061	4,015	+ 46	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·28	9 07	5,691	5·55
Dublin S. District, Electric	,, 13	948	932	+ 16											
Dundee City Tramways	,, 11	1,034	972	+ 172	+ 856	23	23	May 15	44,695	11,641,525	933 006	·90	11·49	1,943	7 13
East Ham Corporation	,, 14	773	644	+ 129	+ 2,497	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6·79
Glasgow Corporation	,, 14	15,913	14,563	+1,350	+15,774h	144¾	143	May 31	756,480	195,767,519	17,945,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	Sep. 20	1,803	1,618	+ 185	+ 1,781	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	Oct. 14	1,348	1,269	+ 79	+ 1,077	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 14	3,317	3,344	— 27	+ 575	27	26	,, 31	112,651	27,102,921	2,910,698	1	9·29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 11	112	128	— 16	— 741	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 11	200	215	— 15	—	7½	7½	May 15	12,201	3,632,855	432,396	·775	6·519	—	7·649
Leeds Corporation	,, 14	5,832	5 613	+ 219	+ 3,547	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 14	2,295	2,000	+ 295	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 7	10,629	10,724	— 95	—	103	103	,, 31	547,625	116,642,663	12.166,419	—	—	—	—
Liverpool Overhead Railway	,, 15	1,444	1,453	— 9	— 863h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	Sep. 30	14,558	13,641	+ 917	+6°,655	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	—	—	—	—	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	Oct. 12	117	131	— 14	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 14	12 564	12,149	+ 415	+15,195	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Metropolitan District Railway	,, 15	7,567	7,029	+ 538	— 2,172	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 15	17,643	17,591	+ 52	+ 185	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 14	129	118	+ 11	+ 357	—	2¾	,, 31	6,159	1,932,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 14	3,698	3,633	+ 65	+ 3,045	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 15	1 661	1,194	+ 467	+13,064	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 14	1,628	1,740	— 112	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	—	—	—	—	—	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 14	822	378	+ 444	—	6½	4½	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·32
Rotherham Corporation	,, 12	472	444	+ 28	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 16	4,005	4,008	— 3	—	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 15	4,733	4,571	+ 162	+ 6,623	65¾	52½	,, 25	240,565	63,952 283	6,049 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 11	916	948	— 32	— 514	—	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 13	780	489	+ 291	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 8	1,224	1,201	+ 23	+ 981	20	20	,, 31	64,858	15,364,463	1,495,685	1·004	10·36	—	6·37
Swindon Corporation	,, 11	186	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D C.	,, 14	715	710	+ 5	+ 655	11·85	10·5	,, 31	38,768	7,412.881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 12	2,023	1,083	+ 940	—	46	8·62	,, 31	—	15,773.742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 11	773	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 mil of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

The Franklin Institute.—We have received the October number of the *Journal* published by the Franklin Institute, Philadelphia, and among the contributions are papers on "The Alternating-Current Generator," by Mr. David B. Rushmore; "Sanitary Protection of Water Supplies," by Mr. Kenneth Allen; and a second instalment of the article on "Mica and the Mica Industry," by George Wetmore Coles.

Obituary.—Members of the Institution of Electrical Engineers and all other friends of Mr. F. H. Webb, its late secretary, will be sorry to hear of the sad loss sustained by him on Monday last, when Mrs. Webb passed away quite suddenly. We are quite sure that the sympathy of their friends will go out to Mr. Webb and the family in this their hour of trial. The funeral will take place at Hampstead to-morrow at two o'clock.

American Physical Society.—The issue for October of the *Physical Review* contains articles on the "Specific Heat of Gases at High Temperatures," under the joint authorship of Mr. L. Holborn and Mr. L. W. Austin; "The Quadrant Electrometer as used for Measuring Current" and "The Luminescence of Sidot Blende," by Mr. E. L. Nichols and Mr. Ernest Merritt, together with the first instalment of an article on "The Joule-Thomson Effect in Carbon Dioxide."

Electric Mining Rules.—We have received from Messrs. W. T. Glover and Co., Limited, of Manchester, a handy little book containing some regulations and data which cannot fail to be of use to those interested in the application of electricity to mining. The first part deals with the rules to be observed in the mine, and is followed by the report of the commission which sat to inquire into the use of electricity in mines. Numerous illustrations of joint-boxes, fittings, etc., suitable for this class of work are also given, and together with other data and notes on cables sections and mining cables form an important feature of this interesting booklet, which should be acquired by all who are concerned with electrical work in mines.

Wireless Telegraphy.—We mentioned last week that two ships of the Aberdeen line had been fitted up with an apparatus for wireless telegraphy. There are evidences of the extension of the system in many directions. The latest town to have a station installed is Norddeich, in Germany, on the North Sea. The area covered by its operations will have a radius of over 900 miles, and will include Germany, Austria, Switzerland, France, Great Britain, and Denmark, as well as the greater part of Italy, Sweden and Norway, and portions of Spain, the Balkan Peninsula, and Russia. The station is being equipped with the Telefunken system by the Wireless Telegraphy Company of Berlin, and will have towers nearly 60 yards high. It is expected to be in working order early in the coming year.

Radium.—As a result of experiments, an interesting discovery has been made by Mr. F. Soddy which furnishes new evidence in support of the now generally accepted view that one element can, under certain conditions, be transformed into another. A solution containing over 2lb. of uranium nitrate was freed from all radium that it contained by repeated precipitation, and was then kept for 18 months in a closed bottle. It was examined from time to time, and was found to have gradually acquired the power of emitting an emanation absolutely identical in characteristics with that given off by radium. Hence the conclusion was arrived at that the uranium was very gradually transformed into radium, though only traces of the latter substance were present in the solution at the end of the period of observation.

Italian Government and Wireless Telegraphy.—The Italian Government, in inviting tenders for work at Coltano Station, have definitely embarked upon the Marconi system of wireless telegraphy by refusing to permit compulsory exchange of messages between it and other systems. In a letter to Mr. Marconi, the Minister of Posts and Telegraphs says that the Ministry, in thus putting into execution the Bill twice approved by Parliament, is also convinced of the value of the conditions entered into and also grateful to the illustrious Italian who generously conceded to his country the use, without compensation, of the extraordinary fruits of his genius.

Books Received.—"Berechnung und Ausführung der Hochspannungs-Fernleitungen," by Carl F. Holmboe (Julius Springer, Berlin. 3s.). This little work deals with the transmission of high-tension current over long distances applicable to railways, telegraphs, and telephones. It is primarily intended for students in higher technical schools and for those already in practice who wish to instruct themselves in alternating-current work.—"The Mechanical World Pocket Diary and Year Book for 1906" (Manchester. 6d. net). We have received the nineteenth annual issue of this pocket book. A large amount of new matter has been introduced, and a section is devoted to an account of the steam-turbine, specially prepared by Mr. R. M. Neilson. The book retains all its old features, and, together with the new sections introduced, should be serviceable to the engineer.

Institution of Civil Engineers.—The usual reminder card giving the list and dates of the meetings of the institution has been issued to members. The institution will commence its eighty-seventh session on Nov. 7, when the president, Sir Alexander R. Binnie, will deliver his inaugural address, and this ought to prove exceedingly interesting, for the president is one of those engineers whose experience is very extensive, and he has consistently been successful. Among the subjects which will be brought forward in papers during the session for instruction and discussion will be "Waterways in Great Britain," "The Widnes and Runcorn Transporter Bridge," "The Steam-Turbine," "Heat Economy in Factories," "The Railway Gauges of India," "The Outer Barrier, Hodbarrow Mines,' and "The Heysham Harbour Works." The dates when these particular papers are to be read will be announced, as they are settled, in the usual way.

Wireless Telephony.—Experiments with a view to working out improvements on the present system of wireless telephony and telegraphy will be taken in hand in America by Dr. O. T. Cruikshank and Mr. Thos. F. Jack as soon as the apparatus which the latter has prepared can be installed. Mr. Jack has been working for several years on a system of wireless telephony, and has completed all his experimental instruments and apparatus. Receiving instruments will be located on the tops of the houses of each of the experimenters, which are situated one-eighth of a mile apart, one of them being 300ft. higher than the other, and messages will be transmitted by wire to a room in one of the houses. The only progress made so far with wireless telephony was by an electrician who, by talking into the shunt field of a direct-current generator, using an ordinary telephone appliance, was able to transmit sound 10 miles. Mr. Jack has succeeded in constructing an entirely different system from the one described above.

Bangalore.—A difficulty has arisen as to the provision of supply of current for lighting in Bangalore, which reveals the absurdity of the divided control of supply over certain areas. An electric lighting installation was recently

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opened in the city, which receives its current from a local sub-station, the sub-station depending in turn on the generators at the Sivasamudrum works at Cauvery Falls. The adjacent civil and military station is illuminated at night by oil lamps. The question arises as to who will undertake the supply. The Mysore Government are prepared to sell their surplus power in bulk to either the station, municipality, or to a local supply company, did such exist. Private enterprise, however, holds aloof from this field, and the municipal authorities have so far taken no action in the matter. It is probable that some time will elapse before a settlement will be arrived at, consequently the inhabitants will be put to no little inconvenience in having to wait for the electrical illumination of their streets and bungalows.

Ice in Water-Power Plants.—A device used by the Ottowa Electric Company for keeping ice off the racks in water-power plants was described at a recent convention of the Canadian Electrical Association. It was designed by Mr. W. H. Baldwin, superintendent of the hydraulic works of the company. The ice rake consists of a metal rake attached to a wooden beam about 5in. square and 20ft. long. To this rake an up-and-down motion is given by means of a small motor. This motion causes the rake to scrape the ice rack from top to bottom and from bottom to top, the lever being balanced so that gravity keeps the rake in contact with the rack. The rake and driving motor are mounted on a small truck running on a track at the top of the platform. The rake travels up and down at the rate of 100ft. per minute. Power is transmitted to it from the motor through friction cones, bevel gearing, and a chain and grooved wheels, the chain being fastened to the rake beam. We are indebted to the *Electrical Review* of New York for the above description of the device, which was communicated to the convention by Mr. A. A. Dion.

Electric Wires and Fires.—It is usual in the case of a fire whose origin is not easy to determine to suggest that the electric wires were the cause. At Bridgewater House, which was recently the scene of a great conflagration, a conference was held with the concurrence of the Commercial Union Fire Office, attended by Mr. Phipps, (secretary to the owner of the house, Lord Ellesmere), the consulting electrical engineers (Messrs. O'Gorman and Cozens-Hardy, represented by Mr. O'Gorman), and Messrs. Hancock and Rixon, to whom the electrical wiring had been entrusted, with a view to inquiring into and determining the cause of the fire. It appears that internally-insulated screwed steel conduit had been used; that there was absolutely no damage to the steel conduit; that there had been no arcing and no wires melted inside the conduit; and that the roasting given to the rubber had been caused by external heat. It was agreed that electricity could not have been the cause. On the other hand, a lead gas-pipe which was found in a partially melted condition near the fireplace is thought to have been the probable cause of the fire. A minute gas leak occurring near a ventilating duct which was also discovered in the floor would cause no smell of gas, but if ignited would slowly melt an ever-increasing hole in the lead tube, and eventually a full blast of lighted gas playing on the timbers would easily account for the fire.

Lucknow Electric Tramways.—A license has been granted by the municipal authorities to the British Eastern Electric Power Company sanctioning the construction of an electric tramway within the Lucknow municipality. The tramway is to be 3ft. 6in. gauge, and is granted subject to the usual conditions being complied with. The maximum speed permitted is not to exceed eight miles per hour on frequented thoroughfares. One of the clauses in the agreement provides that, subject to confirmation by the Local Government Board, the company may manufacture, supply, and distribute electric power within the municipal limits for house and street lighting, together with the right to construct buildidgs, erect machinery, lay electric cables and wires, either overhead or underground. The Municipal Board has also the right to require the licensees to supply current for lighting the roads along which the tramways run at 5 per cent. less than the price charged to ordinary customers. The lamps and posts for this purpose are to be erected at 5 per cent. less than the market price charged for this class of work. The price to be paid by the company to the municipality for the privilege of working the tramways is to be one-fourth of the amount exceeding 5 per cent. of the revenue upon the capital outlay. The agreement stipulates that the original outlay of the company shall be ascertained on the completion of the construction of the tramways, and additions shall from time to time be taken into account. In addition to the outlay, a fair proportion shall be charged for wear and tear and depreciation of rolling-stock in estimating each year's profits.

Municipal Electrical Engineers.—Strong representations are being made to the Local Government Board with a view to inducing that body to allow the expenses of delegates attending conferences of the Municipal Electrical Association and similar institutions. The matter has been taken in hand at the instigation of the St. Annes-on-the-Sea Urban District Council, in consequence of the district auditor having disallowed the expenses of their electrical engineer attending the conference of the above-named society, and having signified his inability to allow such payments in the future unless the association received the official recognition of the Local Government Board. The councils consider that it is highly desirable for the chairmen of their electricity committees and their chief engineers to attend the annual conferences of the association, as much benefit accrues to local authorities consequent upon being represented at the deliberations of the society and perusing its various publications. Having regard to the great importance which attaches to the efficient and economic working of municipal electrical systems, and the vast sums of public money absorbed therein, it is essential that facilities for intercourse between those concerned with the management of the electricity departments should be fostered. In view of the fact that the expenses incurred by delegates to conferences of the Urban District Councils' Association is refunded, it is only right that similar treatment should be meted out to the representatives of the Municipal Electrical Association. The Urban District Council of St. Annes are approaching the various municipalities interested, and the Electric Lighting Committee of the Stepney Borough Council have signified their hearty approval.

Electric Railways in Japan.—The completion of the war and the subsidence of the excitement which attended its termination once again brings into prominence the social and domestic policy of the country, which during the period covered by the war was eclipsed by its imperial policy. Notwithstanding the fact that the minds of statesmen and of the populace have been absorbed in the operations of the military and naval forces, we find that the internal development of the country still continues. The American consul at Kobé (Mr. Sharp), in a report to his Government, announces that Japan is already adopting a system of electric tramways, and gives details of the new road recently opened between Kobé and Osaka. He says that the opening of the Hanshin Electric Railway between Kobé and Osaka marked a great advance in electric traction in Japan, it being the first line constructed to connect

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two large cities. The railway is operated by the electric overhead trolley system, with 1,600 kw. power, and covers a little more than 19 miles. There are in use at present 18 cars, which were made by the Nippon Sharyo Seizo Kaisha, of Nagoya, Japan. The cars are well made, and have a seating capacity of about 50 each. The line is divided into four sections, the fare on each section being 1½d., these being subdivided into ¾d. journeys. All told there are 30 authorised stopping places between the termini, stops being made only when passengers wish to get on or off the cars. There has been much speculation as to whether the new competing service will not greatly affect the traffic between Kobé and Osaka, on the Imperial Government railway. Besides the difference of fare, which is 5d. on the tram and 8½d. third-class and 2s. first-class on the steam cars, the electric cars run every 12 minutes, against every hour on the steam railway, and have 30 stopping places, as against three. The average time, however, is about an hour and a half—about half as long again as the time occupied by the steam cars. On the whole, it is more than probable that the new line of cars will cause a very considerable diminution in the receipts of the Government railway between the two cities. The amount of paid-up capital in the company is £148,500.

Electrotherapeutics. — The measure of progress which has been made in the various applications of electricity for the prevention and cure of disease in America, can be pretty accurately gauged from the proceedings at the annual meeting of the American Electrotherapeutic Association held recently in New York. The reports of the various committees gave evidence that the association's work is well organised, whilst the papers read were of a high order of merit. On the matter of introducing electrical methods in the treatment of cancer, Dr. George Betton Massey asserted that as a result of analytic statistics relating to cancer a much larger proportion than is commonly supposed could be treated by this mode. For the early stages of cancer he recommended mercuric cataphoresis, and for cases difficult of access the X-rays. In his experience, since 1893 about 20 per cent. of cataphoretic operative cases had been improved by the treatment. Dr. Amédée Granger in his experience for cataphoresis on the mode adopted by Dr. Massey used currents varying from 200 to 700 milliamperes, the treatment lasting in some cases for 1 hour and 40 minutes. It was found that sudden changes in the strength of the current had a stimulating effect in the cases of feeble patients. Dr. Fred Harris considered "The Practical Uses of the Sinusoidal Current," and described an apparatus designed in 1893 by Dr. A. E. Kennelly which generated a high-frequency, high-potential current. This apparatus had 12 primary and 12 secondary rotating coils, and when driven at a speed of 4,800 revolutions a minute gave 1,900 alternations a second. The current was controllable both by regulating the speed of the motor and by putting resistances in the alternating circuit, and it gave much better results than other forms of electricity. From his experiences with radium in treating for diseases of the nose and throat, Dr. Freudenthal was able to relate two positive cures in the case of diseases of the larynx by the application of 10 milligrammes of radium put up in an aluminium tube. Among the other contributions were papers dealing with the preparation of "Radioactive Water," by Dr. W. J. Morton; "The Relative Action of the Röntgen Ray and Light upon the Enzymes, and their therapeutic significance," by Dr. E. C. Titus; and "Radiant Energy and Ionisation," by Dr. W. J. Herdman. An interesting variety of electrotherapeutic apparatus was also exhibited at the meeting.

Telephony.—The series of lectures arranged in connection with the Electrical Exhibition was brought to a close on Friday last, when Mr. L. Gill gave an interesting address on "Telephones" at the Olympia. There was a very large audience present, over which Mr. Preston presided. In a popular discourse, destined to make more generally known the workings of the present-day telephone and the methods by which rapid communication is obtained, the lecturer explained the evolution of the transmission of waves set up in speech, from the old toy telephone to the mechanical process which, for commercial purposes, is now worked electrically. The transmitter, a sensitive electrical valve, which when at rest is supplied with a steady current of electricity, but immediately any sound occurs in its vicinity the strength of the current is varied proportionally to the sound, both as regards the character of the sound and as regards loudness. For signalling or speaking, the connections are changed automatically by a switch which is generally made in the shape of a hook on which to hang the telephone. When the hook is up the transmitter and telephone are in circuit, when it is down the bell is in circuit, and with the bell is the condenser which allows the alternating ringing currents to pass, but will not allow the steady signalling current to pass. To describe the magnetic field which exists round the wire that conveys the current of electricity, a number of illustrations were shown upon the screen. The electromagnet is attached to the poles of a permanent magnet. The strength of the magnet is varied by the current in its coils, and the diaphragm, in order to reproduce speech, must very closely follow the rapid variations of the electrical current. In ordinary conversation, the movement of the diaphragm, too and fro, is about $\frac{1}{10}$mm. The current is in a series of waves, and not a steady current as for electric lighting. The current in the telephone circuits is not of the same strength in all parts of the circuit. A guttapercha-covered wire is economically quite impossible, except under very special conditions, mainly because it would require the wires to be separated by very thick walls of insulating material. Paper and dry air have been found to give good results, and telephone cables are now generally made in that way, a detailed description of which was given with illustrations. The telephone is not supplied from a main like the electric light, but is connected by a separate pair of wires with the exchange. The operations of the switchboard and connecting and disconnecting apparatus were also described in such a way as to make the audience familiar with the internal workings of the telephone exchange. The illustrations did much towards this end, whilst the quiet attention which attended the discourse and the hearty applause which marked its termination, manifested the keen interest taken in it by the large assembly.

London Traffic Commission.—In continuation of our observations on the report presented to the Traffic Commission by the Advisory Board of Engineers, made in last week's issue, we note the emphasis with which attention is directed to the loss of money and time which annually occurs in London from lack of travelling facilities, and notice is directed to the possibilities of facilitating travelling by the introduction of motor omnibuses. Figures are given to show that the speed of these vehicles compares favourably with that of tramcars, and is materially faster than that of omnibuses drawn by horses. If they should come into general use, the speed of the present omnibus service will be greatly improved. The Advisory Board consider that if the vehicles can be economically worked, they will have an important bearing upon the transport of passengers in London, and may affect the consideration of railway and tramway policy. The problem, so far as congestion is con-

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cerned, is reduced to the question whether omnibuses or tramcars are the more convenient way of conveying traffic in a public street. The advantages of the tramcar over omnibuses drawn by horses is acknowledged, but the question of motor omnibuses *versus* electric tramcars is still open to controversy. The engineers state that the tentative working in London of motor omnibuses within the past 12 months distinctly indicates that a rate of speed can be maintained by them which compares not unfavourably with the speed of electric tramcars in similar thoroughfares. Speed, however, is not the only consideration; the rapid depreciation of the motor omnibus consequent upon the wear of tyres and the charges for renewals cannot but handicap it in its opposition to the electric tramway. The chairman of the London Omnibus Federation, Mr. J. C. Pound, expressed himself to the Royal Commission as hopeful and even confident as to the successful introduction of the motor omnibus in London, and of its being able to compete with the electric tramcar. The engineers are of the opinion that the time has not arrived for a definite judgment to be formed as to the practical and financial prospects of the motor omnibus in London, and of its true position in a system of rapid transit relatively to the electric tramcar. Whatever may be the result eventually arrived at, however, the engineers remain unshaken in the belief to which we directed attention last week—viz., that the recommendations made as to routes and widening of the streets must remain unaltered. Three of the fundamental deficiencies in London tramways are: insufficient mileage; the stopping of existing lines short of "points of destination"; and dead-end terminals, setting up congestion in the streets. To remedy these, it would be necessary to give effect to the Commissioners' suggestion for the construction of adequate extensions. It is recommended that junctions should be avoided, and the traffic resolved into two components so as to preserve through running in both directions, by carrying each line of each system all across the lines of the other system. On the same principle it is advocated that the tramways should pass the stations of the underground railways whenever possible, so as to afford greater freedom of interchange for those who wish to avail themselves of a faster mode of conveyance in travelling more than a short distance.

Sunday Cars.—The question whether or not cars should be run on Sunday is again to the fore in several centres, and is being hotly debated both in the council chambers and through the medium of the local Press. Most public authorities, recognising the claims of utility, have sanctioned the running of Sunday cars. That the same catholicity in treating this question is not universal, is evidenced by the reports which from time to time reach us from the various localities. The Town Council of Perth were recently called upon to decide whether or not the electric car service should be continued on Sundays. The principal considerations which impelled the objectors were the desire for the diminution of Sunday labour and the solicitation for the welfare of the tram workers, who, it was urged, were entitled to a rest on Sunday. Against this it was contended that the general convenience of the public should be studied first, and that the withdrawal of the cars from the streets on Sundays would inflict great hardship on those who have occasion to use them. To the majority of people the trams are the only means of transit, and to deprive them of this, without interfering in any way with the privileges enjoyed by those who are able to afford the luxury of private carriages, would be a grave injustice. For our part, we fail to see in a service of Sunday cars the violation of any moral principle or religious sentiment. There is no denying the purity of the motive which prompts the movers of the Sabbatarian movement, but at times the zealots among it are altogether incapable of appreciating their incongruities, or of perceiving the mischief likely to be wrought by their narrow-mindness. Even were their efforts successful, the amount of Sunday labour would not be diminished to any appreciable extent, nor is there any evidence that church-going will increase or that the religious sentiment become more profound. If a diminution of Sunday labour is desirable, it should be sought in directions where it is obviously unnecessary, and not where its effects would be detrimental to the interests of the public, for whose use and convenience the system is destined. This is a point which is constantly being overlooked by our puritannical administrators, who imagine that in virtue of their public office they are charged with the guardianship of public morals, which can only be advanced through a particular cult. The necessity of withdrawing the Sunday car service need not be resorted to in order that employés may be assured of a day of rest. Those who are employed in towns where the Sunday service is in vogue do not work a greater number of hours per week than those employed elsewhere, for by adequate staffing and judicious working arrangements this is obviated. The suggestion to decide this contentious question by taking a *plébiscite* is not one likely to prove efficacious if acted upon. The majority of electors cannot be roused from their state of apathetic indifference to exercise their franchise so that the issue of the vote shall be an adequate reflection of the opinion of the electors. But all who use the cars have not the privileges of citizenship, hence a representative decision could not be forthcoming. In this utilitarian age it is impossible to give way to sentiment, or to be guided by ideas which have long been outgrown. It would be better were our civic fathers to admit the hard facts of the day, and, instead of endeavouring to abrogate public privileges, to extend as far as is in their power, facilities for rest and relaxation in accordance with the popular idea.

Magnetic Properties of Iron.—The *Proceedings* of the Royal Society of Edinburgh contain a paper by Mr. James Russell, which gives some conclusions arrived at as a result of experiments conducted by him with one sample of transformer iron (in zero magnetic field), demagnetised by decreasing reversals of co-directional and transverse forces, and also by annealing. In previous communications there were established the magnetic aeolotropy of iron demagnetised by decreasing reversals of co-directional and transverse magnetising forces and of iron left transversely magnetised, whilst it was further shown that iron and nickel demagnetised by decreasing reversals of a directional force develop an induction component at right angles to the subsequent magnetising force, which tends to disappear as saturation values are reached, when the angle between these two forces is either 0deg. and 90deg. The experiments have determined the presence of the following properties in the sample of iron experimented upon: permeability, retentivity, coercive force, and energy loss due to hysteresis. In regard to permeability, annealed iron, owing to the gradually diminishing range of magnetic change, the permeability of the iron is decreased. In demagnetised iron, on the other hand, one-half the magnetic change of induction produced by the first, or the tenth, or the hundredth reversal is always greater than that produced by the first application of a given magnetising force. In other words, the permeability of the iron is increased. When the values are low, annealed iron is less permeable than iron demagnetised by a co-directional force, but more permeable than iron demagnetised by a transverse force. When the value of 1·8 C.G.S. units is exceeded, annealed iron is more permeable than iron demagnetised either by a

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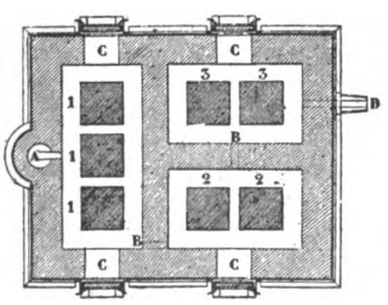
co-directional or by a transverse force. Reversals of the magnetising force modify the molecular condition of annealed and demagnetised iron, so that under like conditions annealed iron is more permeable for low values than transversely demagnetised iron. In regard to retentivity, measurements have also been made on the withdrawal of the magnetising force after its first application, and the results show that the curves of residual magnetisation so obtained accentuate the relative differences which exist in the induction curves under the co-directional, transverse, and annealing conditions of demagnetisation. From the hysteresis loops, the same result obtains when the residual demagnetisation is measured on the withdrawal of the magnetising force after it has been reversed 200 times. To ascertain the coercive force, the iron was carried through six sets of cycles between the positive and negative limits. It was found that the curves of each set of cycles cross the horizontal axis and each other at the same point, and that, consequently, the negative values are required to reduce the iron to zero magnetisation from equal positive values of induction, whether the iron has been demagnetised by a co-directional or a transverse force or by annealing. The coercive force of the iron, therefore, appears to be absolutely independent of the molecular condition impressed upon the iron by these three methods of demagnetisation. Regarding hysteresis loss, differences which exist between the three hysteresis loops for each set of cycles, having the same maximum values of induction, are more easily described as relative differences of shear. The areas of the three curves appear to remain the same so long as the maximum induction is the same. The conclusion is, therefore, arrived at that the energy dissipated as heat when the iron is subjected to cyclic alternation between positive and negative maxima is not affected by demagnetisation, by co-directional or transverse forces, or by annealing. The above summary of the more important results observable in the curves plotted for one sample of iron is only to be regarded as a preliminary communication, Mr. Russell preferring to defer the publication of curves until his experiments have been repeated for other samples of iron and for nickel.

Electric Steel Furnace.—At the annual meeting of the American Electro-Chemical Society, held recently at Bethlehem, consideration was given to the question of the electric manufacture of steel. Mr. Gustave Gin contributed a paper containing particulars of his new process. The construction of the furnace may be seen from the sketch shown below, which comprises essentially: a crucible, 1, for



fusion and refining by oxidation (corresponding to the pig end in the open-hearth practice); a compartment, 2, for the reduction of oxide of iron and recarburisation; a chamber, 3, for the colour test to get the proper carbon test. The electrodes of the compartment 1 are connected to one of the terminals from the source of electricity, and the electrodes of compartments 2 and 3 are both connected with the other terminal. The current passes from the electrodes to the metal through a layer of slag, which is the principal seat of the heating action of the current. The baths of metal communicate by openings, B, of sufficiently reduced section, in order that by reason of the Joule effect the metal may not remain solid. To put the furnace into operation, melted iron or liquid steel is introduced through the orifice, A. It distributes itself through the three compartments on the floors of which scrap iron is strewn, the pieces being placed in connection with B. Then arcs are created, and little by little the material is introduced. The oxidising slag of compartment 1 is composed of some mineral or slag rich in oxide of iron, in addition some lime if the metal to be refined is phosphatic. The slags of compartments 2 and 3 are neutral and little reducible by carbon. Aluminates of lime and magnesia, made from a mixture of bauxite, with limestone or dolomite, give favourable results. The addition of calcium fluoride makes it more fusible and mobile. By means of the method of circulation adopted, the refined metal in 1 passes next into compartment 2, where the reduction of the dissolved ferrous oxide and the recarburisation of the metal takes place. The author makes the point that the electrodes can be raised or lowered at will, and that this is important when the metal is tapped. The paper evoked considerable discussion, and it was doubted by various speakers whether the Gin furnace would be practicable. It has a large radiating surface. There would be some difficulty in keeping the contents of the three compartments separate. The design of the Gin furnace also seems to violate the metallurgical principle that one should not try to carry out essentially different processes in the same apparatus. Dr. Leonard Waldo then presented what was essentially a new paper, in which he pointed out that in electrothermic processes very heavy electric currents must be handled, which involves considerable difficulties. In all of the old electrometallurgy it had been necessary to deliver current through electrodes; in this case the management of the electrode becomes extremely difficult. At some time or other the current through the electrode either passes through a mixed charge with varying resistance or makes an imperfect contact. When that happens, the current arcs; and when it arcs there is the practically uncontrollable temperature of 3,850deg. C., and there results a corresponding impurity, a corresponding difficulty, and a corresponding intense action at the single point of the arc. This is the reason why a furnace without electrodes suggested itself. Dr. Waldo then sketched the principle of the induction furnace as the special case of a transformer with a single secondary winding (the molten bath). The containing crucible had no electrodes; no contact with fuel in any shape; the efficiency is high; the melting takes place at any rate desired. This control of the rate of heating is a most important advantage. The induction furnace permits adding quickly the energy units which make final minutes in the melt take the place of almost hours, when the high temperature is causing costly radiation and racking the mechanical stability of crucibles and furnace construction alike. At high temperatures approaching the melting point it is possible to push the rate of temperature increase to 1deg. C. per minute by adding 2 kw for every 100lb. of steel, or, to put it practically, the steel is raised the last 200deg. C. by adding 40 kw. for 10 minutes. If the furnace chamber is built of the proper material, its life is indefinite, since the heat is generated wholly within this chamber and not in excess of the fusion requirements. Dr. Waldo indicated the efficiency of the best induction furnaces by stating that they melt one ton of steel with an energy consumption of 500 kilowatt-hours. In this type of furnace the coal efficiency rises very much over the coal efficiency in the crucible process.

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TELEPHONE EXTENSIONS IN GUERNSEY.

It is peculiarly interesting that at a time when the attitude of the Local Government Board towards the municipal telephone question is one similar to the "Passive Resister" movement, the earliest exponent of

MR. A. R. BENNETT, CONSULTING ENGINEER, STATES TELEPHONE DEPARTMENT, GUERNSEY.

municipal telephony, the States Telephone Department of Guernsey, should commemorate the installation of a new multiple switchboard, rendered necessary by the rapid extension of their system. In telephony seven years (and this is the time since when the first subscriber to the States telephones was connected) is a long time, or may be a very short period — a long time when the

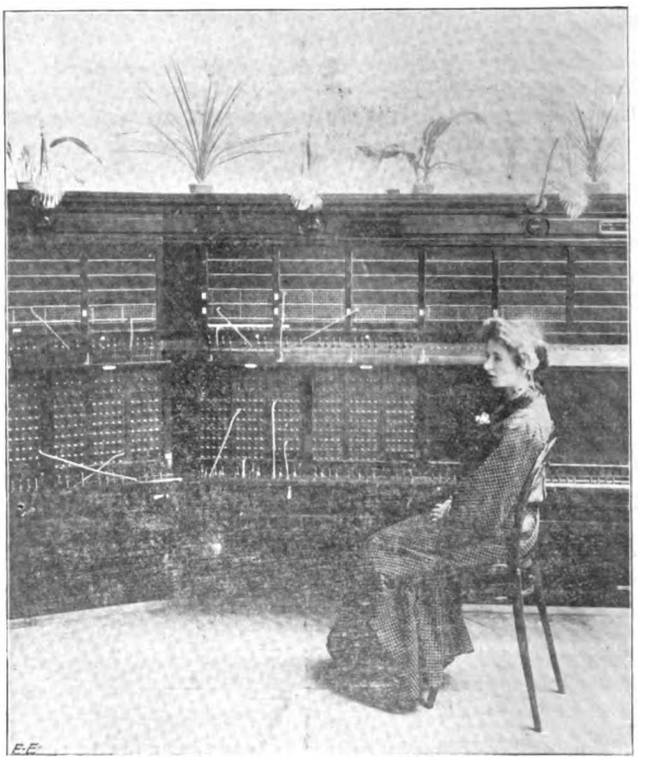
Central Telephone Office and Exchange, Guernsey.

improvements that have since taken place are considered; a short time when looking upon it from the point of view that it has taken the Government decades to realise that telephony should be treated on a more liberal scale than that accorded to it by its former sole monopolist, the National Telephone Company. The States of Guernsey, forming a state within the State, having its own Parliament, its own coinage, made up its mind, after the late Mr. Hanbury had disclosed the new telephone policy of the then Government, to have its own telephone system, and the attempt of the National Telephone Company to establish lines on the island in order to prevent the carrying out of this desire for independence was humorously and forcibly alluded to at the opening ceremony, which took place on the 3rd inst., in the presence of a large company. The

MR. ROBERT M'CLEAN, MANAGER, STATES TELEPHONE DEPARTMENT, GUERNSEY.

Bailiff and President of the States, Sir Henry Giffard, K.C., inaugurated the new multiple switchboard, Lady Giffard making the first through connection on the board.

The exchange building has been refloored and internally reconstructed with fireproof materials, chiefly steel and concrete. It now contains 13 rooms. On the ground floor are the manager's office, two clerks' rooms, mechanics' shop, inspectors' room, and test room, as well as public



Section of New Multiple Switchboard, Guernsey.

telephone office. On the first floor is located the switch-room, and on the first and second floors a six-roomed house for the caretaker has been provided. A battery room has also been erected outside the main building. The original switchboard provided in 1898 accommodated 300 lines only, with space for 200 more. This was rendered obsolete by the surprising success of the system. Thus the exchange private and sundry rentals in 1898 amounted to £115.

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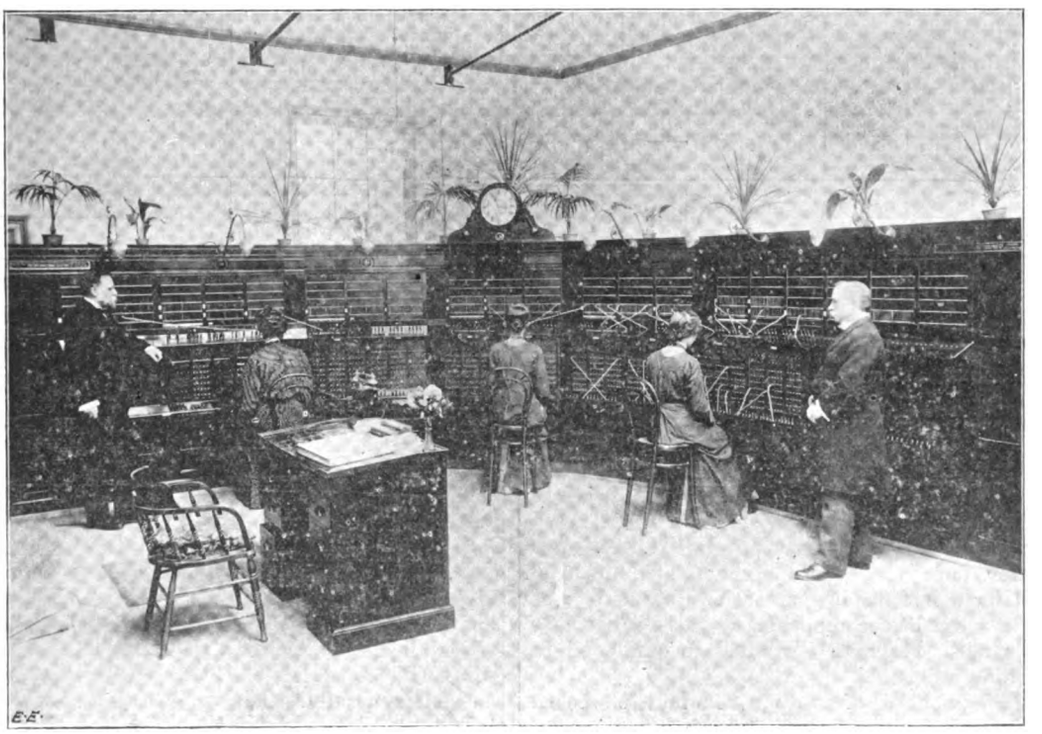
7s. 6d.; in 1904 they had grown to the respectable sum of £4,411. 19s. 6d. The number of subscribers in 1898 was 217; in 1904, 1,162. The public call telephones in 1898 were 9; in 1904, 49. The junction lines in 1898 were 7; in 1904 they had increased to 32; and on Sept. 28 last there were 1,430 stations working in the island, besides the 32 junction lines.

New Multipl Switchboard—States Central Exchange, Guernsey.

The building up of the new multiple switchboard has been carried out under the supervision of Mr. Robert McLean, the resident engineer and manager. It was designed by Mr. A. R. Bennett, M.I.E.E, the consulting engineer, and manufactured by the International Electric Company, of 55, Redcross-street, E.C., who have put in excellent workmanship. It has been finished complete for 900 lines, and has the multiple cables laid in for 200 more. The ultimate capacity of the board is, however, 3,100 lines, and it comprises special sections for public telephone offices and junction lines. Each operator attends to 100 subscribers, separate operators being provided for the junctions and public call lines, which number 50 each, so that there are 11 operators' working places at present provided. The original system of switching—Mr. Bennett's ring-through—is retained, the Telephone Committee considering that it is the best adapted to the island's requirements.

A special feature of the board is the indicator employed, which forms a departure from the well-trodden path of indicator construction. It is absolutely dustproof, inaccessible to the operator, and is automatically restored by the insertion of the answering plug. This indicator is of the revolving type, and consists of a pivoted black flag, which, when released by the attraction of the armature, is deflected by a spring and shows white. Five movements are united in one strip, which carries immediately underneath the corresponding number of jacks, so that mistakes in plugging the wrong number are almost impossible. In accordance



Another Photo of the New Multiple Switchboard, with less beauty and more board.

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with modern telephone practice, a double-sided ring-off has been introduced, and the somewhat difficult question of replacing two separate movements simultaneously by one operation has been ingeniously solved by the manufacturers. The withdrawing of the calling plug replaces automatically both differently coloured ring-offs, and the operator is not allowed to sever a connection until both ring-offs have put in an appearance.

Another important point has been secured by making a conversation absolutely secret. The operator cannot, after having established the connection, cut herself in without disconnecting the two subscribers. The ring-offs are actuated by a common battery, and likewise the pilot lamps, one of which is common to every operator's position, the latter being provided with 12 pairs of plugs, each plug being separated by a translator. The centre of this translator is connected through the ring-off to battery. Each pair of cords is controlled by a three-position ringing and listening key, and transfer keys allow the joining of adjacent operators' positions in the less busy hours of the service. A calling-back key is also at the disposal of the operator in case that for one reason or another the calling subscriber should have left his instrument and requires to be called back, which can be accomplished by this key without changing any plugs. Magneto currents are employed to operate the calling indicators.

All the modern essentials of an up-to-date multiple board are embodied in this exchange, the cables being fireproof, while the carriers are arranged so as to allow easy access to each layer of multiple cable without interfering with the remainder. The jacks can be withdrawn either from the front or from the back, and the ringing and listening keys are mounted on hinged supports, allowing convenient inspection. Moreover, everything has been designed so that transition at any time to common battery calling and clearing will be easy by slightly altering the subscribers' instruments. At present the retention of the ring-through is considered of greater importance than automatic calling and clearing. The spring-jack wiring is parallel for speaking and series for signalling, in accordance with a plan commonly adopted by Mr. Bennett. It is also worthy of note that Mr. R. McLean, the manager, is the author of an improvement which has been introduced and which causes the free tails incidental to series wiring to be automatically balanced in the act of switching. The Guernsey telephone service has always given satisfaction to the subscribers. An improvement in celerity and certainty of switching may, however, be expected as soon as the operators become familiarised with the new apparatus. The total cost of the alterations described above has been £2,700.

At the opening ceremony, Lady Giffard put through the first connection by means of a silver switch plug bearing an appropriate inscription. The inauguration was followed by a luncheon given by the contractors at the Old Government House Hotel, Guernsey. Mr. Oppenheimer, the managing director of the International Electric Company, presided, and speeches were made by Sir Henry Giffard, General Maingay (chairman of the States Telephone Committee), Mr. A. R. Bennett, and others. Mr. Bennett emphasised the great services rendered to the Telephone Committee by their manager, Mr. Robert McLean, and also referred in complimentary terms to Mr. Kenneth Munro (the chief electrician), Miss Guille (the chief operator), and the staff generally. The opinion was expressed by Mr. Bennett that the Telephone Committee would have to be very guarded if ever it became necessary to hand over their system to the Post Office. The rates introduced by the States of Guernsey were by far the lowest in the kingdom, and in the hands of the States had produced, were producing, and were expected to continue to produce, a handsome surplus after making all necessary provision for interest, sinking fund, and depreciation. And they had been found sufficient to provide the best material and apparatus obtainable, and to furnish a service which was

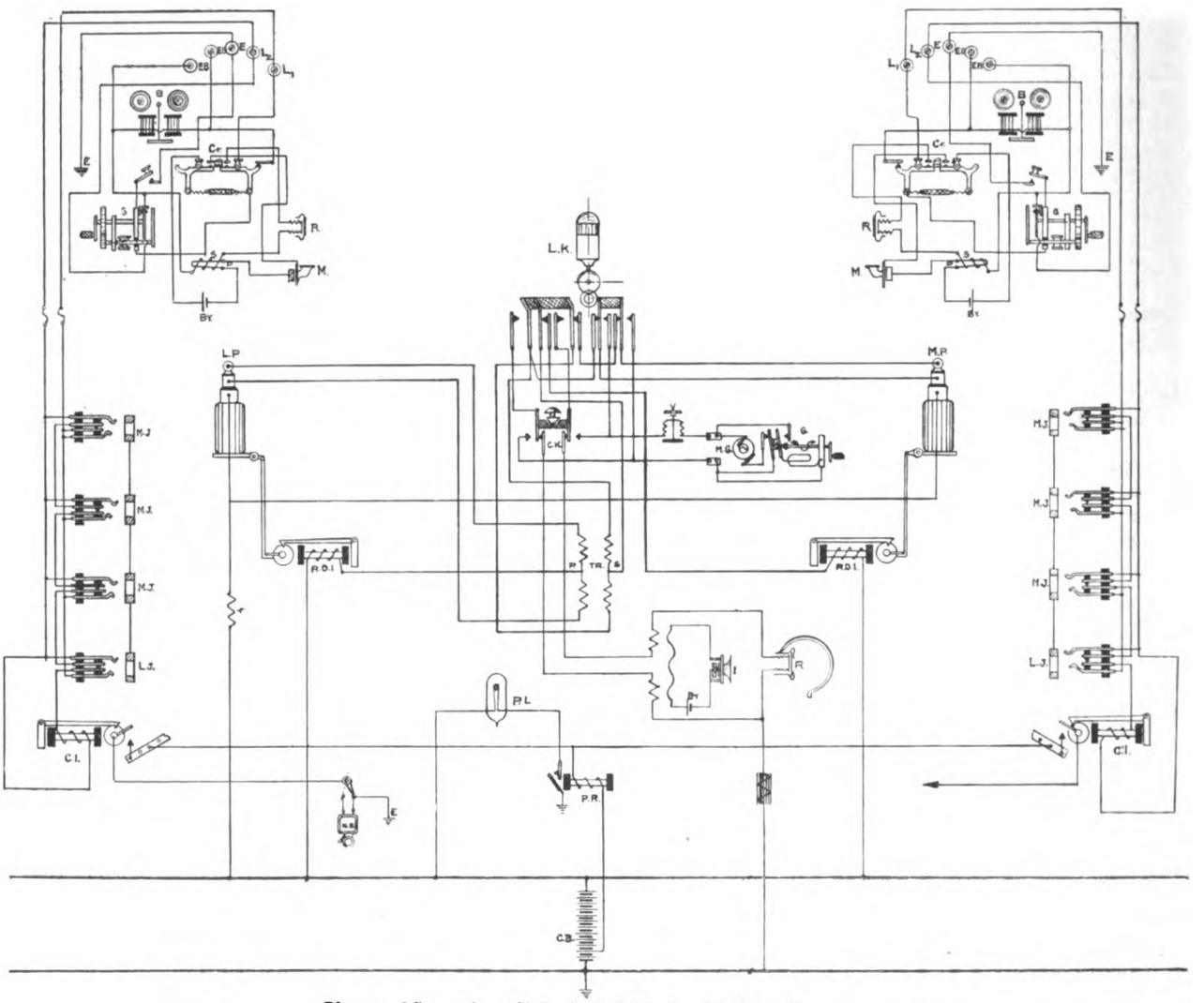

Diagram of Connec ions—States Central Telephone Exchange, Guernsey.

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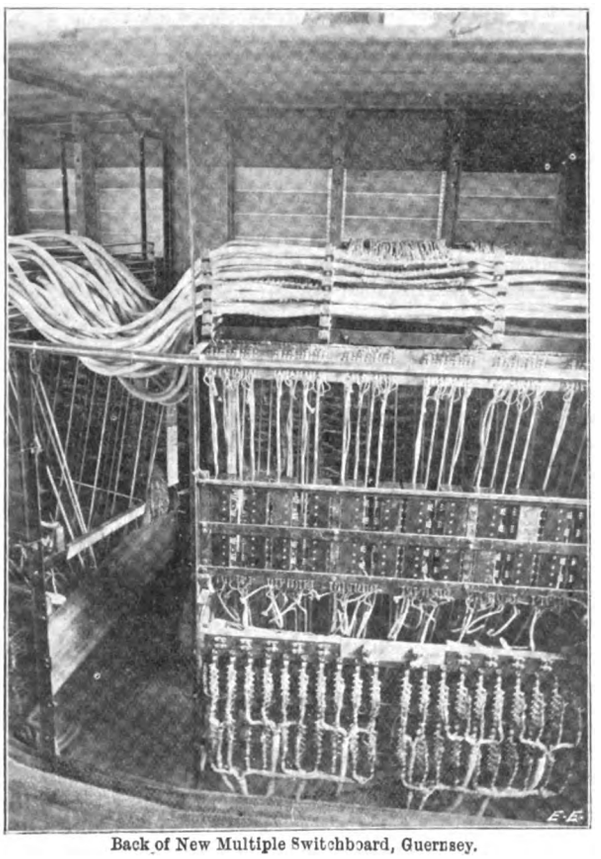
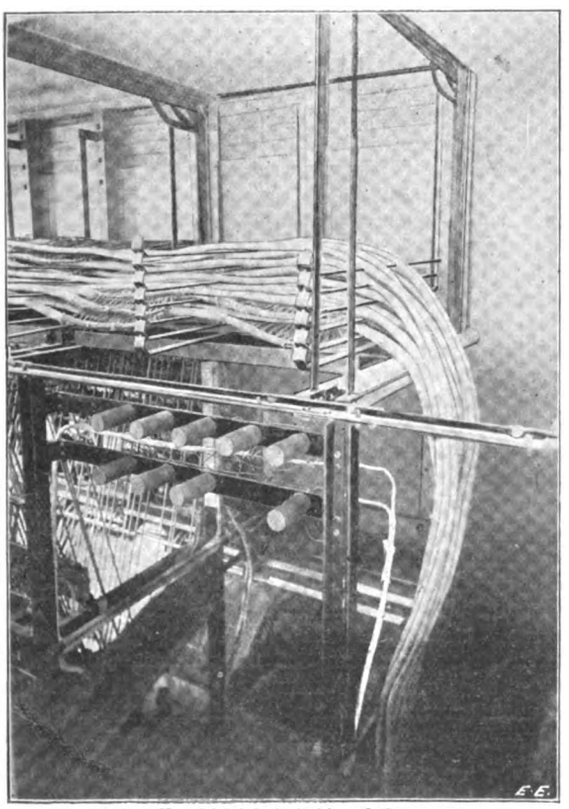
second to none in efficiency. The Post Office declared when the rates were first proposed that they could only result in a loss. Guernsey, Portsmouth, and other municipalities had



Back of New Multiple Switchboard, Guernsey.

demonstrated to the contrary, but the Post Office, if they acquired the system, would certainly not be able to produce equal results, nor would they probably wish to do so. The Post Office dreaded the extension of telephones, because



Back of New Multiple Switchboard, Guernsey.

they thought their telegraph revenue would suffer. They had, therefore, determined to get the telephones into their own hands in order that, if the telephone did ultimately kill the telegraph, the Post Office would have something to put in its stead. But the telephones would be useless to the Post Office unless they could be worked so as to produce a large profit. Hence the Post Office, at the late select committee, refused to pledge themselves as to future rates, and no doubt they intended, when the competing municipalities were out of the way, to work the telephones so as to produce a large profit regardless of the legitimate claims of the commercial community to be supplied at a commercial price. For this reason Guernsey must expect to have to fight a stern battle in order to preserve its rates.

General Mainguy expressed the opinion that if the rates in Guernsey were raised to the Post Office standard, the system would rapidly fall off and become a small one, instead of being, as it is at present, the largest telephone system in proportion to population in the United Kingdom. In Guernsey every subscriber, however low his rate, enjoyed the use of an exclusive line direct to the exchange; his conversation was private, and he had not to wait the convenience of several others on the same line when making a call. There was consequently nothing in common with the cheap rates advertised in England, which refer to party-line connections only.

THE DISTRIBUTION OF ELECTRICITY IN MINES.

BY B. C. H. J.

The use of electricity in mines is now becoming very general, and this article deals with one of the problems raised in connection with the practice—namely, the types of cable that should be used in the various situations, and the most satisfactory methods of installing same. It may be noted that the adverb of plurality is used, as these installations have to be designed on the same principle which lays down that "one man's meat is another man's poison." That is to say, the kind of cable that will suit one colliery will not be acceptable in another, and what is right for, say, the pitshaft is not always to be recommended for the underground roads of a mine.

This diversity of practice is accentuated by the differing systems of electrical distribution, such as continuous current and alternating three-phase current, which also embody the various tensions in use—commonly, from 100 to 3,000 volts. And, as different systems of mains are used in each mine for the different purposes—such as lighting, power, and signalling—so considerable variety of materials and methods may be required for use in connection with one and the same colliery distribution scheme. It will be seen that there is room for considerable diversity of practice, and this opportunity has been taken full advantage of by those responsible for the colliery electrical distributing systems now in use. This indulgence in the gratification of individual taste is now of service to a later generation (whatever its occasional disadvantage may have been to the persons primarily interested), inasmuch as it has shown up the capabilities of the systems used, and has thereby branded the inadvisable among them.

The type of cable used, in the early colliery installations, for all classes of work was vulcanised indiarubber; and to this day it is the best, particularly the rubber installation as then manufactured. But there are cheaper made cables now on the market, and, as the question of prime cost is an important one with many, such less expensive cables are more generally used for present-day work. These more modern cables are divided into two main classes: bitumen sheathed and lead sheathed, which classes are further divided as to insulation and protecting materials, as will be shown.

The plain bitumen cable mentioned is the class that has been very generally used for town lighting and tramways. In the best makes it consists of a solid sheath of specially-prepared bitumen applied under pressure to the copper conductor, and then lapped with strong tapes, being further protected with jute or other lapping as required. The suitability of this for use as a single-conductor cable is undoubted where there is no chance of undue heat being applied, either externally or through overloading the conductor. In cases where such overheating might tend to decentralise the conductor, or where multiple-conductor cables are required (if neither rubber-covered or metallic-sheathed mains are allowable), the conductor is first covered

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with a layer of impregnated paper or fibre, and then sheathed with bitumen either completely around the paper on the single-conductor type of cable or over the outside circumference on the multiple-conductor type, the conductors themselves being insulated from one another by the paper covering. It will be seen that the paper makes a more solidly mechanical dividing medium between the copper strands working at different potentials than can be hoped for with such a plastic substance as bitumen. If, however, the bitumen is unduly stiffened in manufacture it tends to become brittle, so that bending it in cold weather may cause it to crack.

The use of the paper separator is further valued in colliery work by its ability to withstand the increased liability to overloading that is involved when, for instance, coal-cutters get jammed or when trucks run off the rails, thus increasing the current passing. The liability of these all-bitumen cables to decentralise is increased by the fact that such cables are usually hung upon cleats or other suspensions at intervals, and are liable to have their weight at such points of suspension increased by their use as occasional clothes lines and tool racks. Some insistence is made upon this point—namely, of the necessity for a mechanically strong insulating separator in such a type of cable, as the fact does not seem to be as well known as it should in mining circles.

The lead-sheathed type of cable is also served with paper immediately under the lead, as in the standard town-lighting type, but this also requires further modifying to suit the special circumstances of colliery work. In this instance it is the lead that is liable to be affected, either by the peculiarly deleterious pit water or by the exceptional conditions of wear and tear associated with colliery working. As a rule, therefore, lead-sheathed cables are used more as a base to work upon as regards protection, than as the completed article, in this class of electrical distribution. Rubber-covered cables are still used for the lighting and motor connections, but their general use as main cables is, as before mentioned, out of date.

It will be seen, therefore, that the following styles of cables are in use, and their respective advantages will be further discussed:

Vulcanised rubber insulated, braided over all.

Bitumen insulated, braided over all, or jute served, and possibly further protected by armouring

Paper or fibre insulated, bitumen sheathed, and protected as above.

Paper insulated, lead covered, and protected as above.

To take a concrete instance. A coal mine is to be worked by electricity—the lighting, the coal-cutting, the screening and washing machinery, the ventilating, the hoists, mechanics' shop—and, in fact, everything but the main winding gear is to be worked from the dynamo-house. (Mining men will appreciate that there is too imperceptible an advantage in such cage winding, other than by steam-engines, to make it worth while to use electric power for this most vital part of the machinery unless the pit shaft is some distance away from the power-house). This mine instanced is one providing household coal, which means that it is less likely to be dangerous, as regards firedamp, than a steam-coal mine. Its workings are fairly compact, so that there would be little power loss in the mains. It is, therefore, decided to use continuous current. The voltage is 500, the feeder cable down the shaft is to be ·5 square inch, and the distributors in the workings vary from ·25 to ·05 square inch. The question arises as to the best type of cable for the above requirements.

Taking the surface work first, the cables for the screens, the washery, the mechanics' shop, and the pithead lighting are usually cleated overhead, and are subject to rough usage, heavy vibration, and extreme weather conditions on their way from the dynamo-house to their current-consuming devices. The best possible class of cable should, therefore, be put in here, such as the rubber-insulated type, heavily braided and compounded, with a coat or two of varnish painted over when cleated in position. The cleats should be of wood, and should have the square bearing edges slightly chamfered off; they should not grip the cable too tightly. A piece of brattice cloth, or of hose pipe, placed around the cable at the point of support, will lessen the effects of vibratory friction common to such situations. If the dynamo-house is some distance away, such as would be the case where power is generated at one centre for several pits, the feeders would require to be laid either underground or erected on poles. If public property has to be traversed the underground system should be used, with either paper-insulated, lead-covered, or bitumen-insulated, jute-served cables. The method of laying these depends upon the possibility of further extensions later. If no extensions are likely, a solid pitched-in system is recommended, composed of stout creosoted wood or asphalt trough, the cables resting on asphalt bridges and filled in all around with tempered pitch or bitumen to a thickness of about ½in., finally being covered by hard tiles or asphalt concrete to avoid mechanical damage.

If, however, a probability exists of further or heavier cables being required, iron or stoneware pipes should be laid for drawing the cable in. The cables should be further protected by jute serving to prevent abrasion when being drawn into the pipes. Draw boxes should be built at maximum intervals of about 100 yards, on straight runs, for this purpose. The joints should be made by the cable-maker's own men, as they are more expert at this special class of work than ordinary electricians can hope to be. Further, supervision should be given to the whole of the work by a representative of the cablemaker, who in such a case would guarantee the work for a period of time (usually a year) from faults due to manufacture or laying. Incidentally it may be mentioned that there has been a growing tendency among users of cable to be satisfied with the supervision of their own officials, or at the best of a jointer or foreman from the cablemakers, and this comparatively unskilled or irresponsible superintendence has often led to much trouble upon the cable portion of the work at least.

If the whole of the route from the power-house to the pithead is private property, and it is any appreciable length, the conductors may very well be erected overhead on insulators fixed to poles. The poles should be of the stout telegraph type, the cross-arms of well-seasoned oak, and the insulators double-shed porcelain, with ample room underneath for cleaning between the sheds. The conductors need not be stranded with small wires, but may be built up of either No. 0, or 00, or 000, or 0000, whichever is the most convenient multiple of the sectional area of conductor required. Thus, for the ·5 square inch conductor mentioned, four No. 0000 of ·125 square inch each would make the exact size. If these are each erected and strained up separately, then lashed to the insulator with soft copper wire, a solid and simple arrangement will result. It should be noted that if the whole of the conductor is erected in one section, it is harder to get such a flat curve as by straining it up in detail.

The cable for the pitshaft is next to be decided on. There are many types of cables and different methods of fixing in general use, and each arrangement is considered by its erector as the best. As a rule, such arrangements *are* the best for their own particular job only. To summarise some of these in order of simplicity: The lightly-insulated cable with a single insulated suspension at pithead, as used at Ackton Hall Colliery by Mr. R. Holiday, is specially fitted for the local circumstance of a wide pit-shaft where ample spacing can be allowed. In narrower shafts the tendency would be for the conductor to swing into mutual contact, with disastrous effect where dampness occurred. The cables there are mostly triple braided, so that in a dry situation but little leakage or chance of damage to a person touching them should result. The chief advantage is that there are no intermediate supports upon which deteriorating influences may make a base for attacking the insulation of the cable; and, further, the cable is cheaply insulated. It is possible that the new regulations may discourage this arrangement (per Clause 5, Section III.).

The next system, in point of simplicity, consists of insulated and armoured cables, also suspended from the pithead only. This suspension is made from the galvanised iron wire armouring, of which there are two layers, to a steel hanger to which the armour is attached, and which

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has eyes to hold the chain slings or other suspensory arrangements. The armouring, therefore, acts as a protection from damage, and also takes the strain off the pendulous cable.

The next most usual practice is to clip the cables up to the buntons by means of cleats, spaced at intervals of from 10 to 100 yards, depending on the size of the cable or the distance between the buntons already installed for supporting other items of mining transmission. The length of cleat would depend upon the length of span, but it varies from 2ft. in length in general practice. The cleats, however, cannot be made too long, and will be the safer for a packing between the cable and cleat, such as split rubber hose pipe. The methods of fixing the cleats are various and suited to the arrangement of the bunton, to which it is either clipped, or bolted to, or supported upon with intermediate girders. A stout roofing hood should be screwed on to the top of the cleat, to deflect falling material; and special attention should be paid to the protection of the cable at this point. For pits where the water is too bad for any protective metal to be exposed, a well-used practice is to run strong tarred wood casing down the side of pit, into which the cables can be made a tight fit by tapping with a mallet. This casing should further be lined with tarred felt, and the whole arrangement should be thickly coated with Stockholm tar before screwing the cover on, the cover being afterwards tarred over. If the tar is occasionally renewed, the arrangement should be a good lasting one for even the worst of pits. The exceptional conditions to be met with occasionally may be imagined when it is stated that a guttapercha-insulated cable embedded in a thick tarred wood trough has been utterly spoiled, as to insulation, by the action of the shaft water, which penetrated the treated wood and attacked the guttapercha. This casing method is apt to prove expensive if buntons are not closely spaced down the shaft, as additional supports for the casing will be required or a specially made continuous-jointed casing would have to be provided.

In some instances cables are run down iron barrel, which is screwed together in 9ft. lengths and supported at fairly long intervals up to 50 yards. The cable is then held in a long cleat at the top, which cleat is fastened to the pithead timbering; cable cleats being further used at the pipe-supporting buntons. These pipes and their erection are somewhat expensive, but they make a first-class job, especially with a rubber cable; the writer knows cases where the combination has been in satisfactory use for over a dozen years, and is, like Charley's Aunt, "still running."

(To be continued.)

THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.

BY ALFRED STILL, M.I.E.E., A.M.I.C.E.

(Continued from page 561.)

VECTOR DIAGRAM FOR THREE-PHASE TRANSMISSION, TAKING INTO ACCOUNT RESISTANCE, SELF-INDUCTION, AND CAPACITY.

The diagram Fig. 24 has been drawn to scale, and shows the relations between the E.M.F.'s at generating and receiving ends of an overhead three-phase transmission line for the condition of full load. The data upon which the calculations have been based are such as might apply to a practical scheme of power transmission, and the diagram has the advantage of showing the relative importance of the effects due to ohmic resistance, self-induction, and capacity.

Data.—Total power delivered at full load = 4,000 kw.
Power factor ($\cos\theta$) = ·8.
Pressure between wires at receiving end (E′) = 30,000 volts.
Frequency (n) = 25.
Length of line = 100 miles.
Diameter of copper conductors = ·4in.
Distance between centres of wires = 45in.

To calculate the current, C′, at receiving end, we have

$$\sqrt{3}\,E' \times C' \times \cos\theta = 4{,}000 \text{ kw.},$$

which gives us 96 amperes as the full-load current, C′, delivered at receiving end. We can, therefore, draw the E.M.F. triangle, $e'\,a'\,b'$, with equal sides, each of such a length as to represent 30,000 volts, and the vector O C′ 36° 52′ behind O e' (corresponding to the power factor of ·8), and of such a length as to represent the current of 96 amperes at receiving end.

Capacity Current.—On the assumption that the whole of the capacity is concentrated at receiving end, and that the E.M.F. wave is a sine curve, we can calculate the capacity current by means of the formula

$$C_k = 2\pi n K e' \times 10^{-6},$$

where K is the calculated capacity between any one wire and the neutral line (as previously explained), and e' is equal to $\frac{E'}{\sqrt{3}}$. The value of K, as given by the expression

$$K = \frac{\cdot 0388}{\log_{10}\frac{d}{r}} \times 100,$$

works out at 1·65 microfarads, which gives us for the capacity current

$$C_k = 4{\cdot}5 \text{ amperes.}$$

The vector O C_k in the diagram must, therefore, be drawn of such a length as to represent 4·5 amperes to the same scale as O C′, and in a direction at right angles to O e', as explained in connection with single-phase currents. The

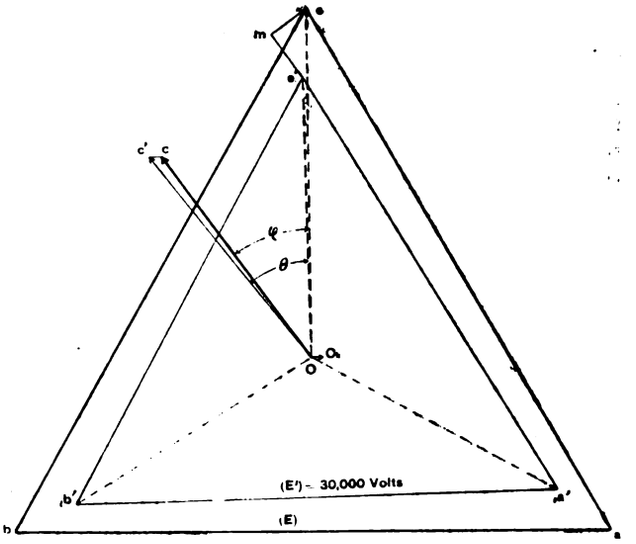

FIG. 24.

total current in the line is O C, obtained by compounding O C′ and O C_k. This vector, which scales 93 amperes, is, therefore, the current delivered to the line at the generating end.

Resistance Drop.—The resistance of a copper wire ·4in. diameter and 100 miles long will be about 35 ohms. This gives us for the drop in volts per conductor at full load C r = 3,250 volts.

Self-Induction.—On referring to the curve Fig. 4, it will be found that the coefficient of self-induction per mile of single conductor ·4in. diameter, with a distance of 45in. between wires, is 1·83 millihenrys, which gives us ·183 henry for the line 100 miles long. Hence the E.M.F. of self-induction per conductor (on the assumed condition of a sine curve current wave) is

$$2\pi n L C$$
$$= 2\pi \times 25 \times \cdot 183 \times 93$$
$$= 2{,}670 \text{ volts.}$$

We are now in a position to complete the diagram Fig. 24. Draw $e'\,m$ parallel to O C and of such a length as to represent the volts required to overcome the ohmic resistance of the conductor—*i.e.*, 3,250 volts. At the point m erect the perpendicular $m\,e$ to represent the impressed volts (2,670) necessary to balance the E.M.F. of self-induction, and join O e. The length of this line will evidently give us the value of $\frac{E}{\sqrt{3}}$, where E stands for the pressure between wires at the generating end. The sides of the large

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triangle scale nearly 37,500 volts, and this is the necessary pressure at generating end. The power factor at generating end (cos ϕ) is, in this example, very nearly the same as at receiving end; it measures about ·81, whereas the power factor of the load was assumed to be ·8. The power put into the line is

$$\sqrt{3}\,E \times C \times \cos\phi$$
$$= \sqrt{3} \times 37{,}500 \times 93 \times \cdot 81$$
$$= 4{,}900 \text{ kw.}$$

And since only 4,000 kw. are delivered at the distant end, the efficiency of the line—on the assumption that the leakage losses over insulators and through the air are negligible—will be

$$\frac{4{,}000}{4{,}900} = 81{\cdot}6 \text{ per cent.}$$

It must not be forgotten that the data on which the calculations are based have been chosen merely for the purpose of illustration; but, at the same time, these figures are such as might apply to a practical scheme.

Most Economical Section of Transmission Lines.—In the examples previously worked out we have assumed certain $C^2 r$ losses in transmission which have enabled us to draw certain conclusions as regards pressure drop, phase displacement, etc. We shall now briefly consider the various points to be borne in mind when determining the most economical size of conductors for any given conditions of electric transmission.

In the first place, it should be clearly understood that the following considerations are entirely distinct from any questions as to *choice of system—i e*, as to whether the conductors are run overhead or underground, whether they are insulated or bare, and, if underground, whether laid on the drawing-in or solid system. The question we have to solve at present is simply this—given a certain system of transmission (whether single or polyphase), will it pay us better to put in large conductors at a high initial cost but having small $C^2 r$ losses, or small conductors at a lower initial cost but having large $C^2 r$ losses? There is evidently a particular size of conductor which will prove to be the most economical to use on any given transmission scheme; but the difficulties of correctly estimating the amount and duration of load are generally considerable, and we have to be satisfied with a more or less close approximation to the best results.

Again, it will sometimes be found that the section of conductor, as worked out in accordance with economical considerations, cannot be adopted in practice for either or all of the following reasons: (1) the current density may be so high as to raise the temperature beyond the safe limit; (2) the pressure drop on a long line may be greater than can conveniently be dealt with; (3) in the case of overhead wires, the section may be so small that the line would be mechanically weak; (4) in the case of extra high pressures the surface of the wire may be so small as to lead to considerable increase of leakage through the air. The corrections to be made in such cases are fairly obvious. The section of the conductor must be increased to the required amount without regard to the question of economy, or it may be found that aluminium conductors can be adopted with advantage. If the cables are insulated, and the economical current density is so high as to raise the temperature unduly, two or more cables would have to be laid side by side and connected in parallel, or the cross-section of the single cable would have to be increased, according to which method proved to be the cheapest.

Prof. George Forbes once stated* that he would like to see an accurate volume published on the correct use and development of Kelvin's law of economy. The writer has no such desire, neither can he appreciate the utility of a book of this kind. It would in all probability resolve itself into a compilation of more or less intricate formulæ, applicable to a number of imaginary cases which might or might not fit in with the conditions to be dealt with in practice.

The following graphical method of determining the most economical section of conductors, which was introduced some time ago by Mr. Edw. W. Cowan and the writer,* is applicable to any system or conditions of supply, and does not involve a knowledge of higher mathematics. As already stated, in calculating the most economical section of the conductors in a transmission line, there are two factors only to be considered: (1) the first cost of the conductors; (2) the cost of the energy lost in the line. Kelvin's law, in its simplicity (and, indeed, when the law of maximum economy departs from this simplicity it ceases to be Kelvin's law), may be stated as follows: "The most economical section of a feeder is that which makes the annual cost of the $C^2 r$ losses equal to the annual interest on the capital cost of the copper in the line, plus the necessary annual allowance for depreciation." The cross-section should, therefore, be determined solely by the current which the conductor has to carry, and not by the length of the line, or an arbitrary limit of the percentage full load drop in pressure; the drop, even if considerable, must take care of itself. If there are reasons which make a large drop undesirable, then, if necessary, economy must be sacrificed, and the line calculated on the basis of pressure drop only.

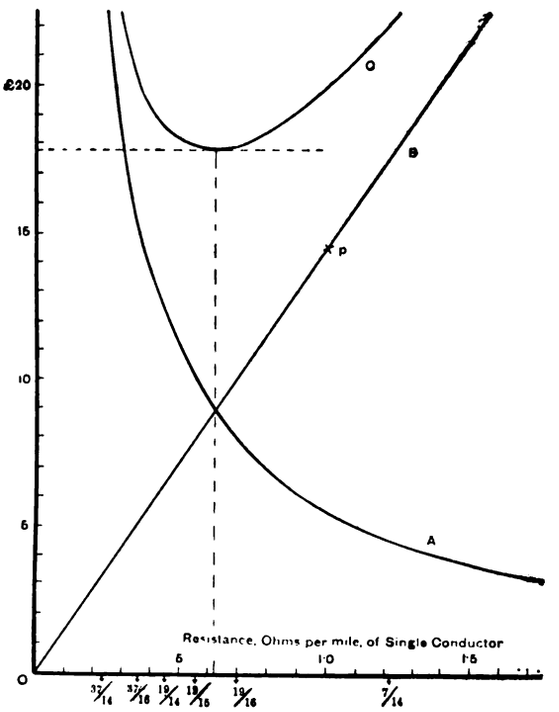

FIG. 25.

Kelvin's law is based on the assumption that bare conductors are used, and that the cost of these, erected in position, is directly proportional to the weight of the copper. This assumption is not justified in practice if insulated cables are used, the cost of which per pound of copper is greater for the small than for the larger sizes. But in the case of an overhead transmission line with bare conductors Kelvin's law may give sufficiently accurate results, because, although the cost of erecting the smaller wires may be greater *per pound* than for the larger sizes, the insulators, supports, etc, may become more costly as heavier wires are used, thus making that portion of the total cost of the line *which depends upon the section of the conductor* approximately proportional to the weight of same. To cover all cases in practice, the law of maximum economy may be stated as follows: *The annual cost of the energy wasted per mile of the transmission line, added to the annual allowance (per mile) for depreciation and interest on first cost, shall be a minimum*

It is not very easy to estimate with any degree of accuracy the probable amount of the $C^2 r$ losses during the year's working. The energy lost in a given conductor depends upon the square of the current and the time during which the current is flowing. If a cable conveys a

* "On Distant Electric Power Transmission," *Journal* Inst.E.E., vol. xxix., May, 1900.

* "The Regulation of Pressure and the Reduction of Light-Load Losses in Alternating-Current Systems of Electric Supply." Paper read before the Northern Society of Electrical Engineers, March 23, 1896.

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current, C, only 12 hours out of the 24 hours, then the energy wasted per day is only half what it would have been had the current been flowing continuously, and the watt-hours may be expressed as $12 \times C^2 \times r$, or as $24 \times \frac{C^2}{2} \times r$. It follows that, in working out the energy lost per annum in the conductor, we have to multiply the resistance, not by the maximum current which the conductor will at times be carrying, but by the mean value of the square of the current throughout the year. The expected average daily load curve should, therefore, be drawn, and the mean value of C^2 calculated therefrom. If the capacity current is considerable, this must be taken into account when calculating the average value of the square of the current. The diagram Fig. 25 will serve to explain how the proper size of conductor may be worked out in actual practice.

Let us suppose that 10 per cent. is to be allowed for depreciation and interest on cost of conductor; then, in the diagram Fig. 25, where the horizontal distances represent resistance per mile and the vertical distances represent money, plot the Curve A, which gives the relation between 10 per cent. of the capital spent on the conductor and its resistance in ohms per mile. Now calculate the cost of the $C^2 r$ losses per mile of cable for any particular value of the resistance, and draw the straight line, O B, through the origin, which will give us the cost for any other resistance of conductor. By adding the ordinates of the Curves A and B, the Curve C is obtained, of which the minimum value corresponds with the resistance per mile of the conductor which will be the most economical to use, whatever may be the length of the line or the pressure required at the receiving end.

Let us briefly consider how the two costs, of which the sum is to be a minimum, should be estimated. In the first place, the capital outlay on which the interest is calculated must include the insulation on cables (if any), and the difference in cost (if any) of the conduits or overhead construction *which is dependent upon the size of the conductors*. No capital charge which is *constant* for all sizes of conductors within practical limits need to be taken into account. This is a point on which there appears to be some difference of opinion. It has been most emphatically stated, on the one hand, that all standing charges, such as trenching, erection of poles, etc., must be included; and, on the other hand, it has been asserted with equal assurance that these constant charges must on no account enter into the calculations of line efficiency. The truth of the matter is that it makes not the slightest difference either one way or the other whether or not these standing charges are included. Here the advantage of the graphical solution of such problems becomes apparent, because even the non-mathematical reader will readily understand that the effect of adding the same length to all the ordinates of the curve A (Fig 25) will be to raise the curve C by the same amount *without altering either its shape or the position (in the horizontal direction)* of its point of minimum value. With regard to what is a reasonable interest to allow on the cost of the conductors for the purpose of drawing the curve A (Fig. 25) Prof. Forbes has pointed out* that if the copper in the lines be mortgaged, the interest we have to consider is merely that paid on the mortgage—say 4 per cent. If the copper is paid for out of capital, the interest may be much greater, being equal to the estimated dividends to be paid on the capital invested. In addition to this, there is the annual allowance to be made for depreciation, which will depend upon the probable life of the line and its scrap value when replaced.

We now come to the second of the two cost items—namely, the cost per annum of the energy wasted in the line. This will generally be the works cost of the power, and must include interest and depreciation on the plant in generating station, including step-up transformers, controlling gear, boosters, etc., through which the current passes before reaching the line. At the same time each scheme must be independently considered, as evidenced by the following statement borrowed from Prof. Forbes's paper previously referred to: "When using water power which is unlimited compared with the demand, the price per annum of the horse-power is the cost of generating the power. When the water power is limited and the demand unlimited, the price per annum of the horse-power is the selling price of the power." There is also a correction to be made in the event of the economical losses in the line bearing a large proportion to the total power transmitted. In this case the cost of power at the distant end of the line may be appreciably greater than at the generating end, and, under normal conditions, we ought to take the cost of the wasted power at something between these two values. If we determine the slope of the line O B in Fig. 25 on the basis of works cost at generating end, this will enable us to calculate the approximate resistance of the line and ascertain the approximate loss of power, together with increased cost per horse-power at the receiving end. We can then revise our previous figure for cost of power wasted in line and obtain a corrected value of the required resistance.

Example Illustrating Use of Diagram.—Consider an overhead line with bare copper conductors, to carry a maximum current of 60 amperes. Let us assume that probable load curves have been drawn, which will enable us to estimate the $\sqrt{\text{mean square}}$ value of the current throughout the year. This might be about one-third of the maximum value—let us say 20 amperes. If, therefore, we multiply the resistance of each conductor by the square of 20, we shall obtain the total power lost in the line on the assumption that this loss is going on day and night throughout the year. This gives us as the total number of Board of Trade units wasted in each conductor per annum *for an assumed resistance of one ohm*:

$$\text{Units} = \frac{1 \times (20)^2 \times 24 \times 365}{1{,}000}$$
$$= 3{,}500.$$

And if the cost of this power be taken at 1d. per unit, the cost would be

$$\frac{3{,}500}{12 \times 20} = £14{\cdot}6.$$

This enables us to plot the point p on the curve O B, and by joining $o\,p$ we can read off the cost of power per annum for any other resistance of conductor.

With regard to the curve A, we shall suppose that 10 per cent. is to be allowed for depreciation and interest on capital spent on conductors, and if we take the cost of these at 1s. 3d. per pound, we can readily plot a number of points through which this curve must be drawn. The curve C, as already explained, is the result of adding the ordinates of curves A and B. Its minimum value in our example corresponds to a resistance of ·62 ohm per mile, which gives us as the most economical conductor a stranded cable somewhere between $^{19}/_{16}$ and $^{19}/_{15}$, or the equivalent solid wire. (It should be noted that, since the curve A is a rectangular hyperbola, the minimum value of C is on the same ordinate as the point where the two curves cross—*i.e.*, where A is equal to B—but this is not necessarily the case when the conductors are provided with an insulating covering.) In order to carry the numerical example a little further, we shall assume that the transmission is on the three-phase system, 50 miles long, with 20,000 volts between wires. The drop in volts per conductor will be

$$C \times r = 60 \times {\cdot}62 \times 50$$
$$= 1{,}860 \text{ volts.}$$

And if we disregard the effects of self-induction and capacity, the loss of pressure between wires at the receiving end will be

$$1{,}860 \times \sqrt{3} = 3{,}220 \text{ volts.}$$

The initial pressure being 20,000 volts, the pressure at distant end is 16,780 volts.

The full-load power at generating end = 2,080 kw.
The full-load power at receiving end = 1,745 kw.
The power lost in the line = 335 kw.
And the efficiency of line = 84 per cent.

(To be continued.)

* "On Distant Electric Power Transmission," *Journal* Inst.E.E., vol. xxix., May, 1900.

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NOTES ON ALTERNATE-CURRENT INDUCTION MOTORS.*

BY T. HARDING CHURTON.

In this paper the author proposes, firstly, to compare the performance and characteristics of motors of the induction type when provided with short-circuit and with wound rotors respectively; secondly, to compare the performances of such motors on single-phase and polyphase circuits respectively; and thirdly, to indicate, by comparisons, the extent to which the working of such motors is affected by the frequency of alternations. For the purpose of illustrating the above comparisons, the performance of a particular size of machine with short-circuit and with wound rotor, for single-phase and for polyphase working, and on circuits of various periodicities, will be shown, the particulars given being the results obtained from actual tests on a number of machines of the same size. The windings were in each case appropriate, of course, to the circuit upon which the motor was to operate. It is not suggested that the comparative results here shown necessarily apply in all cases, but they may at least be taken as fairly representative.

When an induction motor is started up, the field of the stator starts at once to revolve at the full speed of the motor, and the rate at which it cuts the rotor conductors falls from a maximum when the rotor is at rest to a minimum when the highest speed of rotation is attained. The currents thereby induced in the rotor conductors lag behind the stator field, the difference in phase depending upon the strength of the currents, which will depend, of course, upon the resistance of the circuits. And the field due to the rotor currents, reacting upon the stator field, which it consequently weakens, is also, of course, dependent upon the resistance of the rotor circuits. But the torque exerted by the rotor being proportional to the strength of the stator field and rotor currents, and inversely proportional to the phase difference between them, the maximum torque of the motor at a particular speed depends, therefore, upon a certain value being given to the rotor resistance, which value decreases as the speed of the motor increases up to synchronism. For this reason, a motor provided with a rotor, into the circuits of which (either through slip-rings or other device) external resistance may be inserted and gradually cut out as the motor gains speed, starts up better than one having permanent connections. This may be expressed by the formula

$$R_0 = R_2 \times \frac{n_1}{n_1 - n_2},$$

where R_0 = total resistance of rotor circuits;
R_2 = ohmic resistance of rotor winding;
n_1 = frequency of stator currents (or speed of stator field);
n_2 = frequency of rotor currents (or slip of rotor).

In the case of two-phase or three-phase motors a considerable starting torque may be obtained with short-circuit rotors having conductors of comparatively high resistance. But such resistance seriously affects the efficiency, as well as the slip, of the motor when running on load, and motors so constructed are usually employed, therefore, only for intermittent work, such as, for example, operating cranes. When an induction motor is required to combine relatively high starting torque and high efficiency on load, it should have a wound rotor and variable starting resistance. If, however, so high a starting torque is not required, the short-circuit rotor, with low-resistance conductors, is preferred on account of mechanical superiority, greater electrical efficiency, and overload capacity. In a short-circuit rotor the currents and field are much more evenly distributed than in a wound rotor, and the former is consequently less liable to have "dead" points at starting. And though, owing to the more definite polar winding of the wound rotor, the average torque is greater than that of the short-circuit rotor, yet when the coils of the rotor are exactly opposite the coils of the stator, the torque is less than that of the short-circuit rotor. Again, with the wound rotor, the number of slots in the stator and rotor must have a common factor which conduces to a cogging effect.

But a further desideratum in the choice of the type of motor, particularly when of large size, is the maximum current that may be drawn from the mains at the moment of starting, and which will not interfere with the pressure regulation of the supply. As before mentioned, the field due to the rotor currents reacts upon the stator field, which it more or less wipes out, and thus, by reducing the self-induction of the stator coils, allows an increase of current to flow through them from the mains. Now, when a motor with an ordinary short-circuit rotor is started, the currents induced in the rotor are very great, and the current drawn from the mains must also, therefore, be considerable. If a polyphase motor of high efficiency with short-circuit rotor is switched directly on to the mains, with a periodicity of, say, 50 cycles, there will be a momentary rush of current equal to about three to five times full-load current, while the resulting starting torque will be about two and a half to four times full-load torque. If the pressure of the supply current is reduced by a transformer starter, the current from the mains may be reduced to, say, about full-load current, when the torque will be equal to about one-half to three-quarters full-load torque. With a wound rotor, a similar machine would give full-load torque with full-load current, and this current could be switched on gradually.

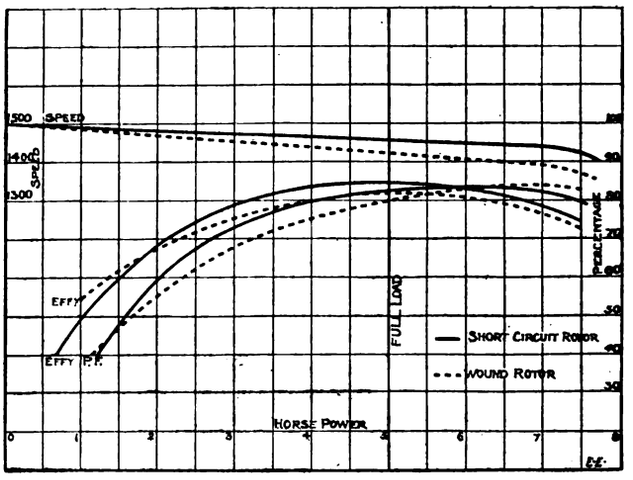

FIG 1.

The type of transformer usually employed for starting polyphase motors with short-circuit rotors is that known as the auto-transformer, which consists, for each phase, of a single coil wound upon an iron core forming a closed magnetic circuit. By tapping the coil at a point intermediate between the two ends, the voltage may be readily obtained that limits the current drawn from the mains to the permissible value, while allowing a considerably greater current to flow into the stator windings. With regard to the starters for motors with wound rotors, as the rotors are invariably provided with a three-phase winding the regulating resistance is always in three divisions. Liquid resistances are sometimes used, but more frequently wire or metal strip multiple-contact rheostats are employed. The curves shown in Fig. 1 are from tests taken upon two motors, one having a short-circuit rotor and the other a wound rotor, but which were in other respects identical machines. It will be noticed that both the efficiency and power factor are higher in the case of the machine with the short-circuit rotor. Both machines were constructed to give 5 b.h.p. at about 1,420 revolutions on single-phase, 200-volt, 50-cycle circuit. The starting torque obtained with the short-circuit rotor machine was ·45 full-load torque with 1·25 times full-load current, while the wound rotor machine gave ·75 full-load torque with full-load current. The slip is somewhat greater with the wound rotor, which would, moreover, pull out of step rather sooner than the short-circuit rotor. The difference between the results obtained with the short-circuit and wound rotors on polyphase working is practically the same as that on

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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single-phase, though with the polyphase system the results themselves are much better, as will be shown later.

Speed regulation has been so far, perhaps, the least satisfactory feature of the induction motor. The usual methods adopted are: firstly, the insertion of non-inductive resistance in the rotor circuits; secondly, alteration of the number of poles of the stator, and, in the case of wound rotors, those of the rotor also; and thirdly, varying the voltage on the stator either by the insertion of resistance in the mains, or by transformer. With regard to the first of these methods, the one mostly in use, though possessing the advantage of simplicity, has the disadvantage of being uneconomical, being analogous, in fact, to the insertion of resistance in circuit with the armature of a direct-current shunt-wound motor. A further objection—one which also applies in the direct-current example—is the instability of the speed with varying load. If any considerable reduction in speed is attempted in this manner, it may become so susceptible to variations in the load as to render certain operations difficult or impossible. For many purposes, however, this method answers sufficiently well, and where the work is of an intermittent character the question of economy is not, of course, of much consequence. The second method, that of altering the number of poles, is not only complicated, involving many connections, particularly in the case of the wound rotor machine, and low efficiency and power factor, but is open to the further objections that the number of steps thus practicable is

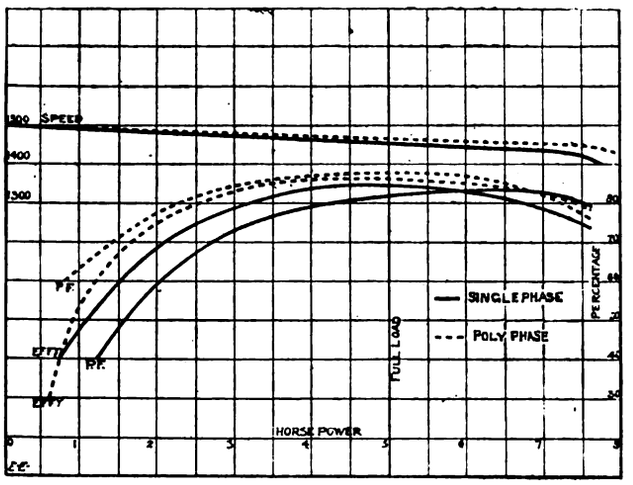

FIG. 2.

very limited, and that the system is too costly for general use. The third method, that of reducing the voltage on the stator windings, is the most wasteful of energy and the least effective. For the purpose of speed regulation, then, the wound rotor motor is the more satisfactory, though for some purposes, such as operating cranes, the short-circuit rotor with conductors of relatively high resistance, combined with graduated transformers for varying the voltage on the stator windings, is sometimes preferred for polyphase motors.

To compare, now, the performance of the motor on single-phase and on polyphase working, it must be remembered that the field produced in the single-phase motor is not a uniformly rotating field as it is in the case of a polyphase motor. When the rotor is at rest, a simple alternating current in the stator winding would produce only an oscillating field which would not cause the rotor to move at all. To start up the motor, therefore, a second winding is placed at 90deg. to the main winding, and by causing the current to lag in one winding and giving a lead to the current in the other winding, a phase difference is produced which creates a rotating field. But whereas the currents in a regular two-phase stator differ in phase by 90deg., those in the single-phase motor cannot be made to differ by anything like so much, and the resulting field is, in consequence, very irregular. As the rotor gains speed the field due to the combined action of the stator and rotor currents becomes more uniformly rotating, but never attains to the uniformity of the field produced by polyphase currents. For the above reason, motors of this type have not nearly so good a starting torque on single-phase as on polyphase circuits. And, for the same reason, the maximum running torque and brake horse-power of the motor is less when working single-phase than polyphase, and the single-phase motor will, moreover, pull out of step and stop with less overload than the polyphase motor will carry. Table I. shows the performance of the motor with regard to starting torque and current on single and two phase circuits of 50 cycles, 200 volts, and with short-circuit and wound rotors respectively. The superiority of the polyphase motor in this respect is clearly shown.

TABLE I.

	Single-phase.		Polyphase.	
	Starting current.	Starting torque.	Starting current.	Starting torque.
Short-circuit rotor	1·25	·45	1·25	·75
Wound rotor	1	·75	1	1

Note.—The figures refer to the normal full-load values.

The curves in Fig. 2 show also that the efficiency and power factor are higher in the case of the polyphase motor and that the slip is greater in the single-phase motor. The lower efficiency of the single-phase motor is accounted for by the greater iron losses due to the irregular flux and to the torque being lower on account of the irregularity of the field. And the power factor is also lower because the greater slip of the rotor retards the rotor field, which consequently becomes more out of phase with and thus opposes the stator field. The leakage coefficient and self-induction of the stator winding are thus increased and the power factor is, therefore, reduced. A great deal of attention has been paid to the methods of starting the single-phase motor, the principal object being generally to obtain as great a phase difference as possible between the currents in the main and starting coils. Condensers, which were formerly extensively used in this connection, have been abandoned on account of the trouble they gave through heating, varying in capacity with varying temperature, and by breaking down. Choking coils were also much more used than at present, the required self-induction now being usually obtained by suitably winding the auxiliary coils. The method of starting adopted by the author is to connect the main and starting coils in series and a non-inductive resistance across the starting coils—that is, in series with the main winding to which it gives a lead—while the self-induction of the starting coil gives the current flowing in it a considerable lag. The auxiliary winding occupies about one quarter of the stator winding space, and is wound in the centre of the main poles, where the main winding could not be usefully employed. It is usually wound with either one-half or twice the number of turns of the main winding. The author prefers the fewer number of turns on account of the otherwise high induced voltage continually on the windings tending to break down the insulation. In some makes of motors this risk of failure of insulation is still further increased by one end of the auxiliary coil being left connected to one end of the main winding, in which case the voltages of the two windings are in series. Thus, in a 200-volt motor the voltage on the windings may be about 550 volts, depending upon the phase difference of the voltage in the windings.

There are several means by which the starting torque of the single-phase motor may be somewhat improved, but which involve lower efficiency on load. And, as in most other problems in engineering, the question as to how far the running efficiency shall be sacrificed to improved starting performance is a matter of compromise. The results actually obtained, depend, of course, upon the details of design, particularly with regard to the flux densities, shape of the stator and rotor teeth, and length of air-gap, as well as upon the materials employed, particularly the quality of the iron in the stator. While the single-phase motor cannot upon equal terms compete with the polyphase motor, it is, nevertheless, in its better forms, an excellent machine.

The question of frequency is a very important matter with regard to induction motors. In the first place, the torque exerted by the motor is inversely proportional to

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the frequency of the supply current, and a given size of motor will, therefore, be capable of giving twice the horse-power on, say, 50 cycles that it can give at the same speed on 100 cycles. In order, therefore, that the motor may give the same maximum horse-power on 100 cycles as on 50 cycles, the speed must be doubled. The loss due to hysteresis is directly proportional to the frequency. If, therefore, the frequency is greatly increased, the induction—and therefore the torque—must be much reduced to prevent heating of the iron and noise. But the magnetisation curve not being straight, the watts spent in magnetising are not diminished in the same ratio as the induction is reduced. Thus the iron loss is greater at the higher frequency, and, other things being equal, the efficiency of the motor is, therefore, lower. And the leakage coefficient being greater at the higher frequency, the power factor is, therefore, lower. This again, by increasing the currents, increases the $C^2 R$ losses, which, therefore, further reduced the efficiency. The hysteresis loss and leakage coefficient increase much more rapidly on the higher range of frequencies than on the lower. For example, the difference is much greater between 50 cycles and 100 cycles than between 25 and 50 cycles.

The curves in Fig. 3 show the difference in the efficiency, power factor, and slip of the same size of motor as before referred to when giving 5 b.h.p. on 50 cycles at about 1,430 r.p.m., and the same horse-power on 100 cycles at 1,880 r.p.m. It will be here observed that the speed on

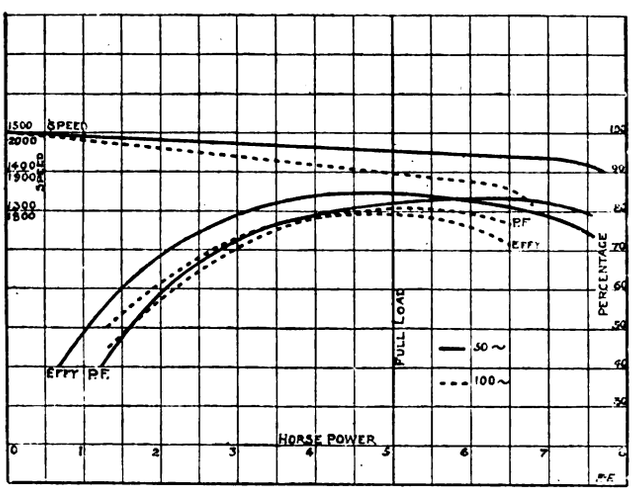

FIG. 3.

100 cycles is not, for the same horse-power, double that on 50 cycles, as would have been expected from the statement above. But it may be explained that this was due merely to the exigencies of manufacture, the same standard stampings having been utilised in each case and the windings varied to obtain the required output with the best results. While this arrangement occasionally necessitates the use of a machine somewhat larger than actually required, economies in manufacture are effected which repay the extra cost of material involved. When it is remembered that there are in the United Kingdom alone over 100 alternating supply systems, of which about 86 are single-phase, working at no less than 17 different frequencies, besides two-phase and three-phase, each with their own variety of frequencies, it will be understood that a manufacturer could not profitably make so great a variety of special patterns as would be required to obtain the greatest possible effect from a given size and weight of machine in every case. High frequency is not only prejudicial to efficiency, power factor, and torque, but is particularly detrimental to good starting performance.

TABLE II.—Starting Torque and Current on 50 Cycles and 100 Cycles of 5-h.p. Motor (Short-Circuit Rotor)—200 Volts.

Cycles.	Starting current.	Starting current.	R.P.M.
50	1·25	·45	1,430
100	2	·43	1,880

This will be seen from Table II., which gives the starting torque and current of the 5-h.p. motor on 50 cycles and 100 cycles respectively. It may be remarked that on circuits of 100 cycles about twice the full-load current is usually taken for starting short-circuited rotor motors, whereas on 50 cycles the starting current does not usually much exceed the normal full-load current.

High periodicity, then, to the motor user implies (1) higher cost of motors and (2) higher cost of working, and to the electricity supply undertaking it means (*a*) lower day load (because of the less inducements to power users to adopt the supply) and (*b*) greater proportional loss on mains, etc., on account of lower power factor of motors. Most of the systems having frequencies above 50 or 60 cycles were established before induction motors were practically thought of. Some of these are, happily, being gradually changed over to 50 or 60 cycles, and it would be well if a frequency of 50 cycles were adopted whenever possible. Standardisation in such matters greatly promotes economy and excellence in manufacture, promptitude of delivery, and is, from every point of view, a consummation devoutly to be wished.

In concluding these notes, a brief reference to the single-phase repulsion motor may not be out of place. If a copper ring is suspended in an alternating field, it tends to turn so that its plane is parallel to the direction of the flux, in which position it does not enclose any magnetic lines. If placed with its plane at right angles to the flux, it will not move, the tendency to turn in one direction being balanced by an equal tendency to turn in the other. Midway between these two positions—that is, at 45deg. to the flux—the tendency to turn would be at its maximum, provided that the currents induced in the ring were in phase with the primary field. Owing, however, to the self-induction of the ring causing the currents induced in it to lag, the position of the ring that gives maximum torque is moved correspondingly forward. If, therefore, an ordinary direct-current armature is placed in an alternating-current field and the brushes given a slight lead in either direction, and short-circuited, the armature (or rotor) will rotate. The function of the brushes is merely to short-circuit the coils as they successively come under the poles, and only those coils that are thus short-circuited are exerting a torque. The object of connecting the brushes together is—if the armature has a parallel winding—to equalise any irregularity of pressure, just as equalising rings are sometimes employed in multipolar direct-current armatures. If the armature is series-wound, the connecting ring is required to short-circuit the coils. The speed characteristic of such a motor is similar to that of a series-wound direct-current motor—it will race if run without load and the torque exerted varies inversely as the speed—and is, therefore, greatest at starting. If the armature windings are suitably connected to three slip-rings to enable resistance to be inserted at starting, and which can be gradually cut out as the motor gains speed, the starting will be improved and the starting current reduced. The effect of connecting the rotor windings in this way is that currents flow in all the conductors, thereby exerting a torque just as in an induction motor. And as the speed of the rotor increases up to synchronism the currents in the rotor come more into phase with those in the stator, and thus the torque due to this inductive effect increases with the speed. We have thus a compound effect, which results in a gradual decrease of torque from that due to the initial repulsion effect to the maximum running torque of the machine as an induction motor. For operating hoisting machinery, and many other purposes, such a motor is very well adapted.

On a 50-cycle circuit the starting torque may be as great as twice the full-load torque with less than 1·5 times full-load current, while three times full-load torque may be obtained at starting with about twice the full-load running current. And if when the motor has run up to speed the slip-rings are short-circuited, the motor will run practically as an ordinary induction motor. If the brushes are left on the commutator they continue, of course, to short-circuit the coils, which, therefore, continue to exert a torque due to the repulsion effect and tend to race. On the other hand, the induction action of the remaining conductors tends to run the motor at synchronism. The result is that, when

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running light, the speed of the motor is a little above synchronism.

The efficiency and power factor of the repulsion motor are not quite so high as those of the induction motor, the current taken for the same horse-power and on the same voltage and periodicity being about 10 per cent. higher; and the horse-power of the motor is roughly 70 per cent. of that which it would be as a single-phase induction machine. Reversing the direction of rotation may be effected either by shifting the brushes to the other side of the neutral position on the commutator, or by shifting the position of the poles themselves. The latter may be accomplished by employing two sets of windings on the stator inclined to one another at the same angle through which the brushes would otherwise have to be moved. Either winding can, of course, be brought into operation by a simple two-way switch. The stator winding is switched directly on to the mains, and the starting current may be kept within the limits usually required by means of the regulating resistance in the rotor circuits. As is well known, when a circuit carrying a current is suddenly opened, the current tends to jump across the break in the form of a spark. And the tendency to spark as the short-circuited coils leave the brushes will, therefore, be understood. This has been, in fact, a serious difficulty with the repulsion motor. However, if the reactance voltage is kept sufficiently low, and the machine provided with slip-rings—so that the circuits are not really broken—the difficulty of sparking may be quite overcome. The prevention of sparking may, indeed, become more difficult in machines of large size, but with regard to that the author has not sufficient data to give particulars.

ROLLER BEARINGS.

BY T. W. HOW, C.E.

Under the auspices of the Tramways and Light Railways Association an interesting paper was read at the Society of Arts' rooms by Mr. Thomas W. How, C.E., F.R.G.S., on "Roller Bearings," with special reference to their application to tramway and railway rolling-stock. The chair was taken by Mr. A. L. C. Fell, M.I.E.E., chief officer, London County Council tramways.

The author claimed that as a result of very many years' persistent effort, practical experience, and exhaustive tests, it was now possible to give reliable data, based upon trials made under varying conditions and by independent authorities, extending over a series of years, on the advantages of roller bearings. After dealing in detail with the technical requirements of a satisfactory roller bearing for heavy and light loads, in which he showed that efficiency largely depends upon true parallelism, proper spacing of rollers and proportionate diameter, length and hardness of rollers, he gave examples of various contrivances for spacing the rollers, regarding the "Empire" floating cage as the most satisfactory owing to its simplicity and easy adjustment. He advocated the employment of solid rollers of special quality steel rather than of spiral or hollow ones, or rollers threaded on spindles. The want of success of earlier experiments made with roller bearings was due to excessive rigidity and improper load adjustment. These are now obviated by means of swivel seatings, so that the alignment of the load is evenly distributed. The author combatted the statement that roller bearings are not suitable for railroad or other rolling-stock because of earlier failures, and he referred to the brilliant successes in applied mechanics which have been the outcome of earlier experiments attended by many failures.

Having given some interesting and conclusive examples of the successful application of roller bearings to shafting and heavy coal-weighing shoots, the author turned his attention to the application of roller bearings to tramway and railway vehicles, and claimed that the starting effort in these vehicles has been proved to be 3lb. per ton of load, with its consequent reduction in coal consumption, electrical energy, and other motive power. After quoting the results of tests made several years ago at Birmingham and Southport, where the economy in current consumption was shown to be from 30 to 40 per cent., the author cited more recent tests made on the Wolverhampton and Croydon tramways respectively, where in the former case a proved economy in current consumption of 15 per cent. was obtained, and in the latter a similar economy was also shown equal to a saving in current of £37. 14s. per car per annum. Examples of railway tests were also given, the most recent being that on the London, Brighton, and South Coast Railway—a complete train fitted throughout with roller bearings which was put into regular service in November last. Notwithstanding that about two-thirds of the total coal consumption of the whole train was required for the engine alone, the test figures show that an economy of 15 per cent. in coal consumption was obtained on the drawbar pull. Taking only 10 per cent., however, as an average economy, this equals a saving of 100 tons of coal per train per annum, and, adding the savings in oil, etc., an economy of £100 per train per annum is shown over the cost of running with ordinary axle boxes. The results of exhaustive tests on the Indian State railways were given, which showed an economy in coal consumption of from 9 to 12 per cent. Taking 10 per cent. as the mean with coal at 10s. a ton, the economy is equivalent to £67. 10s. per train of six coaches per annum. Other favourable examples were given, and the author contended that extended experience had now amply proved that the efficiency and durability of roller bearings constructed upon proper principles are fully assured, whether they be applied to railway or tramway rolling-stock or to other fixed or movable machinery, and that their adoption is a necessity in all cases where cheap power is required, or where existing power stations or rotary machinery are working up to their full limit and have not room for expansion.

The lecture was illustrated by lantern slides, and a number of sample parts were also shown.

FORTHCOMING EVENTS.

FRIDAY, OCT. 27.

Physical Society.—At 5 p.m., "The Theory of Phasemeters," by Dr. W. E. Sumpner; "Apparatus designed for Measuring the Coronal Radiation during an Eclipse," by Prof. H. L. Callendar, F.R.S.

Institution of Electrical Engineers (Glasgow Section).—Fourth annual dinner at the Grosvenor Hotel, Glasgow.

Junior Institution of Engineers.—At 8 p.m. (at the Westminster Palace Hotel), annual general meeting and first meeting of the Incorporated Institution.

TUESDAY, OCT. 31.

Faraday Society.—At 8 p.m., "Alternate-Current Electrolysis," by Prof. Ernest Wilson; "Alternate-Current Electrolysis as shown by Oscillograph Records," by Mr. W. R. Cooper; "Notes on the Crystalline Structure of Electro-Deposited Copper," by Prof. A. K. Huntington; "Some Observations Respecting the Relation of Stability to Electro-Chemical Efficiency in Hypochlorine Production," by W. Pollard Digby, A.M.I.E.E.

THURSDAY, NOV. 2.

Rontgen Society.—At 8.15 p.m., "Ruhmkorff Coil," by Prof. Wertheim Salomonson (of Amsterdam).

Civil and Mechanical Engineers' Society.—At Caxton Hall, "Sea Defences," by Baron H. T. H. Siccama, M.I.C.E.

FRIDAY, NOV. 3.

Junior Institution of Engineers.—At 8 p.m. (at the Westminster Palace Hotel), presidential address by Mr. Dugald Clerk, M.I.C.E., on "The Problem of the Gas-Turbine."

SATURDAY, NOV. 4.

Birmingham Electric Club.—At 7.30 p.m., "Electric Furnaces," by Mr. J. H. Stansbie.

Institution of Civil Engineers.—Nov. 7, at 8 p.m., inaugural address by Sir Alexander Binnie and presentation of awards.

Institution of Electrical Engineers.—Nov. 9, at 8 p.m., the president (Mr. J. Gavey, C.B.) will deliver his inaugural address.

Lytham.—A company is about to be formed to take over the electric lighting provisional order, and the contractors will be Messrs. Foote and Milne, Limited, of Westminster. The installation will be on the three-wire system, and the consulting engineer (Mr. G. E. Fletcher) estimates the cost at £13,500.

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TO CORRESPONDENTS.

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GOVERNMENT CONTRACTS.

Every year a return is made of money spent by the Government in contracts abroad, and every year we have to read and hear diatribes against such transactions. So far as the electrical industry—or, indeed, any other industry for the matter of that—is concerned, the one expenditure that is a blot upon the sheet is an item of £220,054 for telephonic apparatus. The Government expenditure for telephonic apparatus is but a small part of the yearly expenditure for telephonic apparatus in this country, and we fear that could a strict examination of the facts be made it would be found that the bulk of our telephonic apparatus comes from abroad. We are well aware that half a dozen reasons have been advanced for this state of things, but, while the reasons are interesting, they are of little real value unless a practical remedy is found. One manufacturer lays great stress upon our fiscal system as a cause, and urges a change as a remedy. Probably there is much truth in his arguments, yet certainly they do not completely solve the problem. Now, there is no absurdity in approving as well as condemning the same individual, for just as few people are always in the right, so it is most improbable they should always be in the wrong. Hence we may safely commend the Government or other authorities for purchasing the best, while condemning them for putting obstacles in the way of cheap and efficient production. The one important point to consider is the statement that the foreign-made apparatus is better than is obtainable in this country. The point is highly debatable, and has not yet been proved, at any rate, to our satisfaction. Even if the suggestion be true, the cause might well be attributed to our fiscal and economic policy, which increases cost of production; and as the sale prices must approximate towards the same amount, it is easy to understand why costs have to be kept down at all risks in order that some business may be obtained. If the Government pays £220,054 a year for telephonic apparatus from abroad that is better than similar apparatus at the same price produced at home, it is to be commended; but at the same time if the cause of the worse material here is to be traced to the negligence and inactivity of the Government, then the condemnation of the Government must be far and away greater than the commendation. The history of telephony in this country is one of the most interesting even from the manufacturing point of view. We ought to have been in the forefront of manufacturing, but we are not. The same statement can be truthfully made of other branches of manufacturing, and it will prove a hard nut to crack for politicians to tell us why capital from abroad has had to be brought into this country to exploit and develop various branches of electrical manufacturing. So far as this state of affairs is due to politics it means that there is a total decay of political virtue, that we are broken up into small parties, cliques—every clique thinking of private interest and forgetting the public. Broad-mindedness is almost entirely wanting, and the nation is suffering from wilful and not from simple, helpless ignorance. It was cliquism and wilful ignorance that brought about the condition of affairs telephonic, and has necessitated the spending of money abroad. At the present time everybody interested in these matters wants to know what the next move will be. There is no certainty of anything, except the uncertain. Out of the huge expenditures of the Government comparatively little is spent abroad, this telephonic item being by far the largest that interests us; and we call attention to it, not so much for itself, as for its indicating the larger purchase in other directions. The march of progress means that capital must be sunk in the production of apparatus to meet the

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wants of modern requirements. In many instances capital is not forthcoming; hence development cannot take place at home. It is forthcoming for production abroad, and the early birds abroad have the pick of the world's markets. They are always a little ahead, because they were first. This country has been ahead in its business because it had the run of the world's market before any competition was possible, but now it leaves others to take the initiative—to produce and obtain a market—and expects to find it as easy to oust as to retain. A wrong policy, a ruination policy, but one that seems to be gaining ground. The world moves on, and what was possible half a century ago is impossible now. Telephony is not the only direction in which the markets of the world are occupied, and if this country does not soon waken to the altered conditions of affairs, its business will be like the old grocer's who kept on in the way of his grandfather and saw his rivals successful.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ERRATUM.

SIR,—Allow me to point out a printer's error in my answer to Question 817 in your impression of 20th inst. In Table A the last two columns are turned upside down.—Yours, etc., S. S. L.

RAIL CORRUGATION.

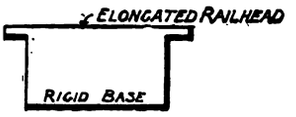
BY ROBT. B. HOLT, PERMANENT-WAY ENGINEER, CITY TRAMWAYS, LEEDS.

There has been so much discussion from time to time as to the effects of expansion and contraction on tramway rails, and so many theories propounded, that in these days of close joints and welded rails one is apt to wonder at the resurrection of a subject which appears to have been settled satisfactorily, by both theory and practice, for some considerable time. I claim the readers' indulgence and beg to present the old subject in a new light—viz., with regard to the corrugation of rail surfaces which is becoming so prevalent, and such a source of anxiety to tramway managers and engineers.

Before entering upon the relation between expansion, contraction, and rail corrugation, it may be interesting to consider a few items forming the subject matter of a very clever paper by C. V. Boys, Esq., F.R.S., which appeared in the *Tramway and Railway World* in 1902 at a time when the question of welding tramway rails was being given much consideration. The author of this paper states: "That a change of temperature of 10deg. C. represents an elongation of nearly 7in. in one mile of welded rail, also that a steel rail can be compressed or extended a two-thousandth part of its length by a force of 14·223lb. to the square inch; the same rail when warmed 1deg. C. will become longer by eleven-millionths of its length. Combining these figures, it will be found that if a steel bar is warmed 1deg. C. and at the same time subjected to a longitudinal compression of 313lb. to the square inch of section it will not change in length at all, or if warmed 10deg. C. and compressed with a force of 3,130lb. to the square inch of section it will retain its original length. So far as the rail is concerned, a change of temperature of 10deg. C. in the rail will not do any harm. For rails exposed to the sun by day and the sky by night 10deg. C. is not one quarter of the possible change of temperature, but the rails being buried except at the head, though 10deg. C. may be exceeded, it can never penetrate sufficiently into the lower part of the rail as to set up longitudinal stress approaching destruction." Also that "the adhesion between the rail and the road will be sufficient to withstand the longitudinal force."

Practice has proved Mr. Boys's theory beyond all possible doubt with regard to the body of the rail; there has been no perceptible elongation of rails and subsequent damage to both tracks and roadway. The results on the whole with close joints have been more satisfactory; and with regard to welded rails, they are the acme of perfection—that is, if welded when rails are laid—there is no drop of the car at the joint, no "hammered-out" ends, deteriorating day by day; and in place of these evils we have easy running with oscillation reduced to a minimum.

But to return to corrugation; this new disease which is shortening the life of our rails, what is the cause of it? The writer does not presume to say, but rather to point to that which appears significant from a practical standpoint. If a change of temperature of 10deg. C. represents an elongation of 7in. in a mile of exposed rail, what effect has this or a much greater change of temperature on the surface of an ordinary tramway rail? The lower portion being buried, of course. We may take it that it is not possible for an upper layer of the rail head to elongate, and the lower part to retain its normal length, when the joints are close, as shown in the sketch. What will result from the effects of the expansion of the upper part of the rail head under a change of temperature of from, say, 10deg. to 30deg. C. or more?



It appears to one, then, taking a practical view of the case, that as this assumed upper layer, which is exposed to all the changes of temperature, can neither elongate nor shorten longitudinally, it must naturally take a course where there is less resistance. It is, therefore, the opinion of the writer that the stresses called into play by a rise of temperature exert themselves along the surface of the rail in a longitudinal direction, and the top layer, being unable to elongate in a straight line, it buckles or corrugates in the way now, unfortunately, so well known to all connected with electric tramways. Precisely the same result can be obtained, taking a humble example, by applying end pressure to some thick elastic material such as soft pitch. Of course, the corrugations, if arising from this action, may be almost imperceptible to begin with, but they will rapidly become more evident by the action of the rolling-stock.

Corrugation is a growth of recent years, and in the days when $\frac{3}{16}$in. was allowed to counteract the effects of expansion, corrugation was unknown. Was this because the upper layer of each rail had room to expand? Take the case of a track the writer has heard of. It has been down seven years, and corrugation is only now appearing. Provision was made for a small amount of expansion at the joints; but in course of time, the rails probably being somewhat soft, this gap has disappeared owing to the metal rolling over it. Does it not seem to point to the effect of the temperature on the rail head? The same can be said of tracks that have been welded after being laid and used for a similar period. When they were welded, thin rail sections were inserted between the rail ends to close the gap, and within a year or two the corrugation appears.

Again, what a number of old tracks, tracks that were neither anchored nor concreted over the rail base, are deformed and rendered a positive switchback owing to the rails "hogbacking." There is something significant in the very appearance of a track in this condition. We shall probably find that the rails were of a much lighter section than those now used, and were not laid in such a rigid manner, therefore it appears possible that the variations of the temperature have some little to do with the action likewise.

This article has been written with a view to opening a discussion on the momentous subject of corrugation, in the hope that it will be freely criticised and the real cause discovered; at the same time the writer considers that it is far better to combat with corrugation than to revert to the old form of joint.

Madrid.—The Public Works Department require designs for a scheme of electric tramways in the town. Particulars from Direccion General de Obras Publicas, Madrid. Designs and estimates by Nov. 27.

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TURBINES v. RECIPROCATING ENGINES.

BY DECAPOD.

As turbines are now becoming close running rivals with reciprocating engines for different classes of work, chiefly electric generator driving and ship propulsion, a valuable criticism on the operation of the two methods of obtaining the most efficient and reliable prime mover may be raised. In the case of the reciprocating engine, its operation is so well known that little can be said to enable it to be understood better than it is at present; it has almost reached the peak of its efficiency and reliability of operation for long runs under the worst conditions, such as driving a generator for heavy railway traction or shipwork in a heavy sea. Limits of steam pressure and temperature are low—450deg. F. for steam temperature is as high as can be considered safe for keeping good smooth rubbing surfaces, such as valves, pistons, and rods; higher temperatures necessitating expensive lubricating oils and a certain amount of uneasiness on the part of the man in charge if the engine is running with fine clearances. Then if surface condensers are used, there is always the trouble of extracting the oil from the hot-well before water can be used again for boiler feed. With triple-expansion engines it has been proved that a 26in. vacuum gives the best results, and, further, there is a limit to the expansion carried out in the low-pressure cylinder due to the condensation and re-evaporation of steam on the cylinder walls, etc. The advantages of reciprocating engines over turbines for shipwork is in the manœuvring, the small size of propellers necessary for the high speed of turbines making it more difficult, especially from rest in narrow waters.

Trials have been made which show that turbine steamers going full speed ahead can be brought to rest in about a minute and a half. This is a good result, but actual experience has shown the relative inadequacy of going astern from rest. The case of the turbine is a most favourable one especially for central stations, it being an ideal drive for alternating-current generators in parallel on account of its equal turning movement. The turbine being a purely rotary motion with no rubbing surfaces, high pressure and temperature steam can be used with its full advantages, the only thing being slightly increased peripheral blade clearances for extra high superheat. The steam consumption of a turbine can be improved by 10 per cent. for 100deg. F. of superheat with steam at 160lb. square inch. Then, again, it pays to have the best vacuum possible, and the steam can be expanded to its utmost limit. The gain from an increased vacuum is so great that it is advisable to pay great attention to the design and upkeep of the condensing plant. For shipwork it is sometimes usual to fit a vacuum augmenter, by which means it is possible to maintain a vacuum of 28½in. in the condenser. Another good feature of the turbine is that it requires no lubricant mixed with the steam, therefore obviating the necessity of any oil extraction from hot-well water. In large turbines for central stations it is usual to have the bearings lubricated by the oil gravity system—that is, with a tank some 40ft. above the engine-room floor level, into which the oil is pumped from another tank below the engine-room floor level, the oil running from top tank through the bearing and into the lower tank to be filtered and cooled, then pumped up to the top tank to be used over again. Oil treated in this way will last for months, care being taken to keep water out of the oil, as it sometimes leaks through from the water-jacket on large bearings, on account of leaky castings. As in all engines, the governor is a very important consideration; a fly-ball type of governor is made use of. The speed of the turbine can be varied within all the limits of the governor spring whilst the turbine is running. This is particularly useful for bringing alternators into synchronism and adjusting their differences of load when in multiple. There being no variation of angular velocity in the turbine, which is necessarily present in reciprocating engines, heavy synchronising currents between two alternators in parallel are avoided. All power being transmitted rotatively, foundations are cheaper than for the same output in reciprocating engines. Many people imagine that the blades wear under the action of steam, but experience shows that with superheated steam this is not so. In the case of where steam is admitted through nozzles, slight wear is noticeable in the nozzles owing to the tremendous velocity of the steam. If there is any water in the steam, this wear is increased tenfold. The bearings of a turbine require to be run with very fine clearances, ·008in. being usual with forced lubrication. Very fine centring of the spindle in cylinder is necessary, as the peripheral blade clearances in sizes up to 500 h.p. are usually only ·02in. with 100deg. F. superheat; with sizes of 7,000 h p, with the same superheat, ·08in. clearances are necessary. The spindle should always be in perfect running balance on account of the fine peripheral blade clearances. The usual method of balancing heavy spindles is to lay them on knife-edges, gravity causing the heavy parts to come to the bottom. This method usually suffices, but no degree of real accuracy can be attained, as one cannot tell for certain which end requires the additional weight to bring it into balance. With smaller sizes it can be run up to speed and marked with a coloured pencil at different points which shows where to add additional weight. A small body revolving at 5,000 r.p.m., the light side is always the one that comes out, so that weight should be added where the marks are. In some cases the marks are different at each end, when weight needs to be added at each end to suit. For slower speeds than 5,000 r.p.m. the marks usually come at certain angles, leading the light side; this can easily be found by trials. As there are so few moving parts in a turbine compared to the numerous moving parts in a reciprocating engine, the repairs and replacements are small in comparison. Greater economy in oil and attention is on the side of the turbine, as they run cleaner, and all that has to be done is to turn on the steam and keep an eye on the oil to bearings. The chances of breakdowns on both the reciprocator and the turbine are probably equal, and the most serious breakdown for a turbine is the wearing down of the balance pistons through allowing them to come in contact with the cylinder casing. As the rings of these pistons are solid with the main spindle, it means turning off the whole of the piston and shrinking on a new end. This is a long job, and means throwing the turbine out of service for at least four weeks. Another serious breakdown is likely to happen from loss of oil to bearings. Such accidents have happened, causing bearings to seize and put such a strain on the spindle as to bend it. Once bent, it is difficult to get it back to its original position and seldom to make it run as true as before accident. A strip in the blades is for shore work usually only a stoppage of about five days in small sizes, and repairs can be effected on sight with ease, the reblading not being as difficult as it would appear to be. With good tools and men used to the work, it is surprising how soon a few thousand blades can be fixed in position. There is usually no sign indicated previous to a strip, and the first thing noticeable is a sudden grinding, then a full stop, the blades shearing off close to the main body of the spindle and becoming wedged between the spindle and the cylinder casing, no damage being done to any other part beyond the actual blades. The usual cause of strips may be put down to too fine clearances with excessive superheat, spindle being out of balance, and shaft whipping causing blades to rub, a heavy dose of water from boilers while on load, or a weak blade breaking off and fouling. A strip does not mean the whole of the blades, and may be anything from two rows to twenty. These three breakdowns are the only ones that can happen of any serious moment, and with the ordinary amount of care and intelligence it can be proved that the turbine is becoming as reliable as the best reciprocating engine.

BOURNEMOUTH TRAMWAYS.

The accompanying map of the Bournemouth tramways shows the extensions referred to in our last issue. The extension on the west to Poole, it will be seen, lies within that borough and the Branksome urban district, while that on the east to Christchurch lies partly within the borough of Bournemouth and partly in Christchurch. The former

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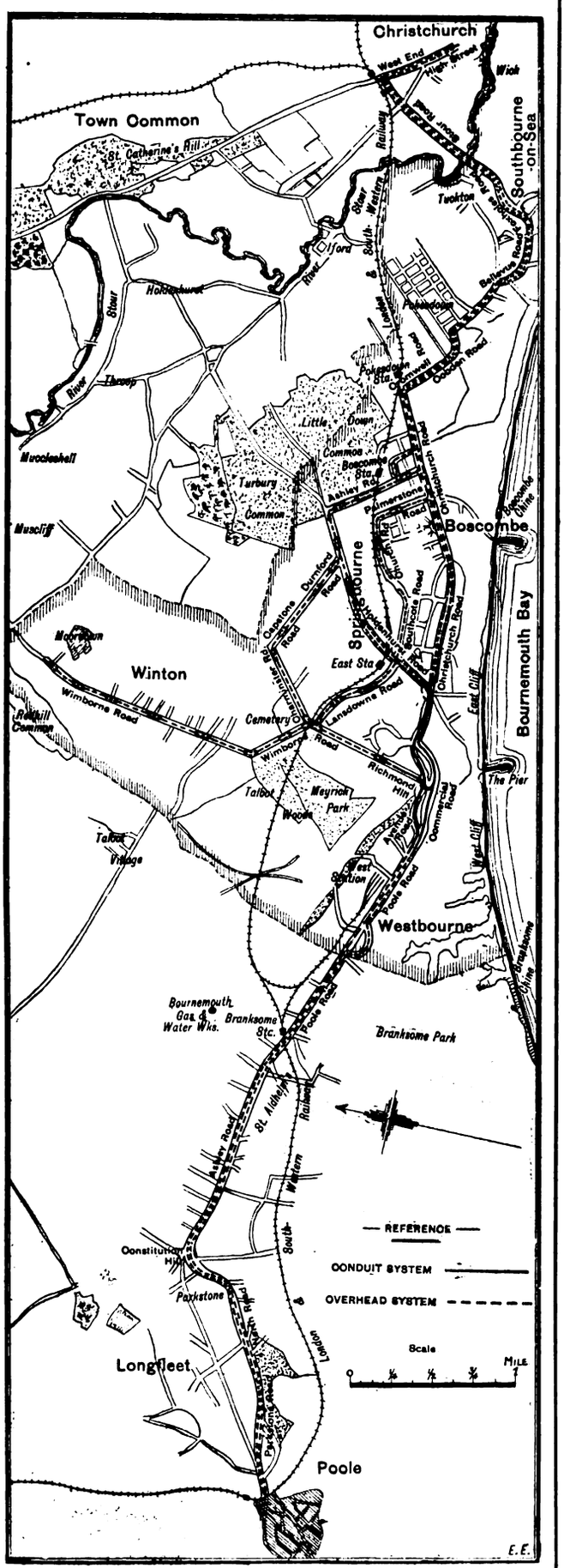
consists for the most part of a line recently purchased from a local company, while the latter is of entirely new construction, as stated in our previous reference. With



Map of Bournemouth Tramways System.

regard to the extension to Poole, it may be added that Branksome is shortly to be incorporated with that borough. The distance between the termini at Poole and Christchurch respectively is about 10 miles, and the conduit sections of tramway occur almost in the centre of the system as shown. Work on the Christchurch extension was commenced on June 1 last by Messrs. J. G. White and Co, Limited, who secured the contract for the permanent way at £38 960. The construction of a new bridge over the river at Tuckton was involved, and the contract for this, including abutments, was let to the Yorkshire Hennebique Company at £4,500. The amount of the British Electric Equipment Company's contract for the overhead line work was £4.315 and that of Messrs. Johnson and Phillips, Limited, for the feeder cables, etc., £5,405. We find we were in error last week in crediting Messrs. Callender's Cable and Construction Company, Limited, with the whole of the cable work for the Bournemouth tramways. They supplied and laid the cables for the original scheme, but not for the Christchurch extension. It may be repeated here that the route length of this extension is 3½ miles, and the total length of single track laid about 5½ miles. Thus the new track is not double throughout as it is represented to be on the map.

In two respects the system of tramways completed by these extensions is especially noteworthy. Firstly, it illustrates the possibilities of the conduit and overhead trolley systems in combination; and, secondly, gives a foretaste of that commonsense era when local authorities shall co-operate to provide improved facilities for intercommunication between towns and districts within natural areas of relatively dense population.

CONSTRUCTION OF CANADIAN NIAGARA POWER COMPANY'S 100,000-H.P. HYDRO-ELECTRIC PLANT AT NIAGARA FALLS, ONT.*

BY CECIL B SMITH, MA.E, M CAN SOC C E.

When the writer became resident engineer for this company in August, 1901, he found that the location of the works and discharging tunnel had been already decided upon, and a shaft for tunnel construction partly sunken, and under directions from Consulting Hydraulic Engineer Herschel the turbine units were being given preliminary study by Escher, Wyss, and Co., who also finally designed them. Aside from the tunnel, which evidently should be built at once of full capacity, the construction then authorised was for a canal of 50,000 h.p., with temporary cribbing on the south side, a wheel pit for 50,000 h.p., and machinery and power house for 30,000 h p., but the company in 1902 decided to build the canal for 100,000 h.p., the wheel-pit for 110,000 h.p. (one 10,000-h.p. unit as a spare), to erect a power-house for 50,000 h.p., and equip it with machinery to the same extent; and this plant, along with conduits for carrying underground cables to Niagara Falls, N.Y., and to a transformer station for 25,000 h.p. outside Queen Victoria Niagara Falls Park, is now practically completed, and is in partial operation.

Some hazardous and approximate soundings had been taken in the Niagara River at the canal entrance, but they gave assurance that the depth of water adjacent to the shore was sufficient without extending operations very far out into the rapids, and a cofferdam was built. The cribs, if placed separately, would have been in rather unstable equilibrium, and the contractor accordingly sunk them in pairs, with turnbuckles in place, using temporary binding timbers to hold each two cribs in correct relative position until sunken into place, after which these timbers were removed by divers. The soundings for each crib were taken from a platform extending out over the water from the cribs previously placed, and the bottoms of the cribs were framed upside down, so as to fit the inequalities of bottom, denoted by the soundings. A floor for sustaining the rock filling was also placed in each crib as nearly as possible to the bottom, and the cribs were partly loaded before being floated into place. In order to hold on to the cribs when placing them in a current of 10ft. to 12ft. per second, several lines of wire rope operated by hoisting engines were used, and only one mishap occurred, when the bottom of the large corner crib was torn off. It was

* Abstract of paper read before the Canadian Society of Civil Engineers.

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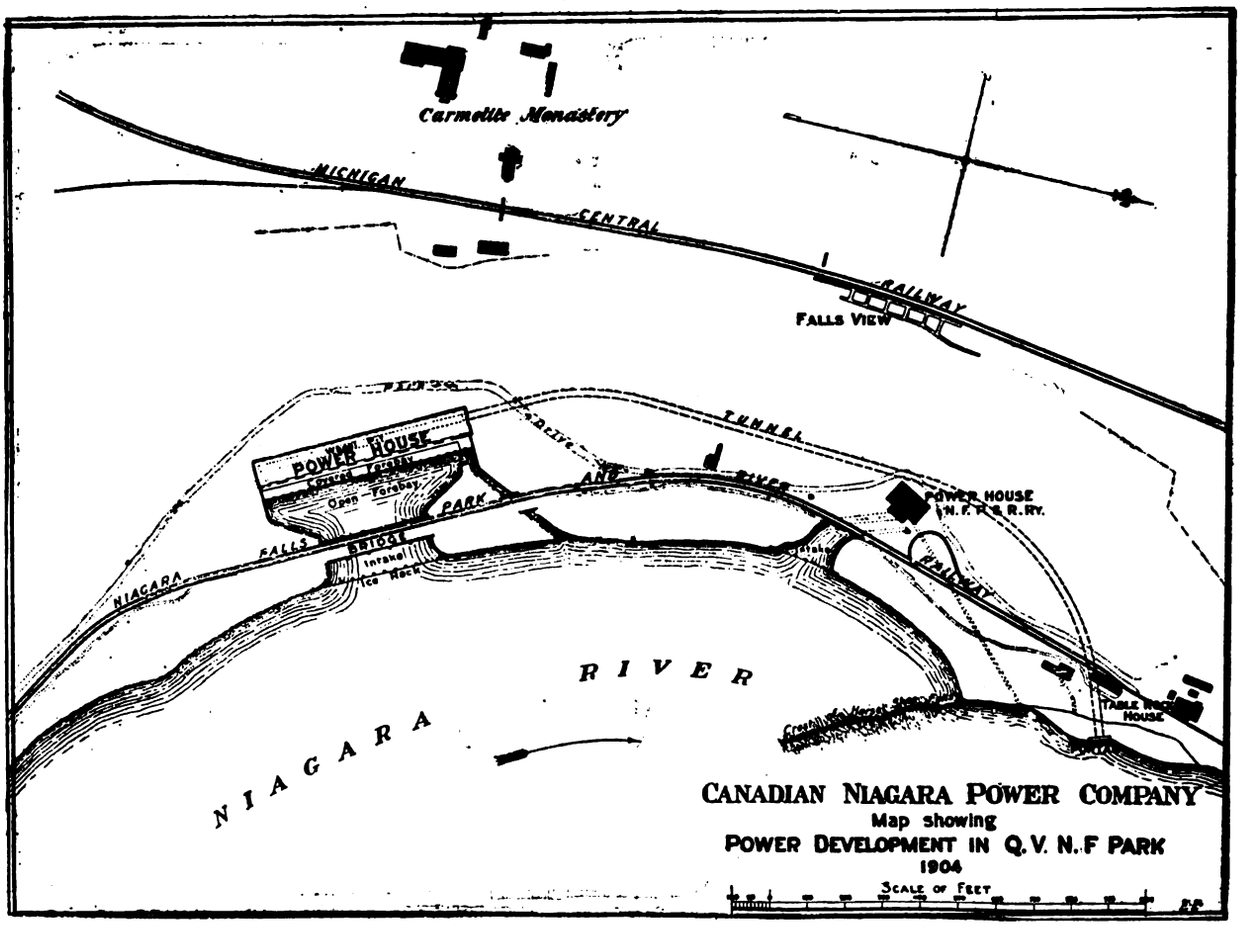
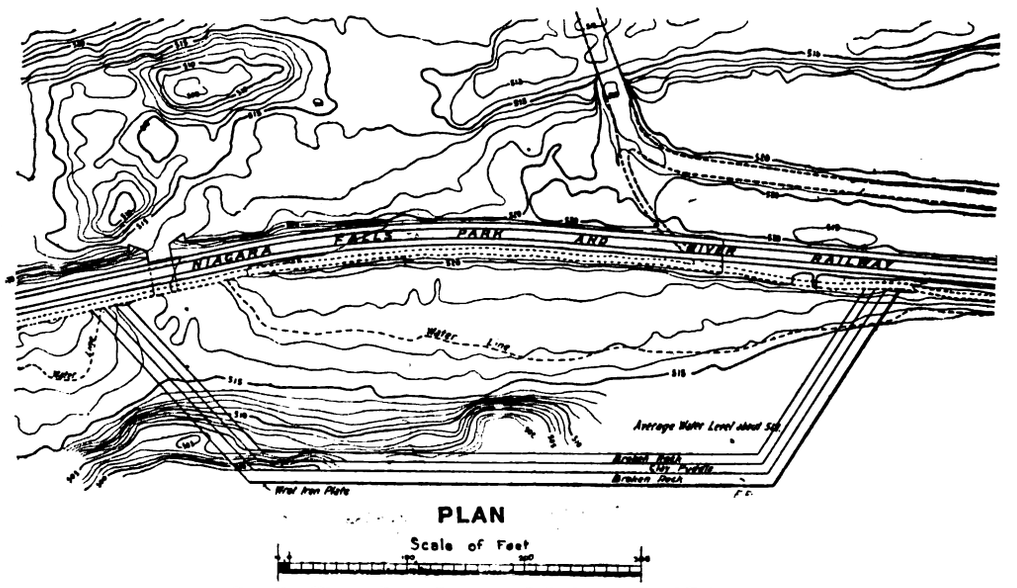
found advisable to add vertical binding timbers, not shown on plan, when cribs were to be placed in the heavy current. These are being found of advantage also during the removal of the cofferdam.

The puddle used was composed of about two-thirds gravel and one-third clay artificially mixed, as a natural mixture could not be obtained within a reasonable distance, and this mixture was found to fall quickly into place whenever leaks opened up, and could be rammed into a perfectly water-tight mass. It was found best, however, to keep the puddle wall well below water-level on one side, so as to enable leaks to be promptly reached and the puddle to settle quickly. The continuous decking was built in place as soon as cribs were filled with rock, and being tied across by timbers above water and turnbuckles below, the cofferdam acted as one mass. In placing tongued and grooved sheeting it was broomed down by hand mauls on to natural bottom, and fitted snugly around timber ties and turnbuckles, after which all openings at bottom, located by divers, were made tight by piling bags of rich cement mortar and ramming them into the apertures. When the cofferdam was pumped out by a battery of 12in., 10in., and 8in. centrifugal pumps lifting about 10,000 gallons per minute, it was found that there was, even after temporary leakage through puddle had been cut down to nominal proportions, a heavy flow of water through the boulders and gravel lying between the cofferdam and solid rock, and as this would have to be handled for over two years it was considered advisable to take steps to stop it, and a puddle trench was sunk to rock at each end of area unwatered, being carried in each case from shore to adjacent points on inside of cofferdam. The cofferdam proper was sheeted on inside between these two puddle cut-off walls, with double tongued and grooved sheeting extending from above water-level down to solid rock, layers of tar paper being placed between the two layers of sheeting, and in order to





Canadian Niagara Power Company—Cofferdam for Canal Entrance.

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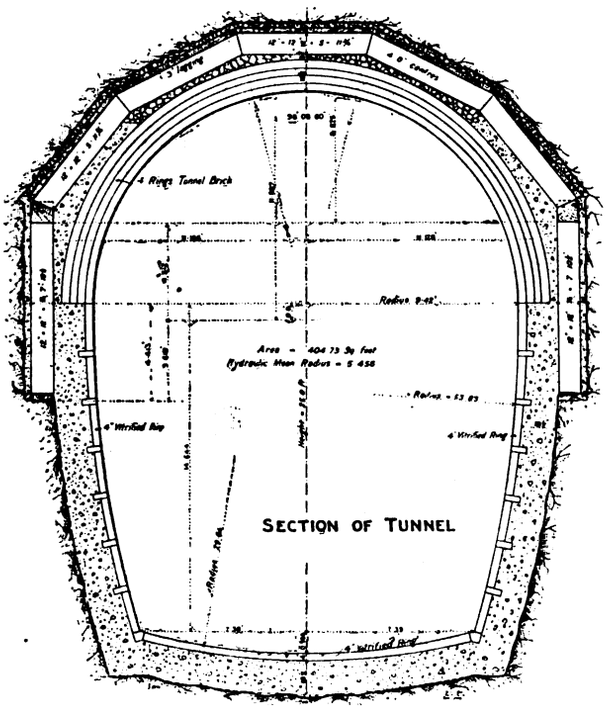
seal the bottom a toe of rich concrete was carried along the bottom, being tied to the rock by thoroughly washing the surface of same, and spiking a heavy line of timber, about 12in. above the bottom, to the sheeting. This interior sheeting held the pressure of water against it until torn off when letting water into the canal, and the whole leakage was cut down to about half of the capacity of one 8in. pump during this period of over two years.

The original intention of the company was to build a steel bridge across the entrance canal, but it was subsequently decided to build a stone and concrete bridge 55ft. wide, composed of five spans of 50ft. each. Canal walls of rock-faced coursed ashlar, backed by 1 : 3 : 5 concrete, were carried out into the river by 50ft. curves. The wheel-pit, which is 570ft. long and 18ft. wide after lining, was excavated through 15ft. of boulders and gravel, 100ft. of limestone, and 50ft. of shale, the sides being separated before blasting by channelling.

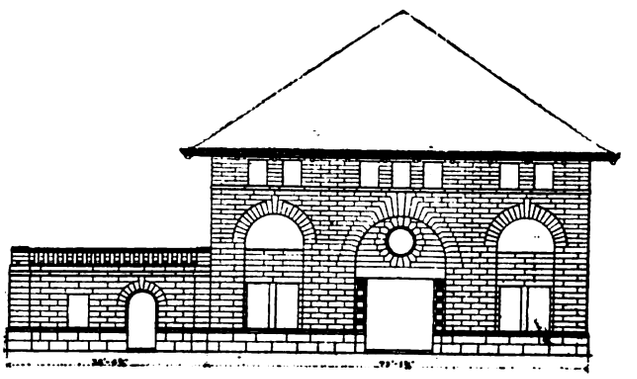
The original design for the tailrace tunnel was of a section 21ft. high, with brick lining 16½in. thick, but this was finally modified to the present section, which is 25ft. high, and has a composite lining, the bottom and sides being of concrete, faced with 4in. of highly-burnt brick,



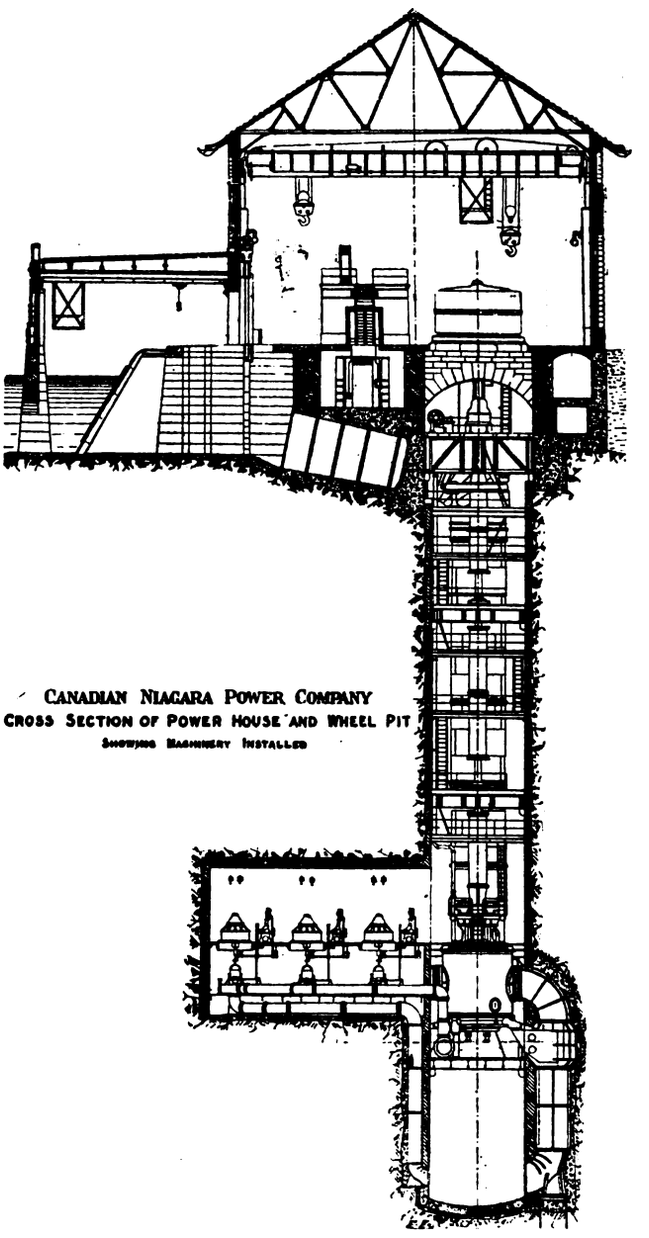
Canadian Niagara Power Company—Section of Tunnel.

while in the arch a brick ring with dry packing was adhered to on account of the difficulty which would have attended the building of a concrete arch. When the discharge tunnel was built for the Niagara Falls Power Company there was no exact information as to the value of the friction coefficient for a brick-lined channel of such large dimensions carrying water at a high speed, and even when the present tunnel was commenced the United States tunnel had not yet been tested to its full capacity, nor properly calibrated, but an examination in the winter of 1902 showed the brick lining, although of a very ordinary quality, to be absolutely intact, unworn, and slimed over after seven years' use, with water flowing at about 27ft. per second. Still, to make assurance doubly sure, the brick facing of the present tunnel was made of a superior burnt smooth brick, and the section made about 20 per cent. larger than the earlier one, so that the velocity will be slightly increased as the grade of 7ft. per 1,000 is continuous, and the alignment of the tunnel very favourable, consisting of two curves of long radius with direct outlet in line with wheel-pit. This tunnel is 2,200ft. long, including the headworks at portal, which consists of a square headwall 60ft. wide, 12ft. thick, and 55ft. high, extending to a depth of 35ft. below water-level, resting on a foundation well into the Medina sandstone; from this headwall the tunnel rises in an ogee curve for some 80ft. to the tunnel proper, and this portion is lined with 2ft. of granite, which it was considered advisable to use in place of brick, owing to the excessive speed of the water when dropping to the river-level, it being understood that the invert of the tunnel at the top of the ogee curve is at the low-water river-level.

The excavation was carried both ways from a shaft sunk midway between the portal and wheel-pit, and was



FRONT ELEVATION OF POWER HOUSE



CANADIAN NIAGARA POWER COMPANY
CROSS SECTION OF POWER HOUSE AND WHEEL PIT
SHOWING MACHINERY INSTALLED

also carried in several hundred feet from the portal, and although the alignment was fixed from two piano wires 12ft. apart, suspended in the shaft, the instrument work at point of meeting of headings was found to be almost perfect, which must be looked on as a result of extreme care in the use of plumbobs, and taking the average of a large number of observations in this and surface instrument

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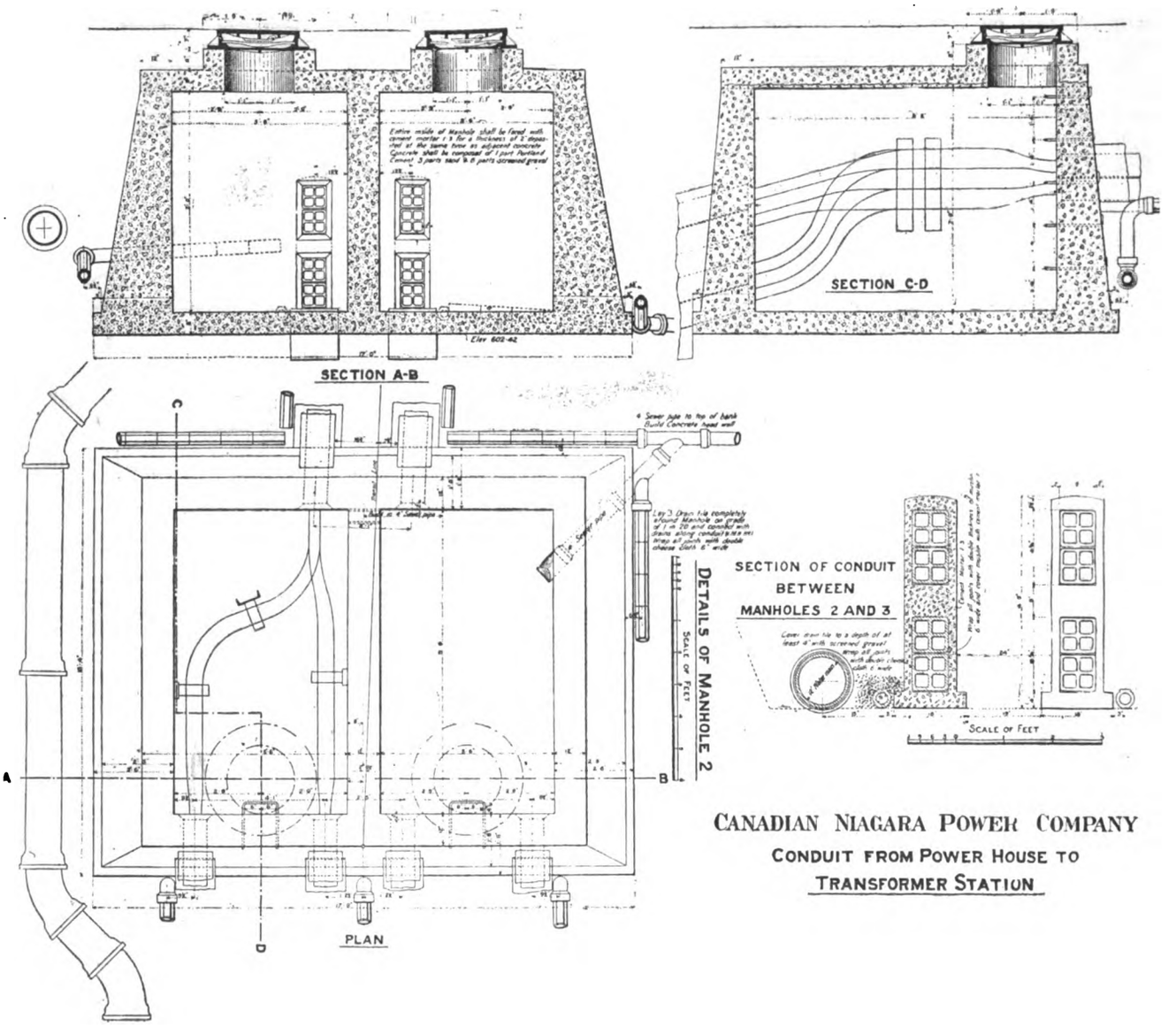
work. Owing to the upper portion of the tunnel being in shale, it was necessary to carry a full timber roof consisting of five centred 12in. by 12in. rings 4ft. apart and 3in. lagging, and these were put in place, along with the wall plates, as fast as the headings were driven, while the plumb posts, carried down to limestone, were inserted at the time the two benches were being taken up. The original idea was to use yellow pine timber, but this was modified by substituting hemlock for centres and plumb posts, where the stresses would be compressive, and, although they were much abused by blasting, the result was satisfactory, owing to the absence of much water to soften and swell up the shale roof; the portion of roof adjacent to the wheel-pit was subject to leakage when the pit excavation was being done just above the tunnel level, and at this point the roof timbers were badly crushed, and the centres settled several inches, the fibres of the hemlock segments being forced into one another.

The process of lining the tunnel was as follows: The concrete invert (1 : 3 : 5) being laid, the vitrified brick invert was placed as far as the corner specials; side forms were then put up, and lagging, wedged back 4½in., was placed as high as the first course of brick headers. After the concrete side walls were built up to this height, the lagging was removed, and the brick facing carried up to and including a header course, after which the process was repeated to the springing, the only variation being that dry packing was used between and behind the plumb posts, in place of concrete shown on plans. The brick arch was built in the ordinary way on full centres, and 4in. by 4in. lagging, a night man building in the key of the arch work done during the day, and labourers placing dry packing above the haunches and driving it home against the roof timbers, also removing centres after being in position two or three days, and bringing them forward to a new position. After side forms and arch centres were removed, the whole tunnel was scraped clear of all mortar with sharp iron tools, leaving the surface smooth and clean. It is believed that a very low friction coefficient will exist in this tunnel, especially when the walls become slimed over with deposits from water, such as have formed on the walls of the Niagara Falls Power Company's tunnel. The shaft for this tunnel was sunk from May to September, 1901. Excavation was completed December, 1902, and lining and headwall in May, 1904, after which the shaft was bricked up, and outlet excavation at portal completed during the summer of 1904. No attempt was made to hasten the completion of this portion of the plant before the machinery installation demanded it, otherwise much greater speed could have been made.



Power-House.—The superstructure covering the generators and switchboard, etc, is a heavy steel-framed building, at present covering five 10,000-h.p. units, but the design is for a complete building 600ft. long, covering 11 10,000-h.p. units, with main entrance at the north end. The main building is 40ft. high to the eaves, and has crane girders 31ft. above the floor, this height being necessary for proper movement of large loads from one part of the power-house to another, after the machinery was installed. The proper light effect is obtained by large arch windows below the crane girders, and a series of smaller square ones just below the eaves. The exterior walls are of Queenstone gray limestone, with sufficient tooling for rich quiet appearance, and the interior lining consists of a wainscoting of enamelled brick up to the window sills, then a belt course of green-veined Vermont marble in line with marble window sills. Above this the lining will be buff

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brick, which will give ample light in the daytime, while at night there is an arc light on each side of the power-house every 24ft. The roof of the main power-house is of steel and terra-cotta tile only, the tiles being interlocking green Ludowici, pointed with mortar, and the eaves are carried well out with a slight upward curve, ending in heavy copper gutters.

The forebay room is attached to the east side of the power-house, and has a flat steel and concrete promenade roof, with an asphalt and tile floor. It is surmounted by a stone parapet wall with 24 foot panels, it being proposed to place electric light columns and flower vases at the panel posts; while, for the purpose of throwing light into the room itself, in addition to arch windows every 24ft, there is a wide continuous skylight in the roof adjacent to the power-house. In the forebay room a five-ton travelling crane spans the whole width, and will assist in keeping racks clean, and lifting them when necessary. All the main window frames are metal, which leaves only the window sash and small upper window frames of wood, so that, practically speaking, the building is strictly fireproof. At the north end the main entrance door will be of bronze with carved side columns, and surmounted by a panel containing the company's seal; while stretching across the north end of the power-house will be a visitors' gallery, from which the best view of the interior of the building can be obtained.

Underground Conduits.—In order to convey current from the power house two lines of conduits were constructed, of the style shown in the illustration, one of which, 2,200ft. long, leads to a transformer station located outside the public park, and the other, 1¼ miles long, extends from the power-house through the park to the upper steel arch bridge. The four-way ducts are embedded in a 1 to 7 gravel concrete, and are spaced generously so as to provide proper heat radiation, it being found that in a large group of cables the centre ones do not have the carrying capacity of the outer ones. The manholes are also entirely of gravel concrete, and are drained thoroughly with 6in. tile, into which are carried the farm tile, laid alongside the ducts themselves; and a curtain wall divides the manholes into two parts, while a further separation in case of fire is obtained by soapstone slab partitions lying horizontally between each group of cables. The ordinary type of manhole carries the cable straight through without any appreciable bends, and a 12in. water-main is used for carrying water from the pumps, located in the power-house, to the water-cooled transformers and stand-pipe situated outside the park on the company's land.

(To be continued.)

ISLINGTON ELECTRICITY ACCOUNTS.

The accounts of the Islington electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £406,436. Abstracts of the revenue account and balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	19,686	15	6
Distribution of electricity	2,070	19	6
Attending and repairs to public lamps	2,611	5	5
Rents, rates, and taxes	1,645	4	3
Management expenses, salaries, etc.	4,892	9	2
	30,906	13	10
Balance carried to net revenue account	22,965	13	5
	£53,872	7	3

Cr. Income.	£	s.	d.
By sale of current for private lighting	35,289	18	9
Public lamps	15,734	5	5
Rental of time switches on consumers' premises	55	4	11
Maintenance of public lamps (see *contra*)	2,611	5	5
Arrears for day supply energy	125	13	10
Guarantee, less energy supplied, for special extension	6	2	2
Sale of scrap material, etc.	31	2	6
Miscellaneous fees	18	14	3
	£53,872	7	3

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	373,262	4	4
Sundry creditors and deposits	3,896	5	4
Cash overdrawn	21,583	4	6
Redemption of debt account	33,174	12	4
Surplus	5,627	9	9
	£437,543	16	3

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	410,239	1	3
Stores on hand	11,495	13	8
Sundry debtors for current supplied, etc.	15,819	1	4
	£437,543	16	3

ST. HELENS ELECTRICITY ACCOUNTS.

The accounts of the St. Helens electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £141,494. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	3,991	4	8
Distribution of electricity	2,008	6	10
Rents, rates, and taxes	401	0	10
Management expenses, salaries, etc.	1,457	10	9
Interest on loans, etc.	3,960	4	8
Sinking funds, repayment of loans, etc.	5,150	13	1
Superannuation fund	14	13	0
Subway charges	116	18	4
Special charges—Insurances	37	11	8
Accidents to plant and machinery account	100	0	0
Renewal of plant and machinery	500	0	0
	17,738	3	4
Balance—profit for the year	1,403	1	6
	£19,141	4	10

Cr. Income.	£	s.	d.
By sale of current per meter, less discounts	12,760	7	4
Sale and repairs of lamps	95	11	2
Motor account	50	5	10
Fitting account	51	19	3
Rents receivable (traction)	6,011	15	2
Interest per bank	50	14	1
Interest—technical education re purchase of plant	17	4	7
Interest—gas account, ditto	103	7	5
	£19,141	4	10

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	128,397	10	6
Sundry creditors	1,700	4	3
Balance at credit of net revenue account	1,403	1	6
Sinking fund account	8,138	13	7
Reserve fund account	2,225	4	2
Consumers' deposits	612	10	5
Bank overdraft	4,972	7	10
Due to treasurer	145	7	4
Stock redemption fund	103	3	9
Premium on stock	354	4	6
Loans repaid from revenue account	8,310	5	0
Loans repaid from sinking fund	1,000	0	0
Stock redeemed	3,075	0	0
Plant and machinery accidents fund	100	0	0
Renewal of plant and machinery	500	0	0
	£161,037	12	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	141,494	0	10
Stores on hand	5,114	8	6
Sundry debtors for current supplied	3,445	19	7
Other debtors	1,984	5	1
Suspense account	25	1	6
Stock redemption fund	835	3	9
Sinking funds	4,138	13	7
Sinking fund investments	4,000	0	0
	£161,037	12	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			2,337,295
Quantity sold	Private consumers by meter	723,227	
	By contract	1,317,594	
	Public lamps	48,923	2,089,744
Quantity used on works	Lost in batteries	123,003	
	Used on works	92,604	215,607
Total quantity accounted for			2,305,351
Quantity not accounted for			31,944
Number of public lamps			35
Maximum supply demanded (kilowatts)			1,007

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WALLASEY ELECTRICITY ACCOUNTS.

The accounts of the Wallasey electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £78,018. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s	d.
To generation of electricity	5,723	9	3
Distribution of electricity	2,414	15	2
Attending and repairs to public lamps	262	19	6
Rents, rates, and taxes	708	6	11
Management expenses, salaries, etc.	1,176	14	10
Special charges—Insurances and bad debts	70	14	0
Expenses for certification of meters	152	1	6
	10,509	1	2
Amount carried to net revenue account	8,758	17	2
	£19,267	18	4

Cr. Income.	£	s.	d.
By sale of current per meter	15,596	19	4
Public lighting	1,183	13	0
Rental of meters and other apparatus	72	9	5
Sale and repairs of lamps, etc.	2,368	8	7
Rents receivable	46	8	0
	£19,267	18	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	78,985	0	0
Reserve fund account	4,108	13	5
	£83,093	13	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	78,018	10	0
Cash with treasurer	5,075	3	5
	£83,093	13	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			2,012,670
Quantity sold	Private consumers by meter, etc.	426,147	1,744,897
	Traction	1,241,350	
	Public lamps	77,400	
Quantity used on works			5,916
Total quantity accounted for			1,750,813
Quantity not accounted for			261,857
Maximum supply demanded (kilowatts)			872

Number of public lamps: 60 arc, 120 incandescent.

PERSONAL.

Mr. John E. Pitcairn, J.P., tramways manager, was entertained to dinner last Friday evening in celebration of the completion of 21 years as manager of the Edinburgh and District Tramways Co.

Mr. Eric S. A. Smith, of 51, Trinity-road, Bridlington, has been appointed canvasser for consumers of electrical energy at the Batterseas electricity works at a wage of £2 a week and commission.

Mr. Richard Jones, late manager of the Electric Construction Works, Bushbury (who is succeeded by Mr. H. Jones, new works manager), was last week at a complimentary dinner presented with a handsome marble timepiece, a pair of bronzes, and a purse of gold.

Mr B. Sherman has resigned his directorship of the Amalgamated Dry Batteries, 16-17, Devonshire-square, E.C., and Mr. F. Heron-Rogers has been elected in his place.

Mr. E. Trenam, controller of the Central Telegraph Office, St. Martin's-le-Grand, is retiring under the age limit after a long and useful service. He was appointed traffic manager, secretary's office, in 1900, deputy-controller in 1901, becoming controller of the central telegraph office in 1902.

Mr. E. Fenton, who has been a student in the York electricity works for the past four years, has been appointed junior assistant mains engineer. This appointment was inadvertently inserted under "Appointments Vacant" in a previous issue.

A smoking concert was held last Friday evening by the members of the Recreation Club of the Hull tramways electrical engineering department. During the proceedings a saddle was presented on behalf of the club by the chairman, Mr. J. Wilkinson, to Mr. H. Garrington, the chargeman over the electrical department at Liverpool street, who is shortly leaving the Corporation's employ to return to his previous occupation of farming.

The Willesden Board of Guardians have appointed Mr. A. Moorhouse, of Burnley, engineer-in-charge in connection with their electrical installation.

The Northampton Institute have made the following appointments for instructors in mathematics for their engineering courses: Mr. D. Heron, M.A., for day courses, and Mr. W. H. Pretty for evening courses.

Mr. R. Hugh Seabrook, of Barking, has been appointed electrical engineer to the West Ham Corporation.

LEGAL INTELLIGENCE.

CLAIM FOR DAMAGES.

At the Scarborough County Court on Tuesday last, before his Honour Judge Raikes, the Scarborough Tramways Co. were sued by George Weatherill, cab proprietor, Scarborough, for £148. 12s. 6d. for damages caused to his horse and landau; £66. 12s. 6d. had been paid into court with denial of liability.

The counsel for the plaintiff stated that the claim related to an incident of July 3, on which date plaintiff was driving from Valley-road to Westborough, and at the time was proceeding up Falconer's-road, down which road there was a double set of tram-lines. As plaintiff drove up Falconer's-road he saw in front of him a cab, driven by a man named Cattle, going up the hill ahead of him, and that the tram which was stationed near the Aquarium had started, and was coming up the hill. Both drivers knew that it was impossible for the tram to pass if they continued driving up the left side of the road, so they both drew into the middle of the road and allowed the tram to pass them. The car went ahead some little distance up the hill, and the cabdrivers resumed their journey, but the car had not gone far before it stopped and immediately began to back. It backed into Cattle's horse, which was forced back, the cab to which it was attached crashing into plaintiff's horse. As a result the latter "locked" the landau and backed towards the wall, causing the landau to cross the rails. The tram travelled down the hill into the landau at such a furious speed that it took the landau bodily down the hill. The landau was overturned, the occupant was thrown out, and plaintiff was thrown into the road. The tram was not pulled up until it got to the bottom of the hill, and the driver explained that his brakes had failed to act. There could be no question of presumption of negligence on the part of the defendant company. The admission of the driver that his brakes would not act was conclusive. That was not the first time occurrences of that sort had taken place in Falconer's-road and other hills. The trams in Scarborough had to ply in places which, on account of the steep gradients, required large motive power, which, it was suggested, they had not got; and what was more, the company required a system in regard to the structure of their cars which would enable them in emergencies of that sort to ply the brakes effectively. Evidence was called to show that that very driver had assisted in bringing a car up Falconer's-road on a previous occasion, which twice or thrice had refused to answer to the brake, showing the imminence of an occurrence of that sort.

For the defence it was urged there was no suggestion of defect in the tram. The company were prepared to meet the question of alleged negligent driving and management, but no suggestion had been made of any defect in construction. The suggestion as to the brakes being unable to control the car was utterly without foundation. What led to the accident was deliberate. As the driver of the up car was going up the hill he saw that a rolly was coming down quickly and attempting to get between the up and the down car, and the driver of the up car saw that unless he stopped, the rolly and its attendant would be crushed between the two cars. He stopped his car, therefore, and reversed it, not knowing that the two cabs were behind him, but he pulled up the car within two lengths, and there was nothing like the car running away.

The driver of the car gave evidence, stating he stopped his car and reversed the motors to prevent the rolly coming down being crushed between his and the down-coming car. He did not know there was anything behind until he had run into the cab.

His HONOUR held that that was negligence on his own evidence. He had no right to reverse his car and go back without ascertaining whether anything was behind. He gave judgment for £93. 14s. 6d.

MUNICIPAL ELECTRICITY.

At the Brompton County Court on Friday last Sir Wm. Selfe heard an action brought by the Hammersmith Borough Council against Mr. J. B. Mulholland, proprietor of the King's Theatre. The claim was for electricity supplied to the defendant for a period lasting from May 25 to July 31, 1903, which had been reduced by mutual agreement from £80. 10s. 6d. to £52. 17s. 3d. This reduction had been made necessary by the fact that the first amount was arrived at from the reading of a faulty meter.

For the defence it was said that Mr. Mulholland was counter-claiming for £152 odd in respect of his loss of receipts by reason of the plaintiffs' failure to provide a continuous supply of electric current in respect of extra limelight which had to be provided, and of additional work which had to be done on account of plaintiffs' failure to instal their motor-generator at the time specified.

Mr. BELL, electrical engineer to the Hammersmith Borough Council, said that the local authority agreed to supply electric current to Mr. Mulholland at the King's Theatre when that place was in course of erection. The Council only supplied alternating current, but they agreed to have a generator installed whereby the alternating current could be converted into continuous current for the defendant's purposes. The defendant had continued to use the Council's electric current ever since, but he had not paid the account in which the mistake had been made.

On the counterclaim the Council submitted that there was no contract to supply continuous current before Dec. 1, 1903, and that therefore there had been no breach, and defendant had suffered no loss at the Council's hands; and, secondly, that the claim did not come within the jurisdiction of the Court.

On the other side it was argued that the Council were not bound to supply the defendant with alternating and continuous current, but seized the opportunity of doing so, because they knew it would pay them about £700 a year.

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The JUDGE suggested that since a point had been raised concerning his jurisdiction, the parties might possibly come to some arrangement.

A consultation was held, and counsel announced that an agreement had been come to. Claim and counterclaim would be withdrawn, and the parties would pay their own costs.

COMPANIES' MEETINGS AND REPORTS

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.

The third ordinary general meeting of this Company was held on Tuesday last under the chairmanship of Mr. Charles T. Yerkes. The directors' report, which was presented at the meeting, stated that the works which are being carried out by the Company on the Metropolitan District Railway, the Baker-street and Waterloo Railway, the Great Northern, Piccadilly, and Brompton Railway, the Charing Cross, Euston, and Hampstead Railway, and the power-house, have made satisfactory progress since the date of the last report. Electricity has been supplied from the power-house at Chelsea through the transmission lines to Earl's Court, and thence through the District Company's own cables for the past six months, for the operation of that company's railway system. Five of the turbo-generators have been installed. The sub-stations for the operation of the District Railway are all completed and operating. The sub-stations for the Baker-street and Waterloo Railway are nearing completion and the machinery is being installed. The sub-stations for the Great Northern, Piccadilly, and Brompton Railway and the Charing Cross, Euston, and Hampstead Railway are in course of erection, and the machinery is being manufactured. All the work of construction on the Metropolitan District Railway has been finished. All of the lines have been opened for public traffic with electric trains. A few steam trains still continue to run during the rush hours, but they will be replaced by electrical trains before Nov. 1. A serious delay occurred in the delivery of the rolling-stock, which was contracted to be delivered during the months of November and December of last year. The balance of cars for this railway will be delivered this month. All electrical equipments for the cars have been received. The new car shops at Mill Hill Park, which have been equipped with the most modern and up-to-date appliances, are in full use, and it is expected that a very large saving in expenditure will result. All of the stations are now lighted with electricity. The construction of the tunnels and shafts between Baker-street and Westminster Bridge-road on the Baker-street and Waterloo Railway has been completed. Lifts are being installed, and the tiling is nearly completed. The permanent way is completed, and the conductor rails are being bonded. The car and repair shops at St. George's-circus are finished and completely equipped. The electrical apparatus for all the trains has been delivered, and is ready to be installed on the cars. A delay has occurred in the delivery of the rolling-stock, which has to some extent retarded the opening of the line, but it is hoped that the line will be opened for public traffic during the month of March next. The balance-sheet shows that the issued share capital amounts to £2,500,000, and there are £7,000 000 5 per cent. profit-sharing notes, other items bringing the total liabilities to £13,651,354. Among other expenditure to date is £8,257,591 on railway construction, and £1,218,697 on power-house, etc., at Chelsea.

In moving the adoption of the report, the CHAIRMAN stated that rapid progress had been made, and several matters had nearly reached the concluding point. Everything had been found to work as satisfactorily as could have been wished. A pleasing feature was that they were well within their estimates. All of the machinery was working well, and the receipts of the District Co. were increasing. Wherever electricity was in full force splendid results were being shown. In certain places steam had still to be used, but this would not be the case much longer, and he felt convinced that their most sanguine expectations would be fully realised.

Lord FARRER seconded the motion.

The CHAIRMAN, in reply to an inquiry, stated that experiments were being made as to the division of classes on the lines. It was not known precisely what the first-class passengers were going to do. Experience had shown that the Company had been giving 14 per cent. of space in the cars to carry 7 per cent. of the passengers. The Board had expected that there would be scarcely any first-class passengers, but in this view they had been mistaken. Their numbers, however, fell very low at first, but in the last three or four weeks they had increased, and they were now about 8 per cent. of the total. The whole question would be regulated according to the directors' experience, and if it were found that first-class cars were not required, they would be taken off. The chairman, in further reply, stated that a good deal more was seen in the newspapers about the smoke nuisance than was seen at the power stations themselves. There was only one power-house at Chelsea, and the smoke had been reduced "to the merest minimum." The only fault they had to find with the power-house practically was the great noise, and the Westinghouse Co. were now making every effort to get rid of this objection

The motion was then unanimously adopted.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The twenty-second ordinary general meeting was held last week, Mr. Henry Wolfenden presiding.

The CHAIRMAN, in moving the adoption of the report (particulars of which appeared in our issue of the 6th inst.), said that when they last met he expressed the hope that the Board would be able to declare a dividend on the present occasion. This forecast had been fulfilled. It was true that the dividend was only a small one, and was not a very adequate return for the years of waiting which the shareholders had undergone, but he ventured to suggest that they should regard it, not so much for what it was, but as a ground of hope for better things in the future. During the year the directors had endeavoured to conduct the business prudently and progressively, keeping ever in view a high standard of quality for the Company's productions and a reasonableness in their selling prices. He did not consider that any advance they showed in trading results was owing to an improvement in the state of trade generally during the past financial year, which had been a period rather of "marking time" in business as a whole, but since June 30 there had been distinct evidence of an improvement in trade, in which the Company had shared. He moved that a dividend of 2½ per cent. on the A shares be paid.

Mr. E. B. ELLICE CLARK seconded the motion.

Mr. JOHN BALFOUR congratulated the directors upon their success; they had, he added, rescued the Company from the throes of financial death. He moved a resolution voting them 750 guineas in appreciation of their services.

Mr. CRISP (the solicitor) pointed out that such a resolution was not legal unless special notice of it had been given; and it was agreed to insert notice of the resolution in the circular convening the confirmatory meeting.

The report was unanimously adopted.

A further resolution was also carried reducing the capital of the Company from £941,090 to £888,071, by cancelling paid-up capital which had been lost or was unpresented by available assets.

ANGLO-PORTUGUESE TELEPHONE.

The secretary, in a circular to the share and debenture-stock holders, states that the managing director (Mr. F. W. Kerr) has just returned from Portugal, and reports to the Board that the condition of the Company's affairs generally is very satisfactory. Since the installation of the common battery system in Lisbon a great improvement in the service has taken place, and Mr. Kerr received assurances from all sides that the service now leaves nothing to be desired. Three new exchanges—Caxias, Queluz, and Cintra—have recently been established; the work of installing exchanges in Almada and Barreiro, on the south side of the river, has now been commenced, and the necessary permissions for laying the cable under the River Tagus, to connect these places with the central office, have been obtained from the authorities. In Oporto the reconstruction of the system has been followed by a steady increase in the number of subscribers, and the future prospects in this place are also distinctly encouraging. The relations of the Company with the Government authorities continue to be most satisfactory. The proposal of the Company to establish telephonic communication with the south side of the River Tagus has been cordially received, as it supplies a want which has long been felt. The issue of £50,000 5 per cent. debenture stock, sold to the Consolidated Electrical Co., in April last, for £45,500, was all subsequently paid for on the due dates. The proceeds have been applied by this Company to the redemption of all outstanding debentures of earlier date; the debt due to the contractors has also been discharged, and the balance (£10,162) has been invested temporarily in short-date Colonial Government bonds, pending its requirement for the extension of the Company's telephone system in Portugal.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report for the half-year ended June 30, 1905 (to be submitted to the meeting on the 1st prox) states that gross receipts during that period have amounted to £348,850, against £300,058 for the corresponding half-year of 1904. Working expenses, including £21,457 for maintenance of cables, absorb £135,960, against £141,707 for the corresponding period of 1904, leaving a balance of £912,900. From this is deducted £3,384 for income tax and £14,615 for interest, etc., on debenture stock, leaving £194,900 as net profit for the half-year. After adding £22,181 brought forward, there is an available balance of £217,081. Two quarterly interim dividends of 1¼ per cent. each, amounting to £75,000, have been paid for the half-year, leaving £142,881, of which £100,000 has been transferred to the general reserve fund, and the balance of £42,081 is carried forward.

WESTERN TELEGRAPH.

The revenue for the half-year ended June 30 amounted to £283,360, and the working expenses to £116,665. After providing £14,146 for debenture stock and debenture interest and sinking fund, and £5,136 for income tax, there remains a balance of £147,411; to this is added the sum of £3,891 brought forward from Dec. 31 last, making a total of £151,303. A quarterly interim dividend, amounting to £31,189, has been paid, and £60,000 transferred to the general reserve fund and £5,000 to the maintenance ships' reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £51,982, leaving a balance of £3,131 to be carried forward.

ROSARIO ELECTRIC.

The report for the year ended June 30 last (to be presented to the meeting on the 31st inst.) states that the balance at credit of profit and loss account is £13,293, to which must be added the amount brought forward, £913, making a total of £12,206. The directors propose to allocate to amortisation of concessional rights, £500; depreciation on buildings, plant, and machinery, £1,981; depreciation on tools, stores, and furniture, £82; writing off half of the expenses of issue of 8,000 preference shares, £1,267; and after paying a

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dividend of 3s. per share on the ordinary shares there remains to be carried forward £2,667. The number of 8-c.p. lamps connected, including theatres (about 11,300 lamps) at June 30, 1905, was 67,994. In view of the continued demand for lighting and power, the directors have ordered a fifth steam dynamo and accompanying boilers and accessories of 500 kw. capacity. The old station plant is still partially in use for serving the street-lighting. It will be necessary to increase the capital of the Company very shortly in order to meet the satisfactory expansion of business. Mr. Western, one of the directors, is now in the Argentine Republic. After the Board have received and considered his report, an extraordinary general meeting will be summoned to deal with the subject.

STIRLING AND BRIDGE OF ALLAN TRAMWAYS.

The annual general meeting of the shareholders of this Company was held in the secretary's office at Bridge of Allan last Saturday. Mr. T. A. Mortimer, Edinburgh, presided.

In moving the adoption of the report, the CHAIRMAN pointed out that there was an increase of £185. 4s. 5d. on the earnings as compared with the previous year, and of that increase the St. Ninians section contributed nearly £100. The expenditure under revenue showed an increase of £45. 10s., due to extra cost of horsing and increased taxes. The sum at credit of revenue was £793. 5s. 5d., as compared with £652 last year. He moved the adoption of the report, and that the dividend be 4 per cent. on the preferred and second preferred shares, and 2½ per cent. on the ordinary shares. Last year the amount written off was only £38.

Mr. KINROSS seconded, and the adoption of the report was agreed to.

Mr. Brand and Mr. Kinross were re-elected directors. Mr. E. Morrison, the auditor, was re-elected.

NEW COMPANIES REGISTERED.

London Outer Circle Railway Syndicate, Limited.—Capital, £20,125. Objects: to promote a company for the construction and working in the counties of London, Middlesex, Hertfordshire, and Essex or elsewhere of a railway or railways for the carrying of passengers, minerals, and goods by means of steam or electric traction or otherwise, and to apply for a special Act of Parliament relating thereto. Registered office: 266 and 267, Salisbury House, London-wall, E.C.

Hopper and Co, Limited—Registered Oct. 12. Capital, £8,000, in £1 shares. Objects: to adopt an agreement with P. Hopper and H. Wilson, and to carry on the business of electricians, electrical and general engineers, ironmongers, builders of electric tramcars and other vehicles, manufacturers, importers and exporters of and dealers in dynamos, motors, telephones, bells, batteries and electrical apparatus, etc. No initial public issue. Registered office: Elmsdale Works, Elmsdale road, Walthamstow.

Star Foundry (Brighton), Limited—Capital, £5,000. Objects: to acquire and carry on the business recently carried on at the Star Foundry, Bread-street, Brighton, and now at the Star Foundry, Shoreham-road, Portslade, as Geo. Burstow and Sons, as ironfounders, mechanical and electrical engineers, etc. Registered office: Star Foundry, Shoreham road, Portslade, near Brighton.

Electrical Instrument Manufacturers, Limited.—Capital, £5,000. Objects: to carry on the business of electrical engineers, contractors, etc., with a view thereto to enter into an agreement between T. Ward of the one part and H. G. Matthews of the other part.

Diamond Electric Lamp, Limited—Capital, £20,000. Objects: to adopt an agreement with H. Diamant and A. Chiesa, and to carry on the business of manufacturers of and dealers in arc lamps, electricians, mechanical and electrical engineers, manufacturers and suppliers of electricity for light, heat, motive power, or otherwise.

International Electric Railways and Water Power Syndicate, Limited.—Capital, £12,000 in £20 shares. Objects: to acquire concessions, rights, powers, or privileges relating to the construction of, and to construct, maintain, work, and use railways or tramways adapted to electric or other traction in any part of the world, etc.

Liens Registered.

Electric Conversion Syndicate, Limited.—An equitable charge, dated Oct. 13, 1905, to secure £16,500, has been registered. Property charged: uncalled capital to the extent of 7s. 6d. per share on 32,350 £1 preference shares in this syndicate; £47,500 first mortgage debenture stock of the South Lancashire Electric Traction and Power Co., Limited; 20,638 £1 fully-paid preference shares in the Sunderland District Electric Tramways, Limited; 18,441 £1 ordinary shares in the Durham Collieries Electric Power Co., Limited; 1,585 £5 preference shares in the North Wales Power and Traction Co., Limited; and 14,500 £1 shares in the Canadian Electric Traction Co., Limited. Holders: Messrs. Herbert Wagg and Russell, Southsea House, E.C.

Electric Safety Appliances Co., Limited (London).—A mortgage debenture, dated Oct. 14, 1905, to secure £100, charged on the company's undertaking and property, present and future, has been registered. Holder: R. J. Bott, 235, Phillip-lane, Tottenham.

APPOINTMENTS VACANT.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office. See advertisement.

Switchboard Attendant, Southend Town Council electricity works. Salary, £1. 1s. per week.

Assistant Lecturer and Demonstrator in Electrical Engineering, Leeds University. Salary, £175 a year.

Premium Pupil, Electricity Works, Canterbury. See advertisement.

Tramway Constructional Engineer for the Far East. Apply Box R 7, *Electrical Engineer* Office. See advertisement in last issue.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Resident Engineer, commencing salary £300, rising to £400 per annum; Sub station Superintendent, salary to commence at £250, rising to £350 per annum; and Shift Engineer, salary to commence at £150, rising to £250 per annum; Birmingham Corporation. Applications by Oct. 30. See advertisement in last issue.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Bermondsey.—Tenders for new plant will shortly be advertised for.

Vienna.—The Government Railways require tenders for telegraph tape. Tenders by Nov. 10.

Wimbledon—We understand that tenders will be called shortly for electric pumps for the sewage works.

Porto.—The Municipality require tenders for a concession for working the electric tramways in the town. Tenders by Nov. 8. Preliminary deposit, 100 contos de reis.

Stoke-upon-Trent.—The Guardians invite tenders for (1) rewiring a portion of the workhouse and cottage homes, and (2) replating the battery. Tenders by 9 a.m. on Nov. 1.

Felny (Belgium).—The Provincial Government require tenders for electric lighting of the town. Tenders by Oct. 31. Applications to the Town Hall, Felny, province of Hainault.

Shoreditch—The Borough Council invite tenders for the extension of plant at their Whiston street generating station. Tenders to the Town Clerk by Nov. 7. See advertisement.

Belfast.—Electric light and fittings are required in the Scottish Temperance Assurance Buildings, Belfast. Tenders to Mr. Henry Beaver, architect, 22, Donegall-place, Belfast, by Nov. 3.

Edinburgh.—The Parish Council invite tenders for an installation of intercommunication telephone system throughout the offices, Castle-terrace, Edinburgh. Tenders to the Clerk by 10 a.m. on Nov. 7.

Sao Luiz—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 16. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Brisbane.—The Postmaster-General invites tenders for 150 branching system table telephones. Tenders by Dec. 1. Particulars may be obtained from the Postmasters-General at Sydney, Melbourne, Brisbane, and Adelaide.

Altrincham.—The Altrincham and Bowdon Administrative Sub-Committee for Education invite tenders for the electric wiring and fittings required for the Stamford Park new Council schools. Tenders to the Clerk by noon on Nov. 3.

Barrow-in-Furness.—The Corporation invites tenders for the supply and erection of a 500-kw. combined steam-engine and generator, balancer booster, switchboard, water-tube boiler, mechanical stoker, economiser, travelling crane, cooling tower, pipes, etc. Tenders by 12 noon on Nov. 13. See advertisement.

Clacton-on-Sea.—The Urban District Council invite tenders for the supply and erection of (Section A) gas-engines and dynamos; (B) switchboard; (C) underground mains; (D) accumulators; (E) meters; (F) crane; (G) buildings. Tenders to Mr. G. T. Lewis, clerk, by 3 p.m. on Nov. 6. See advertisement in last issue.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension of that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Netherlands.—The Board of Trade have been notified by the acting British consul at Amsterdam (Mr. F. A. Chambers) that the Zuid-Hollandsche Electrische Spoorweg-Maatschappij (South Holland Electric Railway Co.) will be prepared to receive tenders for the making of ground works, engineering, and additional works between the Ceintarbaan and "piket 120 by 70" (in connection with the works of Contract No. 14), the laying of rails and switches, and the supply and use of gravel ballast, as well as some works in connection with the railway, in accordance with Contract No. 17. The estimated cost of the work is 936,000fl. (£78 000). On Oct. 25, at 10.30 a.m., an explanation will be given, meeting place Café, "Plaats Lommerrijk," on the Bergweg, near Hillegersberg. Copies of the contract, with drawings, may be obtained from Messrs. Beversen and Van Hoorn Heerengracht, 38, The Hague, at a cost of 12·20fl. (£1. 0s. 4d.). Tenders should be written on stamped paper, and received before 1 15 p.m. on Nov. 2.

RESULTS OF TENDERS.

Southend.—The Town Council have accepted the tender of the Callender Co., at £25. 10s., for the supply of cable for repairing the overhead equipment.

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Battersea.—The tender of West Bros., at £43. 15s. 6d., has been accepted for the supply of 10,000 tiles required in connection with the Nine Elms electric lighting scheme.

Kensington.—An order has been given to Henley's Telegraph Works for the supply of lead-covered cable at the price quoted by them—viz., £123 4s. 6d., less 2½ per cent.

Shoreditch.—The Borough Council have accepted the tender of Willans and Robinson, of Rugby, at £18,475, for two Willans-Parsons turbines with Siemens generators, together with condensers, etc.

Pontypridd.—The Electricity and Tramways Committee have decided to accept the tenders of the Brush Co., at £3,603, for the equipment of the tramway from Pontypridd to Hafod, and of Messrs. Henley, Birkenhead, at £2,585, for the laying of the cables.

Spain.—Messrs. Jackson and Phillips, Madrid, have contracted with the Compania minera industrial de Mancilla (Logrono) of Paris for power transmission scheme of 200 h.p. for a distance of 15 km. to the mines of this company. The contract includes the erection and equipment of an engine house, of 1,500 yards open channel, and 700 yards tunnel.

Great Western and Metropolitan Contract.—The contract for the equipment of the trains on the Hammersmith and City line of the Great Western and Metropolitan Companies has been awarded to the British Thomson-Houston Co. The contract is for 20 trains, the number of coaches per train being six. The equipment will consist of the B.T.H. type G.E. 76 motor and the Sprague-Thomson-Houston system of control.

Steam-Turbine Orders.—Messrs. Willans and Robinson, of Rugby, report the following contracts settled in favour of their steam-turbines: Four turbines of 1,000 kw. each for the Cleveland and Durham Power Co.'s new station at Middlesbrough; three turbines of 1,000 kw. each for Bruce Peebles' Durham scheme for supplying power to a number of collieries; two turbines of 1,000 kw. each for Bruce Peebles' Fife scheme; one turbine of 1,500 kw. for the Borough of Islington; one turbine of 1,000 kw. capacity for Drake and Gorham; and two turbines of 1,500 kw. capacity each for the Borough of Shoreditch.

Buralem.—The Markets Committee of the Corporation have received the following tenders for the lighting by arc lamps of the general markets:

Cross and Cross, Walsall	£82	0	0
E. M. Evans, Manchester	104	17	0
D. Wilson and Co., Huddersfield	133	13	6
Hooper, Neary, and Co., London	146	0	0
Wainford, Froggatt, and Francis, Stoke	152	0	0
Blackburn, Starling, and Co., Hanley	194	0	0

Engineer's estimate, £95. 10s.

London County Council.—The following tenders have been obtained in connection with the equipment of the through tramways route between the Strand and the Angel, Islington:

Supply of low-tension cables.

Callender's Cable and Construction Co., London	£4 025	4	4
British Insulated and Helsby Cables, Prescot	4 068	10	0
Siemens Bros. and Co., London	4,093	12	4
Anchor Cable Co., London	4,141	5	4

Note.—Although the amount of the lowest offer received for the cables was considerably in excess of the estimate therefor, owing principally to the increase in the market price of copper, the vice-chairman, in view of the great urgency of the work, authorised the acceptance of the tender.

Laying of cable-ducts.

J. A. Ewart, London (accepted)	£2,813	14	0
Reid Bros., London	2,974	8	0
British Insulated and Helsby Cables, Prescot	2 992	0	0
J. Mowlem and Co., London	4,435	0	0

The tender of Evered and Co., of Birmingham, at £275, has been accepted for the supply of switchgear for the sub-stations.

Paris.—The following results of the recent adjudication of Post Office tenders are available. Prices are per 100 km.: (1 and 2) 100,000 km. of 3mm. and 110,000 km. of 4mm. galvanised iron wire, Marcellot, Kurville (Haute-Marne), 304 50fr.; (3) 90,000 km. of 4mm. ditto, Forges tréfileries et pointeries de Oreil, 304fr.; (4) 100,000 km. of $^{11}/_{10}$ bronze wire, Cie des Tréfileries du Havre, 29, Rue de Londres, 309 50fr.; (5) 70,000 km. of $^{15}/_{10}$ ditto, Cie générale d'électricité 5, Rue Boudreau, 314fr.; (6) 60,000 km. of ditto, Cie générale d'électricité, 314fr.; (7) 95 000 km. of high-conductivity 4mm. copper wire, Forges de Franche-Comté, Besancon, 244 50fr.; (8) 80,000 km. ditto, Cie française des métaux, 242fr.; (9) 150 000 km. dicto, Mines et fonderies de Pontgibaud, 3 Rue des Mathurins, 242 75 fr.; (10) 95 000 km. of high-conductivity 3mm. copper wire, Sté d'electro-métallurgie de Dives, 241 40fr.; (11) 105 000 km. of 4mm. ditto, Cie des Tréfileries du Havre, 241 75fr.; (12) 105,000 km. ditto, Cie des Tréfileries du Havre, 240 75fr.; (13) 95 000 km. ditto, Grammont Pont-de-Chéroy (Isère), 243 50fr.; (14) 1,000 km. of 1mm. ordinary copper wire, Charpentier Page, Valdois (Haut-Rhin) 243 50fr.; (15) 80,000 km. of 2mm. bimetal wire, Cie française du bimétal, 194 50fr.; (16) 70 000 km. ditto, Sté d'électro-métallurgie de Dives, 11, Place de la Madeleine, 195fr.; (17) 7,000 km. of 3mm. ditto, Cie française des métaux, 10, Rue Volney, 192fr; (18) 19 km. of rubber-insulated, lead-covered, single-conductor telephone wire, type 88/1, Sté alsacienne de constructions mécaniques, Belfort, 390fr. per km.; (19) 40 km. ditto, two conductors, type 88/2, Sté industrielle des téléphones, 25, Rue du Quatre-Septembre, 815fr. per km.; (20) 20 km. ditto, three conductors, type 88/3, Geoffroy et Delore, Clichy, 3 700fr. per km.; (21) 30 km. ditto, De la Mathe, Saint-Maurice (Seine), 3 675fr. per km. All the contracts for telegraph and telephone accessories were let to French firms. The Colonial Office have accepted a tender for galvanised iron of the Forges de Franche-Comté as follows; for 100 km. of 2mm., 35fr.; 3mm., 34fr.; 5mm., 32 50fr.

BUSINESS NOTES.

TRACTION.

North-Eastern Railway.—It is reported that the North-Eastern Railway are about to electrify their system between Newcastle and Sunderland.

Southend.—The electrical engineer in his last return states that the traffic receipts for the past month had been £1,993, the rate per car mile being 13·97d.

Birkenhead.—At the next meeting of the Council a recommendation will be received from the Tramways Committee for a reduction of fares on two of the routes.

Ipswich.—At the borough police court last week James Miller was fined 20s. and costs for driving a cart in such a way as to obstruct the passage of an electric tramcar.

Bromley.—The Borough Council have decided by a large majority to seek statutory powers enabling them to undertake a service of motor omnibuses within the borough.

Rawtenstall.—At the last meeting of the Council the Mayor stated that there was no further information to be reported in reference to the tramways or electricity question.

Metropolitan District Railway.—The pneumatic Westinghouse system of signalling is being adopted by this company, and by the end of November will be completely installed.

Perth.—The new electric tramway system successfully went through the official Board of Trade inspection last week. The service is to be formally opened on Oct. 31 and for public traffic on Nov. 1.

Atterclife.—An old man was knocked down and run over by an electric tramcar when in the act of crossing the road on Wednesday week. At the inquest the jury returned a verdict of "Accidental death" and exonerated the driver from any blame.

Lucknow.—A license has been granted by the municipal authorities to the British Eastern Electric Power Co. sanctioning the construction of an electric tramway within the Lucknow Municipality. Particulars of the agreement will be found in another column.

Pontypridd.—Owing to their difficulty in getting a supply of local stone to complete the contract for laying the tramway within the stipulated time, the Council have agreed to grant the contractors, Messrs. Krauss and Co., an extension of six weeks.

South Lancashire Electric Traction Co.—It is reported that this company, which was in the hands of receivers, is about to acquire a new lease of life. Several large debenture holders have agreed to reorganise the concern and utilise its valuable properties.

Linlithgow.—At a meeting of the County Council held last Saturday it was reported that the National Electrical Construction Co. proposed to again ask authority to construct a tramway to Queens Ferry. The Council approved of a recommendation to oppose the application for compulsory powers.

Falkirk.—The electrification of the tramways is now completed, and the Board of Trade inspection of the route has taken place. The service has now been opened to the public, and, according to present arrangements, will be a five minutes' one, but in quiet times the cars will run less frequently.

Leith.—The section of electric tramways in Constitution-street and Bernard-street was inspected and approved of by the Board of Trade inspector last week. Until the Tramways Committee have a meeting to discuss the question of fares, there will be a penny fare from Bernard-street and Pilrig.

Poole.—The Council at a meeting last week decided to give their consent to the scheme for a light railway about to be promoted, the route to extend from the County Gates and running through Branksome Park and Sandbanks to Swanage. The Chamber of Commerce have given their support to the scheme.

Eastbourne.—The Motor Omnibus Committee recommend that, in view of the present small receipts on the Parade route, the service of motor 'buses be discontinued for the winter months. A total of 136,602 passengers had been carried on the 'buses during September, and the receipts amounted to £857. 0s. 7d.

Spain.—The Provincial Government of Navarro have given a concession for an electric tramway to Don Domingo Elizondo granting him the free use of the provincial highways and a subvention of 10,000 pesetas per kilometre, to be increased to 12,500 if he does not use the roads but only the bridges. The concessionaire has to pay to the Government half of his net profits after they exceed 6 per cent.

Grimsby.—The Town Council have approved a draft of an agreement to be entered into with the Great Central Railway Co. for the supply of electricity in bulk. The energy supplied will be charged for on the maximum demand system, a fixed charge being made of £4 per annum per kilowatt of maximum demand required at any one time, and, in addition, a charge of ¾d. per unit to be made for all current consumed.

Southsea.—A deputation waited upon the Council to urge the desirability of establishing a service of motor omnibuses to run through King's-road. The result was somewhat surprising, for a hint was dropped that it might be possible to institute a service of cars over asphalted roads which would not require the expense of a permanent iron way, but might be worked with a couple of overhead wires to carry the current.

Keighley.—At the October meeting of the Town Council the tramway statement which was presented showed that the receipts had been £4,648, and the expenditure £4,008, which left a balance of £640 on the working of the concern. After the payment of interest

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and sinking fund charges, amounting to £2,352. 15s. 7d., there was a net deficiency of £1,612. 12s. 6d. on the year. The adoption of the accounts was moved and carried.

Horndean.—The light railway company have postponed their decision not to utilise the Corporation supply of electricity during the winter months. A special sub-committee of the Tramways Committee, at a meeting last week, considered the relationship between the Corporation undertaking and that of the company, and it was decided that if the company submitted a fair offer the question of purchase of the light railway would receive sympathetic consideration.

Weymouth.—The Trades and Labour Council, in a letter to the Corporation, urge their serious consideration of securing for the town powers to lay down and carry out a system of trams as recommended in scheme O by Prof. Kennedy, or in the event of their not doing so themselves to sublet these to a private company. It is stated that when the subject again engaged the attention of the Corporation the letter would be considered in conjunction with Prof. Kennedy's report.

Aberdare.—A London syndicate have asked the Council for their support in the promotion of a Tramways Bill in Parliament for Aberdare. They also stated that if such a Bill were carried and the Council found the money to construct the tramways, they would be prepared to lease the same. The Parliamentary Committee unanimously decided to have nothing further to do with the promotion of a tramways.

Durham.—At a meeting of the Rural District Council on Thursday week it was reported that a communication had been received from the Board of Trade stating that they had made an order sanctioning a further extension for six months of the period for completing the Durham and District Light Railways, but that the promoters had been informed that the Board would be unwilling to entertain any further application for an extension of time unless progress should have been made with the work.

Manchester.—We note that welded rail joints are to rule in Manchester. The system is being adopted along all new routes of the tramways, and less wear of the rails at the joints is anticipated in consequence. The electric tramcar building and repairing works erected recently by the Manchester Tramways Committee in Hyde-road were opened on Tuesday last by the Lord Mayor. The works, which cover about four acres of land, are said to have the most modern equipment of any in the country.

Dundee.—The recent *plébiscite* taken in connection with the running of Sunday cars has resulted in a large majority in favour of the Sunday service. Out of about 22 000 voters, 19,000 voted, and the majority amounted to over 4 000. The Tramways Committee have resolved upon an extension of the line to the eastern boundary at a cost of about £4,000. To carry out this work the Corporation is vested with statutory powers, the Act providing that operations must be completed by July 26 next year.

Haslingden.—The Town Council are preparing to promote an omnibus Bill in the next session of Parliament. Powers are sought principally for the reconstruction and electrification of the tramways and for the supply of electricity to the trams. It is proposed to get powers to extend the reconstructed system to Three Lane Ends, Helmshore, and Ewood Bridge, all within the Haslingden borough. The opportunity will be taken of obtaining powers for a number of improvements that are deemed necessary.

Tram Obstruction.—A carman was charged at Stratford on Tuesday last with causing an obstruction, by allowing his van to remain longer on the road than was necessary. He had been unloading furniture at a spot where the electric cars passed over a loop line, which was only 4ft. 10in. from the kerb, and a number of cars on either side of the van were obstructed for 50 minutes. The Bench dismissed the summons on the ground that defendant did not stop an unreasonable time, and that the inspectors should have been prepared for such an emergency.

Paddington.—At the last meeting of the Borough Council, relative to the London County Council's project of electric tramways along Edgware-road a letter was read from the Motor Omnibus Co. against the proposal, saying that they already carried 4,000,000 passengers, and were prepared to make their service more efficient Several deputations presented petitions in favour of the Council's scheme, and the General Purposes Committee of the St. Marylebone Borough Council advise assent to the scheme provided the borough has not to contribute towards the expense of road widening.

Ayr.—A copy of the tramways accounts presented to the Borough Council for the year ended May 15 has come to hand, from which we see the income totalled £15 082, being an average per car mile of 9 89d., while the expenditure reached a total of £8 033, averaging 5·27d. per car mile leaving a balance of £7,049. Out of this sum £2,267 has been utilised in payment of interest on capital, while renewals absorbed £250. The general manager reports that the overhead equipment is in good repair, whilst the track and permanent way have been well maintained. The cars are in good condition, though trouble is being experienced with the wheel flanges.

Liverpool —In acknowledging a vote of thanks for his services as chairman of the Tramways Committee, Sir Charles Petrie, at a meeting of that body last week, remarked that the concern had grown enormously since 1897. They were now carrying something like 2¼ million passengers every week, and the increase in the receipts during the past nine months, compared with the corresponding period of last year, was £7,500. He expressed a hope that there would be a continuity in the work of the committee, and that new members coming on to it would be guided by the experience of those who had served on it for some years. The vice-chairman, Alderman Smith, replying to a similar vote, took occasion to air his disagreement over the question of fares.

Aberdeen.—The Tramways Committee have decided that discount on celluloid tokens shall be discontinued from Nov. 1. Six more cars are to be fitted with covered tops, making 28 cars in all so equipped. These are considered sufficient to supply the wants on every route. At a meeting of the Council a letter was read from the secretary of the Aberdeen Suburban Tramways Co., stating that he was now authorised to make an offer in full of all claims in respect of the work done on the Deeside and Donside roads during the time the tramway rails were being laid, the sum mentioned to be in full settlement of all claims up to date, but not including a sum of £49 in respect of a new drain from the road at Pitfodels, the offer to remain open to Wednesday last. The terms were agreed to.

Tarporley.—On Thursday week Sir Herbert Jekyll, on behalf of the Board of Trade, heard the Cheshire County Council's objections to the confirmation of the order for the Tarporley light railway. The most important objection of the County Council was to the level crossing on the main road from Chester to Tarporley and to Manchester and Liverpool. On behalf of the promoters it was stated that the cost of the requirements of the Council would amount to about £6,000, and it would be a question whether the scheme would be proceeded with if they were compelled to find all the money. The present capital was small, and perhaps they might come to the Board along with the County Council and come to some agreement after discussing the matter privately, and the Board could then settle between them what should be done to safeguard the interests of the public.

Torquay.—The differences that have arisen between the contractors and the Corporation in connection with the construction of new tramways have been accentuated by the refusal of the mayor to call a town's meeting in compliance with an influentially-signed requisition. The requisitionists are arranging for a meeting on their own account. The Local Government Board inquiry into the application of the Council for sanction to borrow £9,500 for the extension and improvement of the present power station on Beacon Quay in order to enable the Corporation to carry out their agreement with the Dolter Co. to supply them with electric current for the working of the tramways will be held on Tuesday next. Notwithstanding the fact that the matter of paving has not yet been agreed to by the Board of Trade, the contractors commenced operations on Monday last in the presence of only one representative from the Council.

Belfast.—At a meeting of the Tramways and Electricity Committee the monthly accounts, amounting to £7,330 for the tramways department and £1,037 for the electric department, were presented and recommended for payment. The town clerk informed the committee that he had received the arbitrator's award charges amounting to £8,000, and these must be taxed by the taxing officer in London. The work of testing the new system on the Lisburn-road, the Malone-road, and the Stranmillis-road, which could not be performed earlier, as the contractors had not completed their arrangements, was carried out on Thursday week by means of one of the tramcars which have been converted from horse traction to electric traction. The car went over each of the three routes, the time occupied altogether being 1¼ hours. We understand that the result of the test was most satisfactory, though in one or two cases it is probable that alterations may be made in curves which are not considered as desirable as they might be. The car itself was found to work admirably, and to be quite as comfortable as any of the new cars supplied under the contract.

London County Council.—At the meeting of the London County Council held on Tuesday last a joint report of the Highways and Parliamentary Committee was presented, as a result of which it was resolved that a joint conference be held between the metropolitan borough councils and the London County Council to consider the question of supply of electric energy in London. The Highways Committee propose that a Bill should be promoted for the purchase by the Council at various dates of certain short lengths of tramways in or on the boundary of the county of London which are not included in the company's lease. The lines in question are those (*a*) from the Council's lines in Stamford Hill to the county boundary; (*b*) from Seven Sisters-road, *via* Green-lanes, to the county boundary near Hermitage-road; (*c*) from Green-lanes, *via* Seven Sisters-road, to the county boundary near Amhurst-park; and (*d*) in Seven Sisters-road, between Stroud Green-road and Green-lanes. The last named line was originally outside the county of London, but the county boundary has been altered, so that the down line of the tramways is now outside London, and the up line in London. The total length of line affected is about three miles of single track, of which about one-half mile of single track is in Hornsey. The agreement with the company for the purchase of its remaining interests in the Council's (northern) tramways has now been completed, but it will be necessary to obtain parliamentary confirmation of the subsidiary agreement.

Salford.—Some time ago the Tramways Committee of the Manchester and Salford Corporations agreed to a scheme whereby a service of tramcars should be run into Trafford Park, so that passengers could be conveyed to the large works there. This has involved the solving of a very difficult problem, inasmuch as the Ship Canal has to be crossed, and the bridge over it swings open to allow of the passage of ships. To enter the park from Salford the tramcars will have to cross this bridge, and its equipment for tramway purposes has added another to the many interesting engineering feats in connection with the waterway. The tramway wires and other necessities have had to be erected in such a manner as not to interfere with the working of the bridge, but this has been successfully accomplished, and very little work now remains to be done in connection with the scheme. In the hope of preventing any mishaps, signals have been erected 150 yards away on each side of the bridge, and when the huge structure is closed these signals will be placed at "danger." As a further safeguard in case the signal should not be seen or be disregarded by the motorman, "points" have been placed on the metals some distance from the bridge. These will be worked electrically by a canal official, who, at the same time that he opens the bridge, will put up the danger signal and close the

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points. The closing of the points will mean that the car is carried off the usual track, so that the danger of a vehicle crashing into the gates which are thrown across the roadway when the bridge is open will be almost entirely removed.

Cleethorpes.—At a meeting of the Urban District Council the following report was presented by the Electrical Sub-Committee with reference to the tramways question: Owing to the tramways company failing to arrange terms with the Grimsby Corporation with respect to their proposed extensions, the Bill which was to have been promoted, and in which the committee was depending on having an agreement inserted, was allowed to drop as impracticable. On Oct. 5 the clerk, along with Mr. Councillor Brockway, had a long interview with Mr. Lees (Lees and Butterworth), and explained the position of the Council. A long consultation subsequently took place between Mr. Lees, Mr. Chapman, Mr. Wintringham, and Mr. Vesey Brown. In the event of an amended order having to be applied for, it was decided to visit the Board of Trade with the intention of getting power in the amended order to lease part of the undertaking, but Mr. Collins, the official in charge, would not give an opinion without first consulting the solicitor to the Crown. After a lengthy discussion it was eventually agreed that the better course would be to defer the completion of the purchase until July 3. 1910, the tramways company agreeing to accept the sum of £15 400, instead of £17 000, the present purchase price. Also, if the Council desired to then defer the completion until July 3, 1912 they would allow a further sum of £640 for depreciation. The tramways company also consented to recoup the Council for out-of-pocket expenses incurred in procuring the loan to the amount of £100, to be paid on the signing of the agreement. The sub-committee recommended that the arrangement be embodied in an agreement to be prepared by Messrs. Ashurst, Morris, Crisp, and Co., and that it be subject to the confirmation of the Council. The committee approved of the action taken and the arrangements made by the sub-committee.

Edinburgh.—A sheriff's inquiry was recently held concerning the accident which occurred at the Lady Victoria Pit, resulting in the death of a young man by electrocution. The jury found that the man met his death by coming in contact with an electric wire. With regard to the proposed tramway extensions, a report has been issued by Prof. Kennedy. He is of the opinion that the expense of laying down the conduit system along the route from Gilmore-place to Colinton, a portion of which is now worked by horse cars, was out of the question. Even if the traffic justified such an expense, it would probably be better to extend the cable lines than to introduce an entirely different system of equal cost for short distances. It had been suggested that these outlying lines should be worked by tramcars, each carrying its own petroleum motor, the cars running along the ordinary lines. There was no trustworthy experience of information as yet as to the cost of running or of maintaining such cars, and the travelling in them would be much less comfortable than the travelling in ordinary tramcars. He, therefore, thinks their choice practically lies between extensions by means of overhead lines or by some surface-contact system. Of the Dolter and the Lorain systems, the latter had certainly had far the larger amount of practical use. The former had had sufficient use to enable him to form the opinion that it had been brought into practical working condition. He believes that with proper care either of the two systems might be used on the Gilmore-place line. He is not prepared to say positively that either of the two systems was better than the other on the whole. A comparison between the two was a very complicated affair. At present he would only suggest, further, that it might be advisable to ask both the Lorain and the Dolter Companies to supply them with three or four "dummy" studs, which they might put down at their proper intended level between the rails, so as to find out by practical trial whether their shape or elevation above the general road level caused any practical inconvenience.

Leeds.—A few years ago the Horsforth District Council handed their provisional order for tramways over to the Leeds Corporation, who later obtained powers to construct the necessary lines. The extensions are making much progress, and the main track, from Kirkstall Abbey to Calverley-lane End, Horsforth, has been completed, operations having been started in the autumn of 1904 with the direct object of finding work for the unemployed, but the running of cars thereon forms part of a scheme which was definitely adopted in 1904—viz., to early extend the city tramways to Rodley, and in course of time to outside places, if desired. Such a policy involved the consideration of what method of generation and distribution should be employed. The present low-tension system is not economical when power is carried beyond a distance of 3½ or four miles from the generating station, and, therefore, it was decided to introduce the high-tension alternate current. In accordance with this decision, arrangements were made for extending the power station in the Calls, and for the installation of generating plant but there have been unforeseen difficulties arising from the close proximity of the power station to the river. These difficulties have now been overcome, and the work is being carried forward as rapidly as possible. Still it is very doubtful whether the plant, which includes a couple of turbines of the Curtis vertical type, will be ready before the end of the present year. The use of turbines for generating electric current for traction purposes alone is one of the very latest of engineering devices. It is said that, so far as this country is concerned, they are only thus employed in a few instances in London, though both the Yorkshire and Lancashire Electric Power Companies have utilised them at their generating stations for the combined purposes of lighting and power. In Leeds the current will be generated at 6 500 volts three-phase, and will be distributed from the central station in the Calls to two sub-stations which are being erected—one at Bramley Town End, and the other at Hawksworth, Kirkstall. At these points there will be transformers which will change the current to the potential required for use by the cars.

LIGHTING AND GENERAL.

Briton Ferry.—The Council propose putting down the town installation during the next few months.

Bray.—The cripples' home is being wired for 70 lights, which necessitates the laying of a cable at a cost of £31.

Paris.—The Government have approved of thoroughly modernising the Paris telephone system at a cost of £400,000.

Horsforth.—We understand that the Urban District Council are about to transfer their electric lighting order to the Yorkshire Electric Power Co.

Manchester.—An inquiry will be held to-day into the Town Council's application for sanction to borrow £60,000 for electricity extensions.

Edison and Swan United Electric Light Co.—The dividend warrants in respect of the dividend declared by this company at the meeting on the 12th inst. will be paid on Thursday, Dec. 1.

Malvern.—Electricity is to be installed at Malvern Priory Church for lighting and organ blowing. A committee, consisting of the clergy and churchwardens, has been appointed to carry out the schemes.

South London Electric Supply Co.—The company announces that the sales of current for the quarter ended Michaelmas last amount to £17,577, against £16,755 for the corresponding quarter of last year.

Pitlochry and Dunkeld.—The Lords Commissioners of the Treasury have now authorised the establishment of telephone exchanges at Dunkeld and Pitlochry, and their connection with the trunk system of the country.

Liverpool.—The Electric Power and Lighting Committee have recorded a vote of thanks to Councillor Max Muspratt, deputy-chairman of the Electric Power and Lighting Committee of the Liverpool Corporation, for his services during the past year.

Aberdeen.—During September the output of the electrical station at Ferryhill was 367,455 Board of Trade units, of which 178 274 units were for lighting, and 189,181 units for traction purposes. It has been agreed to extend the electric cables in King-street and mains in the Rosemount district.

Liversedge.—The District Council at their last meeting discussed a resolution authorising the clerk to borrow the sum of £1,500 for the purposes of electrical supply (by arrangement with the Yorkshire Power Co.). Eventually the question was referred back to the committee for report.

Court of Common Council.—An application from the Charing Cross, West-end, and City Electricity Supply Corporation for the consent of the Corporation to change the pressure from 100 to 200 volts in those parts of the western area where a supply of 100 volts has been given has been agreed to.

Stirling.—Mr. Hanson, the electrical engineer, in his last report, states that for the four weeks ending Sept. 30 19,534 units were generated at the power station, as compared with 17 319 for the same period of 1904. The total number of connections was 18,116 8-c.p. lamps, as against 16,070 at the same period last year.

Folkestone.—The electricity supply company having invited their customers to pay a visit to the Electrical Exhibition at Olympia, Addison-road, arranged with the railway company to run a cheap excursion train to London last week. A train composed of absolutely new second-class saloon carriages was used and duly appreciated.

Laminated Leather Belting.—We have received a catalogue issued by Mr. James Hendry, 252, Main-street, Bridgtown, Glasgow, which contain illustrations and price list of his patent leather belting. The belts can be made any length free from splicings, run perfectly noiseless, straight and true, and are of a uniform thickness throughout.

Irvine.—At last week's Town Council meeting considerable discussion arose upon a motion to the effect that a report approving of the acceptance of the offer of Messrs. Mercy and Marr to carry out an electric lighting installation for part of the town at a cost of £6,600 be accepted. Several amendments found no seconder, and nothing was done.

Newport.—It is reported that the price for electric lighting is to be reduced by 1½d. per unit—that is to say, from a maximum of 5½d. to 4d., and a minimum of 3d. per unit. A reduction will also be made in the supply of current for heating and cooking. The Electricity Committee have decided to promote a large exhibition of electrical appliances.

Partnership.—Mr. Robert MacGregor, for many years a partner in the firm of Messrs. W. Dunn and Co., Durban, Natal, has been admitted a partner in Rowland Carr and Co. We are informed that Mr. J. C. Brown, who is so well known amongst electrical engineers throughout the kingdom, will now devote the whole of his attention to outside work.

Torquay.—An enquiry will be held next Tuesday into the application of the Town Council for sanction to a loan of £9 500 for the extension and improvement of the present electric lighting and power station on Beacon Quay, in order to enable the Corporation to carry out their agreement with the Dolter Co. to supply them with the electric current for the working of the tramways.

Electric Furnace.—Messrs. Marryat and Place have been instructed to supply to the University of Glasgow a duplicate of the 1,000-ampere Moissan furnace they have been showing in operation at Olympia. During the last week of the exhibition the diamond obtained from carbon dissolved in iron was on view. The microscopic output consisted of about 50 diamonds, which were mounted upon one slide. Enlarged 40 times the structure could be clearly seen.

Football.—The annual match between the Robertson Electric Lamp Works and the General Electric Co., London, took place on Saturday last at the Lamp Makers' ground at Twyford-avenue, Acton, and after an enjoyable game the Lamp Makers ran out the winners by seven to

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one The Lamp Makers have started their second season well, having won both their league matches, and it is hoped they will win another at the expense of Wigmore United on Saturday next.

Hull.—The Stoneferry Bridge, which spans the River Hull about two miles from the Humber, was formally opened on Monday by the mayoress. It is a steel swingbridge, constructed in two spans (a movable span of 150ft., giving a clear opening to river traffic of 61ft., and a fixed span of 26ft.), and it is worked by electric power from the Corporation mains. The structure, which was designed by Mr. White, the city engineer, with approaches, has cost over £20,000.

Luton.—The electrical engineer in his last report states that since Sept. 8 46,537 units have been generated and an equivalent of 580 8 c.p. lamps and one motor of 5 h.p. connected, making a total of 275 consumers with 16 306 lamps and 105 motors of 517½ h.p. The number of units generated shows an increase of 132 per cent. over the number generated during the corresponding period of last year. Applications had been received for over 800 additional lamps and 117 h.p. in motors.

Edinburgh.—The Electric Lighting Committee have been discussing the question and cost of lighting common stairs with electricity, and will recommend that the proposal of the Cleaning and Lighting Committee to light such districts as the stairs in the Canongate and Cowgate could not be entertained, but that in future the Electric Lighting Committee would be prepared to do stair lighting in districts where the wires were already in houses for private use at the rate of £1 per 5 c.p. lamp.

Rubber.—A dispatch has been received at the Foreign Office from H.M. Minister and Consul-General at Adis Ababa (Sir J.L. Harrington, K.C.V.O., C.B.), stating that a London company have been granted by the Emperor Menelik a concession of the right to gather and export rubber from the present known rubber-bearing districts of Abyssinia, for a period of 10 years on payment of a royalty. Sir J. L. Harrington remarks that this concession should have the effect of increasing trade between Abyssinia and the Soudan by way of the Sobat River.

Birstall.—An enquiry has been held into the application of the District Council for powers to borrow £2,000 for electricity purposes. It is proposed to take current in bulk from the Yorkshire Electric Power Co., at the price of 3d. per unit for the first 1½ hours of each day or night, and 9d. for all current afterwards. Mr. J. E. Ellis, electrical engineer to the Morley Corporation, submitted a statement showing that, upon an estimated consumption of 30,000 units in the first complete year, and 40,000 in the second year, at 4d. per unit for lighting purposes, there would remain a profit of £75 and £158 for the respective years.

Huddersfield.—The Electricity Committee have recommended the supply of energy for power purposes, and the chairman (Councillor Chatterton) and the engineer will shortly submit a draft scale of charges and conditions on the lines of the discussion at the meeting. The engineer's last report shows that there were 2,159 consumers in September, this being an increase of 17 over the previous month, and 148 168 lamps were connected, or an increase of 733 over the previous month. Application has been made to the Board of Trade for sanction to the erection of an overhead line from Golcar to Crimble.

Finchley.—We understand that last week's fire at the electric light works, Squire's-lane, caused damage to the extent of about £2 000, but that the generating rooms escaped with but comparatively little damage. The cause of the outbreak is unknown. It occurred in the clerical department, after office hours. The roof of the offices was completely burned away, only the four walls of the block being left. The battery was slightly damaged. Expensive testing instruments and laboratory appliances, irretrievably ruined, form no small part of the total damage. The most important of all documents were kept in a strong room, and when it was opened on Wednesday afternoon it was found that not a single paper or book had so much as been scorched.

Brighton.—At the last Council meeting the proceedings of the Lighting Committee, containing the following, were approved: "A letter was read from the engineer recommending that no alteration be made in the existing tariff for a supply of electricity to consumers beyond the borough boundary. It was resolved that the charge for electricity supplied to private consumers outside the borough for the ensuing year should be the same as at present—viz., 7d. per unit for 400 hours' use of the maximum demand per annum, and 1d. per unit afterwards." Nearly 100 members of the committees of the Brighton Ratepayers' Associations, under the leadership of Alderman Carden, paid a visit to the electric lighting works at Southwick on Saturday.

Macclesfield County Asylum Lighting.—The electric lighting of the new infirmary annexe at the above has now been completed, consisting of three steam dynamos, switchboard, wiring, and all necessary gear, etc. The whole of this installation has been carried out according to the engineers' specifications, and a feature of the work is that this has been done at a saving of about 2 per cent. less than the accepted tenders. The contractors for the wiring, fittings, and public lighting are Messrs. D. Firth and Son, of Manchester, and for the plant Messrs. J. H. Holmes and Co. The consulting engineers are Messrs. Lacey, Sillar, and Leigh, of Westminster, and King street, Manchester, who have worked in conjunction with the county architect of Chester, Mr. H. Beswick.

London Gazette.—The Wembly Urban District Council have decided to apply for an electric lighting provisional order. The partnership between Edwin Lansing and Thomas Frederick Griggs, carrying on business as electricians and electrical engineers at 19, Victoria-buildings and Golden Gate Works, Old Trafford, Manchester, has been dissolved by mutual consent. The first meeting in the estate of Thomas Hill, electrical engineer, 24, Vicarage-road, Wolverhampton, will be held at the Official Receiver's Office, Wolverhampton, on Nov. 7, at 11 a.m. Thomas Leman, St. Peter's Churchwalk, Nottingham, has been appointed trustee in the estate of George Robson and John Samson Robson, electrical engineers, Empire-buildings, Newgate-street, Newcastle-on-Tyne.

London County Council.—On Tuesday it was agreed to lend the Stepney Borough Council £3 770 for electric lighting, and the Woolwich Borough Council £5,111 for electric lighting and street-lighting. The Highways Committee's recommendation that expenditure on capital account not exceeding £5 300 be sanctioned for the provision of additional high-tension feeder cables for the Elephant and Castle tramways sub-station, and that the committee be authorised to make arrangements for the supply of the cables was approved. The Highways and Parliamentary Committee were authorised to make arrangements for a conference with representatives of the City Corporation, the Council of the city of Westminster, and the metropolitan borough councils to consider the question of the supply of electrical energy in London. They were also empowered to arrange conferences with the companies supplying electricity.

Keighley.—A recent report on the electricity undertaking prepared by Mr. J. M. Smith shows a total expenditure of £51,064. The receipts have increased from £2 102 for the year 1902-3 to £4,723 for the year ended June 30 last, and the gross profit from £168 to £1,500. Against this gross profit there is to be set £2 512 paid in interest and sinking fund and other charges, making the deficit for the year £1,012, to which has to be added a deficit of £267 brought forward from last year's net revenue account. To meet this charge the estimates had provided for the appropriation from the rates of £1,752, which left a balance of £472 towards meeting next year's loss. The number of units sold for private lighting and motive power have increased in three years from 98 345 to 197,093, while last year the tramways had also taken 160 498 units. The number of consumers during the year 1902-3 was 133, last year they numbered 227.

Watford.—The number of consumers connected to date is 432. It has been agreed to supply Messrs. G. W. Jones, Limited, printing works on the following terms: 1d. per unit, all plant to be electrically driven, contract to be for five years, minimum amount to be consumed to be £400 per annum after first twelve months' working, lighting other than by arc lamp not to exceed 20 per cent. of the whole. The following resolution has been passed and will be sent to the Local Government Board: "That, in the opinion of this Council, it is highly desirable that the various officers of the Council should be enabled to attend such conferences as pertain to their respective departments, as much valuable information is to be obtained thereby, and that representations be made to the Local Government Board of the importance of local authorities being enabled to send delegates to such conferences, and to endeavour to induce the Board to allow the expenses of delegates attending the conferences of the association, in the same way as are the expenses of delegates attending the Urban District Councils' Association."

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: County of Durham Electrical Power Distribution Co.'s 20,000 5 per cent. preference shares of £5 each, fully paid, Nos. 1 to 20,000; Lisbon Electric Tramways' 500,000 ordinary shares of £1 each, fully paid, Nos. 1 to 500,000; 425 553 6 per cent cumulative preference shares of £1 each, fully paid, Nos 1 to 425,553; and £500 000 5 per cent. mortgage debentures of £100 each Nos. 1 to 5,000 (registered); Montreal Light, Heat, and Power Co.'s 170,000 shares of 100 fol. each, fully paid, of the capital stock (Montreal certificates). The committee have been asked to appoint a special settling day in Johnson and Phillips's 6,635 ordinary shares of £1 each, fully paid, Nos. 1 to 6,635, and £116,667 5 per cent. first mortgage debenture stock. And to allow the following securities to be quoted in the official list: Newcastle and District Electric Lighting Co.'s 20,000 shares of £10 each, £9 paid, and 10,000 shares of £10 each, £5 paid; Oriental Telephone and Electric Co.'s £100,000 4 per cent. redeemable debenture stock.

Electric Share Market.—The *Financial Times* says the electric share market has maintained a firm tone during the past week, and business has been on a very fair scale. In the supply section Charing Cross ordinary have further risen ¼ to 7⅞, but City of London preference have fallen ¼ to 15⅞. County of Londons have advanced ⅜ to 10½, and the preference have gained ⅛ at 12⅞. Chelsea debentures at 110½ are ½ higher, and the ordinary have hardened ⅛ to 6, but Metropolitans have fallen ⅜ to 10¼, Westminsters ¼ to 12⅜, Smithfield Markets ⅜ to 2¼, Oxfords ⅛ to 6⅛, and Edmundsons ⅛ to 5⅞. Manufacturing descriptions have met with little attention, and the only movement is in Telegraph Constructions, which have fallen ½ to 34½. Among traction issues the recovery in British Electrics has made further progress, and the ordinary have risen ⅜ to 9⅞, while the preference have gained ¼ at 11¼. Bath Electric Trams debentures have risen 1 to 103, but London United Trams debentures have fallen 1 to 101. Anglo-Argentine Trams have gained ⅛ at 8½, and Buenos Ayres and Belgranos have also put on ⅛ at 3⅞. Cape Trams, however, have relapsed 1/16 to 1⅛ on the proposal to issue fresh debentures, and Calcutta Trams have declined ⅛ to 9⅜.

Southend.—The electrical engineer has been authorised to purchase a wattmeter, at a cost of £17, for registering electrical energy used in conjunction with the tramway cars. The main in Victoria-avenue is to be extended northwards. The electrical engineer in his last report states that during the last month mains have been extended in Victoria-avenue and Baxter-avenue, and five additional Nernst lamps erected on the Beach Estate. Forty-eight consumers have been connected, with an equivalent of 1,484 8 c.p. lamps. One consumer with 20 lamps has been disconnected. There are now 955 consumers with an equivalent of 56,496 8 c.p. lamps; 231 of those, with an equivalent of 9,614 lamps, have been connected during the six months ended Sept. 30. The armature of No. 2 machine at the generating station broke down on Sept. 18 owing to three bad connections in the armature winding; the same trouble, due to faulty workmanship

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having occurred before. The number of units generated for lighting during the month was 91,035, as against 64,690 for the same month last year—an increase of 41 per cent.—and the number of units for traction was 48,507, as against 48,086—an increase of 0·87 per cent.

Bath.—With regard to the recent inquiry into the application of the Town Council for sanction to the borrowing of the sum of £19 000 for purposes of electric lighting, the Local Government Board have decided to comply with the application so far as it relates to the borrowing of the sums of £17,120 and £1 000, the latter sum in respect of meters. In arriving at the sum of £17,120, the Board have deducted the following items of excess expenditure which they do not regard as being suitable subjects for a loan—viz: temporary works in fixing boilers, £36. 17s. 1d.; temporary erection of boilers, £505. 13s.; spare boiler tubes, £7. 16s.; spare valves and springs, £16. 2s.; spare armatures, £117. 5s.; spare brushes, £2. 0s. 11d.; temporary works on switchboard, £49 2s. 8d.; hand tools, £41. 9s. 4d.; timber, £21. 9s. 4d.—total, £797. 15s. 4d. A further deduction of £2 has been made on account of the excess expenditure on the steam and exhaust piping, and condensing plant having been incorrectly stated. The Board have also, in accordance with the usual practice, deducted a sum of £80 in respect of the debt outstanding on works which will be superseded in connection with the proposed alteration of the position of the present water-softening plant. The Board consider it very unsatisfactory that the estimate on which they sanctioned the loan of £30,000 should have been so largely exceeded.

Shoreditch.—At the last meeting of the Borough Council the Lighting Committee reported that in connection with the estimate approved by the Council on Jan. 17, 1905, they had considered the tenders for the supply and erection of two steam turbo-generators, etc., which were referred to them by the Council on July 18. Tender forms and specifications were applied for by 14 firms, of which one returned the documents at once as being unable to tender. Tenders were received from 11 firms, comprising 23 offers. These were carefully examined by the borough electrical engineer, and the committee, before coming to a final decision, reduced the tendering firms to three, with five offers. The committee gave the most serious consideration to these offers and the report of the borough electrical engineer, and having had an opportunity of seeing similar plant running under working conditions, they were of opinion that Messrs. Willans and Robinson's offer of Willans-Parsons turbines with Siemens generators was the most advantageous to the Council. The price was £18 475, the lowest for this combination, although not so low as other tenders for other combinations. The committee, therefore, recommended that the tender of Messrs. Willans and Robinson, of Rugby, for two of their Willans-Parsons turbines with Siemens generators, together with condensers, etc., for £18,475, be accepted, the firm agreeing to put in the necessary foundations and floor, and subject to the necessary contract being entered into. The report was, after some discussion, adopted. At the same meeting, Mr. Hall, in answer to questions by Messrs. Read and Edmunds, said the Lighting Committee were considering the tenders for bulk supply from the various surrounding authorities. They were of a very complicated character, and required a great deal of consideration, and he asked the Council to bear with the committee, and give them time to make a complete report.

Oxford.—The Electricity Committee reported at the last meeting of the City Council that in order to meet the continuously-growing demand, and to have an adequate margin of generating plant, an additional 200-kw. set of the most modern design has been installed at Osney works, and the steam capacity of the plant has been increased by an additional quick-steaming boiler, fitted with a superheater, which is calculated to produce steam with the lowest possible coal expenditure. An addition has been made to the main switchboard to control the new sub-stations that have been added, and the extensions of machinery in the remaining sub-stations. The central distributing station at Ship-street has been removed to a building specially designed for the purpose, at the rear of 23, Cornmarket street. An additional sub-station has been erected for the supply of the east of Oxford, in Union-street, Cowley-road. It is anticipated that in the course of a few days this sub-station will be in full operation. Additions have been made to the sub-station in the police passage, and are also in course of progress at the North-parade station. At the latter station a storage battery will be erected in order to more effectively regulate the pressure in the North Oxford district. The whole of the sub-stations have been overhauled, and are now entirely fireproof. The high-pressure mains feeding the sub-stations have been largely increased in capacity, and have been increased to an extent which it is calculated will meet the ultimate demand of the city both for lighting and the supply of motive power, either for traction or any other purpose. The low-tension mains of the company have been extended in Cowley-road, and the whole length of Iffley-road; also in many of the roads adjoining the Banbury and Woodstock roads. The use of the light has been largely extended in the University buildings, the Radcliffe Camera and the Indian Institute having been installed, while additions have been made at Merton and other colleges, and also at the University Museum. The demand for the light in the business and residential districts of the city continues to increase rapidly, and it is estimated that the number of lights added during the year will be above the average of former years.

Edinburgh.—The Electric Lighting Committee have adopted a report by Sir Alexander Kennedy upon the condensation of steam at the Dewar-place and M'Donald-road stations, suggesting that for Dewar-place station water could be obtained from the canal at Port Hopetoun, led into the works by pipes, and allowed to play on the steam-pipes, thereby condensing the steam into water, which would be again available for the boilers. The canal water could be let out again into the canal at Port Hamilton. For M'Donald-road station water could be drawn from and returned after use to the Water of Leith. In giving comparative statistics showing the increase of the electric light undertaking during the last 10 years, Mr. Alex. Stevenson, convener Electric Lighting Committee, Edinburgh Corporation, points out that in 1896 there was a revenue of £15,762 from 452 consumers, who brought 883,335 units. The Council now own two stations with a total capacity of 7,280 b.p. and 12 000 b.p. respectively. The output from the first was eight million units last year, while four millions were generated in the other, and during 1905 8,334 consumers paid £118,953 for 11 648,501 units. The aggregate of the capital expenditure up till May 15 last was £905,000. There is a reserve fund of £78,000. In each of the last three years about £28,000 was contributed to the sinking fund. In 1895 the cost for arc street-lighting was £20 per lamp. This expenditure has been gradually decreasing, and the Council have recently authorised the installation of 50 arc lamps of a new type at £9. 10s. per lamp. During the last five months the demand for current shows the same steady progress as in former years, supply having been applied for equal to 27,651 8-c.p. lamps. Mr. Stevenson concludes as follows: "The success of the undertaking is, no doubt, largely due to the fact that in Sir Alexander B. W. Kennedy and Mr. F. A. Newington, the consulting and resident engineers respectively, we have two men of outstanding ability at the head of affairs. The Council was also very happy in the choice of ex-Bailie Mackenzie as the first convener of the Electric Lighting Committee, for he devoted himself to the work in a manner which merited and received the admiration of his colleagues."

King's Norton.—At the last meeting of the King's Norton and Northfield Urban District Council, Mr. W. H. Davison presented the report of the Electric Lighting Committee, which stated that the Board of Trade were now prepared to consent to the proposed transfer by the Council of certain of their powers under the King's Norton Electric Lighting Order, 1898, to Callender's Cable and Construction Co., Bellias and Morcom, and the Electric Construction Co. The Local Government Board would be prepared to consider applications from the Council for sanction to loans in the matter, subject to the consent of the Board of Trade being obtained to the transfer, to the terms of the agreement being such as the Local Government Board considered satisfactory, and to the financial position of the Urban District Council interposing no obstacle. It had been ascertained that in order to establish a complete scheme of electric lighting within the district the original estimate of £35,000, made some years ago, would prove inadequate, and at a conference with the three companies an initial outlay of £50 000 was suggested. The committee understood that as the demand for current increased it might be necessary, by reason of extensions to plants, mains, etc., to increase the capital outlay to an approximate sum of £100,000. The committee recommended that they be authorised and empowered to continue the negotiations with the three companies above mentioned, and to settle with them the terms of the agreements to be entered into by the Council with the proposed new company: (*a*) for the construction and erection of the works, plant, and accessories for the purpose of providing the necessary works within the district; and (*b*) for the transfer (when the works were completed) of the powers and obligations of the Council, under the Electric Lighting Order, 1898, for a period of 21 or 25 years as might be agreed, and providing, *inter alia*, an option for the Council to take over the undertaking after the expiration of 10 years without any premium or compensation, or at any other period upon terms to be agreed, the above agreements being made subject to and conditional upon the sanction of the Local Government Board, the Board of Trade, and any other authority whose sanction or consent might be necessary. The report was adopted.

PROVISIONAL PATENTS, 1905.

OCT. 16.

20893. Improvements in holders for incandescent electric lamps and other electric fittings. John James Brooke, 6, Bank-street, Manchester.

20898. Improvements relating to electrolytic apparatus. Claus Nissen Rüber, 7, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Oct. 15, 1904, being date of application in Norway.) (Complete specification.)

20950. Improvements in controlling devices for electric motors applicable to the motors of elevators and the like. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company, United States.) (Complete specification.)

20951. Improvements in electric elevator control systems. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company, United States.) (Complete specification.)

20960. Improved non-reversing two-way running trolley pole for electrical traction. Hilary Quertier, 53, Chancery-lane, London. (Complete specification.)

20989. Improvements in machines for making incandescent lamps. Peter Banta, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 14, 1904, being date of application in United States. (Complete specification.)

20990. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

OCT. 17.

20995. Improvements in vessels for containing fused salts during electrolysis. Sherard Cowper Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

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21020. Improvements relating to rotary-current interrupters. John Otto Heinze, jun., 7, Southampton-buildings, London. (Complete specification.)

21034. Single-phase alternating-current motor with commutating poles. Englebert Arnold and Jens Lassen la Cour, 34, Castle-street, Liverpool. (Date applied for under Patents Act, 1901, Oct. 17, 1904, being date of application in Germany.) (Complete specification.)

21038. Improvements in or relating to the electrical transmission of power on motor vehicles and boats. Herbert McNulta, 57, Barton-arcade, Manchester. (Date applied for under Patents Act, 1901, Dec. 10, 1904, being date of application in United States.) (Complete specification.)

21064. Improvements in and relating to alternating-current electric motors. The British Thomson-Houston Company, Limited, Hans Sigismund Meyer, and Paul Alphonse Mossay, 83, Cannon-street, London.

21068. Improvements in apparatus for controlling electrically-propelled trains. Siemens Bros. and Co., Limited, and Francis Lydall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21070. Improvements in connection with polyphase alternate-current electric commutator machines. Elektrizitäts-Aktien-Gesellschaft vorm. W. Lahmeyer und Co., 47 Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Oct. 17, 1904, being date of application in Germany.) (Complete specification.)

21071. Improvements in and relating to conduits or casings for electric conductors. Richard Henry White Knight and Ludwig Nagel, 323, High Holborn, London.

21095. Method for the production of hollow poles of concrete with a metal insertion forming an interconnected framework for electric conductors and the like. Hans Aebi, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 21, 1904, being date of application in Germany.) (Complete specification.),

Oct. 18.

21108. Improved non-slipping device for locomotive, steam and electric traction engines. Alexander Marr and Thomas Chalmers, 179, Maraland-road, Brooklands, Cheshire.

21145. Improvements in and relating to methods of collecting and conveying electric currents. Siegfried von Ammon, Oswaldestre House, Norfolk-street, Strand, London.

21162. Telephone receivers and the like. Rod B. Bumiller, 8, Quality-court, London. (Complete specification.)

21173. Improvements in installations for electrically igniting the charges of internal-combustion engines. Arthur Harold Nicholson, Birkbeck Bank-chambers, Chancery-lane, London. (Complete specification.)

21181. Improvements relating to electrical measuring instruments. Thomas Wilcock Varley 7, Southampton-buildings, London. (Complete specification.)

21198. Improvements in or connected with the pole-pieces of dynamo-electric machines. John Herbert St. Hill Mawdsley and John Wesley Burley, Norfolk House, Norfolk-street, Strand, London.

Oct. 19.

21202. Improvements in electric light fittings. Veritys Limited and Frederick William Thorpe, Plume-street, Aston, Birmingham. (Complete specification.)

21204. Improvements in apparatus for moving electrically the points on electric tramways and railways. Joseph Patrick Tierney and John Malone, 44, Booterstown-avenue, Booterstown, county Dublin.

21223. Improvements in electric step motions. Arthur George Brown, Arthur Whitten Brown, and Edward Claire Whelan, 17, St. Ann's-square, Manchester.

21224. Improvements in conduits for electric cables and the like. The Simplex Steel Conduit Company, Limited, Frederick Huggins, and Laurence Maxwell Waterhouse 34, Castle-street, Liverpool.

21228. Improved form of high-tension distributer. Sidney Adolph Horstmann, 13, Union-street, Bath.

21243. A new or improved composition particularly adapted for purposes when insulation is required. Caesar Marter, c/o. J. W. Stocker, 150 Fenchurch-street, London.

21248. An electric machine for use in automobiles and for other purposes. Jean Antoine Edouard Pellorce, 115, Cannon-street, London.

21253. Improvements in dynamometric governors. Joseph Ord Richardson, 46, Lincoln's-inn-fields, London.

21261. Improved arc lamp suspender. James Ruddick and Henry Ernest Fry, 24, John-street, Bedford-row, London.

21268. Improvements in or connected with magneto-electric apparatus for igniting the charge in internal-combustion motors. Maurice de Saint-Romain, 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, April 27, 1905, being date of application in France.) (Complete specification.)

21268a. Improved construction of accumulators or secondary batteries. Alexander Elias Dakhyl, Antonio Galanti, and Hanna Nassyf Dakhyl, 175, Fleet-street, London.

21279. Improvements in electric batteries. Arthur John Fippard, 33, Cannon-street, London.

21289. New or improved apparatus for indicating and obviating leakage from conductors of electricity. John Miles Moffat, Rueben James Bott, John William Manley, and the Electric Safety Appliances Company, Limited, Norfolk House, Norfolk-street, Strand, London.

21290. Improvements in protective devices for automobile motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Oct. 20.

21383. A new or improved method and means of hermetically sealing a wire or metallic electric conductor or other substance through or into vitreous substance such as lead Jena or quartz glass. Charles Orme Bastian and George Calvert, Birkbeck Bank-chambers, Chancery-lane, London.

Oct. 21.

21386. Improvements in or relating to electric lamps of the character known as vapour lamps. Robert Francis Venner, 6, Old Queen-street, Westminster, London.

21391. Electro-deposition of zinc. James Swinburne, 82, Victoria-street, London.

21439. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

21444. A new or improved electromagnetically operated heat-supply valve for heating and ventilation. Fritz Kaeferle, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, July 17, 1905, being date of application in Germany.) (Complete specification).

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 9.

1904.

22164. Apparatus for use in the distribution of alternating electric current. Berry.

22369. Means or apparatus for regulating the difference of potential between portions of electric current distributing systems. Berry.

22522. Arc lamps. Wellington and Daniell.

22631 Methods of exciting electromagnets by alternating electric currents. Latour. (Date applied for under International Convention, Oct. 20, 1903.)

22962. Vacuum brake apparatus for electrically-operated and other trains. Gresham, Gresham, and Kiernan.

23205. Regulation of alternating electric distributing systems. British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

24620 Electric clocks and the like. Parsons and Ball.

25331. Treating the contents of electrolytic cells. Hargreaves.

26588. Systems of electrical distribution. British Thomson-Houston Company, Limited. (General Electric Company.)

26589. Electric switches. British Thomson-Houston Company, Limited. (General Electric Company.)

26603. Apparatus for forming devices for holding or suspending overhead electric conductors, or trolley wires or the like. Winslow.

26849. Apparatus for electro-deposition of metals. Bailey.

27201. Electrostatic wattmeters and watt-hour meters. Wilson.

27235. Emergency brakes for railway and tramway vehicles or trains. British Thomson-Houston Company, Limited. (General Electric Company.)

27404. Machines for making compound lengths of wire, rods, or the like from two metals and for counting and arranging the same in boxes. British Thomson-Houston Company, Limited. (General Electric Company.)

27763. Coin-freed mechanism. British Thomson-Houston Company, Limited, and Kingwell.

29138. Electric dry batteries. Day. (Empire State Dry Battery Company.)

29231. Apparatus for opening and closing electric circuits at predetermined times. Gunning.

1905.

1009. Electrical connections for secondary batteries or accumulators. Elieson.

1224. Trolley retrievers for electric tramcar and the like. Earll.

1400. Incandescent electric lamp sockets. British Thomson-Houston Company, Limited. (General Electric Company.)

1762. Means for electrically turning on and lighting up gas lamps, and particularly those whose burners are beyond reach of hand. Pare.

2579. Protector or cover for electric conductors, pipes, or the like. Wilhelmi.

3049. Combined electric coupling and two-way plug. Stokes.

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2739. Protective devices for electric circuits. British Thomson-Houston Company, Limited. (General Electric Company.)

4353. Compensating poles for dynamo-electric machines. Elektrizitäts Act. Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, April 16, 1904.)

4881. Electromagnetic brakes. British Thomson-Houston Company, Limited, and Larzelere.

5042. Electrically-operated pianos. Weber.

5049. Electric insulators. Bloxham. (Goffin.)

7036. Electrically-propelled vehicles. Weiss.

8524. Safety appliances for exposed electric conductors. Thorne.

8631. Dry battery. Weatherill.

10669. Combined electric switches and fuses. Callender's Cable and Construction Company, Limited, and Ward.

11036. Alternating-current measuring instruments. Conrad and Bradshaw. (Date applied for under International Convention, May 27, 1904.)

11362. Galvanic battery plates. Hubbell.

13383. Electric conductors and methods of insulating the same. British Thomson-Houston Company, Limited. (General Electric Company.)

13425. Cluster electric lamp sockets. Fairweather. (Benjamin Electric Manufacturing Company.)

15591. Devices for electromagnetically influencing the arcs of electric arc lamps working with alternating current. Carbone.

17146 Particular type of rheostat. Veritys Limited and Gott.

17170. Device for conveying fresh air, telephonic, and other messages to the interior of submerged submarines, applicable also for other purposes. Smith.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅞-1
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	6¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2¾-2⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅛-¼
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100	..	93-97
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5⅛-5¼
Crompton and Co.	3	..	1⅜-1⅞
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅜-1⅝ xd
—— "A" Shares, 01-017,139	5	..	2-2¼ xd
—— 5 per cent. Debentures	100	..	92 97
—— 4 per cent. Deb. Stock, Red.	100	..	85-90
Electric Construction, Nos. 1 to 112,100	2	..	⅜-½
—— 7 per cent. Cumulative Pref.	2	..	1⅜ ⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	..	96-98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-100
W. T. Henley's Telegraph Works, Ordinary	5	..	12 13
—— 4½ per cent. Preference	5	..	⅝-¾
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15¼-16½
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	33½-35½
—— 5 per cent. Bonds	100	..	102 104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	12¼-12⅜
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-10⅛
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11⅛-12⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	107-109
Bromley (Kent) Electric Light and Power Co.	5	..	5⅛-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	9⅜-10⅛
—— 7 per cent. Preference	5	..	9¼ 9⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	8¼-9⅜
—— Nos. 60,001-80,000	5	..	8⅞ 9⅜
Cambridge Electric Supply Company, £10 Ord.	8	..	12⅛-13⅛
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	105-108
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	7⅛-8
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	..	4⅜-5
—— ditto (1903) 40,001-80,000	5	..	4⅜-5⅛
Chelsea Electricity Supply	5	..	5⅜-6⅛
—— 4½ per cent. Debentures	100	..	110-112
City of London, Ordinary	10	..	12¼-13
—— 6 per cent. Cumulative Pref.	10	..	13½-14¼
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104-106
County of London Electric Supply, Ordinary	10	..	9⅜-10½
—— 6 per cent. Cum. Pref.	10	..	12⅜-12⅝
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	104-106
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6⅛
—— 6 per cent. Cum. Pref.	5	..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100	..	109-111
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	8¼-8⅜ xd
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	101-104
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	..	31/32-1 1/32 xd
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	12-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10¼
London Electric, Ordinary	3	..	2-2⅛
—— 6 per cent. Pref.	5	..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-102
Metropolitan Ordinary, 100,001-300,000	5	..	10 10¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅜ 5⅞
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98 100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	102-104 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5	..	8-8⅛
—— do., 57,0 0-75,000	5	..	8-8⅛
—— 5 per cent. Pref., 1-57,00	5	..	6¼ 6⅜
—— do., 57,0 0-75,0 0	5	..	6¼-6⅜
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98 100
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	..	6⅜ 6⅞
—— 4 per cent. Debenture Stock	100	..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ord 1-12,000	5	..	2 2⅛
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3¼ 4
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8⅛ 9⅛
—— 3½ per cent. Deb.	100	..	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅜-4⅞
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5-5⅛
Westminster, Ordinary	5	..	11⅜-12⅛
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5	..	5⅛-5⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5	..	5⅜-6⅛
—— Ord.	5	..	8⅛-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	104-106
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9⅛-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	¼-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3⅜-4⅛
—— 4½ per cent Deb. Stk., Red., Prov Certs. all pd.	100	..	98-98
British Columbia Electric Railway Co., Ord. Def.	100	..	126-129
—— Ord. Pref.	100	..	109-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	105-108
—— 4 per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c. xd
—— 4 per cent. Vancouver Power Deb.	100	..	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	9⅜-10⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	11-11⅛
—— 5 per cent. Perpetual Debenture Stock	100	..	121-123
—— 4½ per cent. 2nd Deb. Stock	100	..	99-101
Buenos Ayres and Belgrano Trams.	5	..	3 11/16-3 15/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	6⅝-5⅞ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5⅛ xd
—— 5 per cent. Deb. Stock, Red.	100	..	106-108
—— Prov. Cert., all paid	100	..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,268	5	..	8-9⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	3¾-4⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13¼-14⅛
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,0 0	10	..	15-16
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14⅛
—— 4 per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2⅛-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8⅛
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9⅜-10⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	⅛-1¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum Pref	10	..	9⅜-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8⅜-9⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100	..	102-105
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,152 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	..	91-93
—— 4 per cent. Pref.	100	..	101-103
—— " " deferred	100	..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	113-116
Liverpool Overhead, 5 per cent Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-100½
Waterloo and City, Ordinary	100	88-90

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	112-113
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref	10	13-15
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d	£	d
Aberdeen Corporation	Oct. 21	1,180	1,234	— 54	— 1,645A	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 21	195	215	— 20	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 22	957	1,002	— 45	— 6·9	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 21	332	316	+ 66	—	2	2	,, 31	17,133	4,7·9,7·8	265,525	·86	14·5	8,866	—
Blackburn Corporation	,, 18	831	850	+ 21	+ 965	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 19	483	582	— 119	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 21	237	278	— 21	— 830	16½	16½	Dec. 31	31,846	2,325 677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 22	1,875	1 815	+ 60	—	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 18	1,224	1,252	— 28	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 21	4,080	4,414	— 334	— 7,036	96	77	,, 31	230,085	47,108,000	5,033,392	1·172	10·927	2,396	—
Brighton Corporation	,, 22	813	901	— 88	+ 626	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 20	4,562	4,837	— 275	—	51½	51½	Dec. 31	259,739	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 21	1,032	1,016	+ 16	—	10 60	10·60	March 3	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 22	279	331	— 65	— 1,233	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 14	1,983	1,9 2	+ 66	+ 330	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 21	156	178	— 22	— 531	8·5	8·5	Dec. 31	10,713	2,935 00?	359,756	—	7·14	—	5·18
Central London Railway	,, 21	7,106	6,699	+ 407	— 1,502	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65 10	57,931	35·80
City and South London Railway.	,, 22	2,909	2,806	+ 103	— 428	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	,, 19	450	476	— 26	+ 764	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	Sep. 1	250	251	— 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Oct. 21	225	198	+ 7	—	4½	4½	,, 3	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 20	92	109	— 17	+ 64	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 20	3,553	3,822	+ 269	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dublin S. District, Electric	,, 20	796	896	— 100											
Dundee City Tramways	,, 18	834	819	+ 75	+ 932	25	25	May 15	44,695	1 ,611,525	933 006	·90	11·49	1,943	7 13
East Ham Corporation	,, 21	712	654	+ 58	+ 2,655	23	23	March 31	36,652	13,089,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 21	14,948	14,922	+ 26	+15,800A	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	Sep. 20	1,803	1,618	+ 185	+ 1,761	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	Oct. 21	1,2 5	1,283	+ 42	+ 1,119	35	35	,, 3	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 21	2,166	2.167	— 1	+ 574	27	26	,, 31	112,651	27,102,921	2,910,693	1	9 29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 18	105	126	— 21	— 761	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 18	185	208	— 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 21	5,463	5,480	— 17	—	89	89	March 25	298,233	64,223,646	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 21	1,976	1,813	+ 163	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 14	10,649	10,533	+ 116	+ 8,840	103	103	,, 31	547,625	116,642,663	12 166,419	—	—	—	—
Liverpool Overhead Railway	,, 22	1,3 6	1,495	— 109	— 972A	6·57	6·57	June 30	8 ,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 14	14,484	13,145	+1,339	+63,571	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 21	152	165	+ 13	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 19	114	141	— 27	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 21	12 109	12 241	— 132	+15,422	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4.299	6·99
Metropolitan District Railway	,, 22	8,255	6,993	+1 26	— 905	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 22	17,732	17,612	+ 120	+ 3·5	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 21	120	117	+ 3	+ 261	—	2¾	,, 31	6,159	1,9·2,547	206,358	·82	7·14	2,233	—
Newcastle-on-Tyne Corporation	,, 21	3,666	3,874	— 108	+ 2,984	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 22	1 632	1 218	+ 334	+13,448	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 21	1,506	1,669	— 163	+ 1 222	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	,, 19	549	609	— 60	— 331	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 21	770	377	+ 393	+17,123	6½	44	,, 31	14,881	2 837,110	336,547	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 19	426	435	— 10	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 23	3,991	4,109	— 118	—	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 22	4,742	4,6·9	+ 53	+ 6 676	65¾	52½	,, 25	240,565	63,952 283	6,043 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 18	868	913	— 45	— 393	—	18	,, 31	49,365	9,294,771	1,108,369	1·27	11 02	—	7·85
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 13	780	489	+ 291	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 22	1,188	1,228	— 40	+ 980	20	20	,, 31	64,858	15,364,463	1,495,685	1 004	10 36	—	6·37
Swindon Corporation	,, 18	171	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D C.	,, 21	662	678	— 16	+ 640	11·85	10 5	,, 31	38,768	7,412.881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 19	1,896	1,060	+ 836	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 18	726	—	—	—	—	7½	,, 31	36,757	7,666,786	869,508	—	10·898		

* Including steam trains. † And 88 miles of interlacing track. a Train mile. b Per mile of single track. A Half-year's figures.

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NOTES.

British Association.—The General Purposes Committee held a meeting on Tuesday last in order to decide upon the town where the association should meet in 1907. Invitations were considered from Leicester and Dublin, and it was decided that, having regard to the fact that no meeting had ever been held in Leicester, to accept the cordial invitation from that town.

Book Received.—"Die Drahtlose Telegraphie," by Dr. Eugen Nesper (Julius Springer, Berlin. 3s.). This treatise deals with the influence of wireless telegraphy on economics, and treats especially with the "Telefunken" system. There are 29 illustrations, and the value of the work is further enhanced by the addition of a patent and literary bibliography dealing with the subject.

New Pacific Cable.—It is reported that information has been received at the North German Cable Works at Nordenham, announcing the successful laying of a cable between Shanghai and Yap, the principal island of the Caroline group. The work was carried out by the cable ship "Stephen," and the final test showed that the electric condition of the cable was perfect. The cable was opened for the reception of messages on the 1st inst.

Military Telegraphy.—For some weeks past the French War Office has been actively engaged in conducting experiments with a view to securing reliable communication for military purposes between Paris and the eastern garrison towns by means of wireless telegraphy. Though many difficulties had to be encountered, these were eventually overcome, and after the system had been extended as far as Vardun and Chalons, the important stronghold of Belfort was furnished with apparatus for wireless telegraphy. There is now complete and permanent communication between Paris and all the eastern garrisons.

Post Office Changes.—Two important changes are announced in the personnel of the Post Office staff by the retirement of the controller (Mr. E. Trenam) and the deputy controller (Mr. J. W. Eames), which took effect on Tuesday last. The new controller, whose appointment is officially announced, is Mr. A. E. Eames, brother of Mr. J. W. Eames. Mr. A. E. Eames has been the senior assistant to the controller. The new deputy-controller is Mr. J. Newlands, who in 1901 succeeded Mr. Trenam as traffic manager, the appointment he now vacates. A very pleasant and interesting ceremony took place at the Central Telegraph Office on Tuesday last, when Mr. E. Trenam, the late controller, was presented with a gold watch and chain as a token of esteem and regard by his London and provincial colleagues.

Wireless Telegraphy.—Reports continue to circulate recording the development of the system of wireless telegraphy, and it is now stated that two new vessels, which are being built for the Cunard line, are to be equipped with long-distance transmitting and receiving instruments, at a cost of £4,600 each. While crossing the Atlantic, Mr. Marconi is reported to have received wireless messages from both England and America, but owing to the fact that the "Lucania," on which he was travelling, was not fitted with instruments sufficiently strong, he was unable to send replies. It is further stated that the Navy Yard at Washington recently intercepted a wireless message from the "West Virginia" to the cruisers "Colorado" and "Pennsylvania," a distance of 1,100 miles, mostly overland. Communications with the "West Virginia" lasted three hours, until the noise of work being resumed in the yard interrupted the messages.

Heat Engines.—In his presidential address to the members of the Birmingham University Engineering Society, on "The Possibilities of the Heat Engine," Prof. F. W. Burstall pointed out that, owing to the advanced stage which the science of thermodynamics has reached, we can easily predict the lines on which the heat engine of the future will be developed. He considers that the steam-engine has reached its maximum efficiency, and that much more development in this form of engine cannot be expected, owing to its great loss of economy. He looks in the future for the utilisation of the sun's heat direct for heat engines. Discussing the prospects of the gas engine, Prof. Burstall said that the future ideal production would be an engine with a very high compression, thorough scavenging action, and of the four-stroke cycle. He considered that the outlook for the success of gas-turbines was remote, the practical difficulties in their way being so great.

Electrical Driving.—The superiority of electricity as a driving force was demonstrated in a lecture which Mr. Percy Rosling delivered at a meeting of the Leeds Association of Engineers. He treated his subject from a commercial standpoint, and enumerated the points to be considered when an electrical drive was brought into comparison with a purely mechanical one. As to the question whether it was more economical to be supplied with current from a private generating plant or from a central power station, the lecturer held in favour of the latter as a source of supply. He claimed that, in order to bring the capital spent on generating plant into line with the capital used in a business generally, it was necessary to debit it with an adequate percentage. There was, therefore, a considerable saving due to the extra output obtained through the greater average speed of the electrical drive, as, moreover, the use of induction motors eliminated the loss due to the slips of the main and intermediate belts.

Steam v. Electricity.—Addressing the Wolverhampton and District Engineering Society, of which institution he is president, Sir Alfred Hickman laid stress upon the necessity for the adoption of up-to-date methods in the factory and the utility of scientific instruction to those engaged in engineering. Commenting upon the change in motive power which had taken place in connection with manufacture in the Midlands, he asserted that the supremacy of steam had not only been challenged, but superseded. For his own part, he had put on the scrap heap 24 steam-engines, and instead utilised electric motors supplied from a generating plant with gas-engines as prime movers. The consequent saving in fuel alone amounted to £7,500 a year. He believed that soon all steam-engines would be done away with or kept on one side for emergencies. The principle at the bottom of this change was that, instead of pressure, they had explosion and a higher thermal efficiency. This seemed to be revolutionising the whole system of motive power in the country.

Telephone Cable.—One of the problems which confronts the telephone engineer is to obtain a cable on which the losses occurring in the line may be minimised, and one which may be at the same time commercially possible. Experiments, however, have been made on a new type of cable in Sweden, and the results are said to be extremely favourable. In manufacturing these cables, the intention had been to reduce their capacity to a minimum by passing the bare copper wires through perforated discs of insulating material and introducing the cable thus formed into an iron tube. The distance of the two conductors of the same line is 1·7mm., that of two lines 2·8mm., and the distance of the conductor and

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iron sheath in the most unfavourable case 5mm. By this arrangement the capacity of the internal conductors of 2mm. diameter was reduced to 0·00985 microfarad for 1 km. and that of the outer conductors to 0·0182 microfarad per kilometre. The copper wires are wound helicoidally to avoid induction effects. If the above distances be increased to 20mm., 36·5mm., and 10mm. respectively, the capacity will be 0·00935 and 0·0125 microfarad.

London Supply of Power.—We gather that the fight for the right to supply power in bulk throughout Greater London will be even more keen in the 1906 session of Parliament than it was this year. The number of applicants will be larger, and the opposition between the rival promoters will lead to a harvest both for the parliamentary Bar and for expert witnesses. If our information is correct, there will be two municipal applicants for powers—*i.e.*, the London County Council and an association of a number of metropolitan borough councils. Amongst the companies applying, the Administrative County of London Company, which, under the direction of Mr. C. H. Merz, was so nearly successful, will be again to the fore, and the rival applications will include one from the City of London Electric Lighting Company. The County of London Electricity Supply Company are also applying for a wider area for power distribution purposes, and a combined application, in which the Westminster Electricity Supply and St. James's and Pall Mall Companies are interested, is also to be made. All the applicants cannot receive the further powers they seek, and it is exceedingly likely that the session will terminate before the usual time in August, so that no decision may be arrived at on the question.

Elements of Iron.—At the opening meeting of the Sheffield Society of Engineers and Metallurgists, a lecture on "The Behaviour of Phosphides and Carbides when together in Iron" was given by Mr. J. E. Stead. Results were given confirming Prof. Arnold's and Mr. McWilliam's observation that solid phosphide of iron diffuses into solid iron and steel at elevated temperatures. It was also shown that when iron phosphorus and carbon are associated in local patches at high temperatures, on cooling the steel slowly, the carbon is expelled into the surrounding iron or steel, and that this peculiar behaviour is responsible for the existence of the white ghost lines or threads in large forgings. The lecturer proved that on reheating such annealed steels the carbon diffused back again into the carbonless portions, and could be retained there by comparatively rapid cooling. The micro-structure and mechanical properties of a series of steels were described, and proof was given of the existence of three distinct modes of segregation: (1) the microscopic in the body of the crystal itself; (2) the minor segregations which were entangled at the junctions of the crystallites; and (3) the major or axial segregation well known to all steelmakers. The lecturer suggested that if large ingots of fluid steel were revolved on their axes during the freezing period, probably the ghost lines would not appear in the forging, or if they did they would be very small; the reason for this belief being that motion of the fluid steel would tend to the production of small crystals, and small entanglements of the segregated portions, whereas illustrations were given showing that sometimes the crystals in very large ingots were as much as 7in. in length.

Air Conductivity.—During a recent trip from Liverpool to Boston, Mr. J. E. Burbank was afforded an opportunity for making some observations on the specific conductivity of the air at sea. In the September issue of *Terrestrial Magnetism and Atmospheric Electricity* of Baltimore there appears a description of the instrument employed, which was a new one devised by Dr. H. Gerdien. It consists of a tube about 20cm. in diameter, in the centre of the lower side of which is a side tube connecting with an electroscope. The inner electrode consists of a thin brass tube with hemispherical ends 1·4cm. in diameter, placed in the axis of the tube and connected with the leaf holder. In the rear part of the tube is a fan driven by hand by means of a worm gear. This fan drives a current of air through the tube, and observations made manifest that the velocity of the air currents through the tube may vary within wide limits without changing the observed values of the conductivity. During the voyage, however, it was found convenient not to use the fan, but to allow the wind to blow through the tube. This method was found to be just as reliable as when using the fan. By means of the latter instrument, the time required for making observations was greatly reduced, satisfactory readings being obtained in from three to five minutes. The excellence of its insulation was shown during a dense fog which prevailed, the inner becoming so damp as to necessitate its frequent removal for the purpose of drying. Leakage tests made after the observations, however, showed no appreciable fall of potential. The results showed conductivities varying from one-third to two and one-half times those of the air at Göttingen and at Cheltenham, Md. On one occasion a heavy fog prevailed, and during that time the conductivity fell to about one-tenth that of the Göttingen air. The fog appeared to affect both kinds of ions to nearly the same extent. Other fogs showed the same effect of decreasing the conductivity, but none to the same extent just mentioned.

Electrical Engineering Progress.—At the annual conference of the Leeds Section of the Institution of Electrical Engineers, Mr. A. B. Mountain delivered an address on the development of electricity supply undertakings during the last 10 years. He gave some interesting figures showing the advance which had been made since 1894, when there were 60 undertakings with a capital expenditure of £6,107,680 as against 445 undertakings with a capital expended of about £61,962,000 at the end of 1904. The consuming devices reduced to the equivalent of lamps had increased about tenfold, whilst the number of units sold increased about 15 times, the price of units meanwhile having decreased by 48 per cent. The uncertainty of electricity works proving financially successful, and the small scale upon which such works were planned, together with small generating plants installed, were some of the many difficulties which had to be encountered 10 years ago, and led to the growth of capital expenditure at the same rate as lamps connected. Present experience proves that by providing large generating plant, the capital expenditure would be reduced 50 per cent. and that mains could be provided at a cost of about 20 per cent. less than in 1894, and, owing to the fact that the pressure of supply has been doubled, such distributing mains will now supply four times the number of lamps. Mr. Mountain is at a loss to understand the capital expenditure and lamps connected increasing at the same rate. He considers the explanation is due to the extension of works and mains having been carried out upon extensive lines to meet future requirements, in which case further lamp connections should improve to a very large extent the results obtained from undertakings. He instances the case of Huddersfield, where the total capital expended upon the undertaking per 8-c.p. lamp was, in 1894, £3, and is now £1. 5s. 1d. The conclusions to be drawn from Mr. Mountain's survey of the progress of electric supply undertakings are that the introduction of

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large generating plants will lead to ultimate economy, and that reduced charges will still further enormously increase the output of energy for both lighting and motive power purposes.

Electrolytic Metal Wires. — The possibility of obtaining thin metal wire by electrolytic means is discussed in a paper contributed by M. Henri Abraham to the French Academy of Sciences, in which the author suggests a method somewhat similar to the well-known Wollaston process of making platinum wires. The wire which is to be reduced in cross-section is taken as positive electrode in an electrolytic bath; its electrical resistance is measured from time to time, the current being stopped as soon as the cross-section of the wire has attained the figure required. The electrolytic bath should be rather dilute so as to have a very great resistance, when the current will be uniformly distributed throughout the length of the wire without its being necessary to give the two electrodes a strictly determined relative position. In fact, nearly the whole of the resistance of the liquid will be in the immediate neighbourhood of the thin wire. Distilled water containing some thousandths of its weight of copper sulphate can be used as a bath when dealing with copper wire, or else a similar amount of silver nitrate if silver wires are to be treated. The operation should be controlled so as to be rather slow, in order to allow the metallic salt forming around the wire to diffuse into the bath. Unless this precaution be taken, electrolysis will show a rather unstable behaviour. Wherever the current happens to be too strong, an excess of salt will be formed; when the bath becomes too conductive, the current will augment and burn the wire. If, on the other hand, such salt as has been found be allowed to diffuse into the bath, the behaviour of the electrolysis will prove quite stable, as the thickest parts of the wire are preferably attacked, owing to the resistance of the neighbouring liquids being smallest in the neighbourhood of these points. Currents of about 0·01 ampere per square centimetre wire surface are especially convenient for the operation. The current intensity should be reduced as the wire becomes thinner, the preparation of a satisfactory wire lasting about half an hour. The author states that wires treated with necessary caution show sufficient homogeneity to allow their new disruptive load to be calculated approximately by dividing their former disruptive load through the ratio of their present and their initial electrical resistances.

Edinburgh Tramways.—Some time ago a motion was passed by the Corporation to remit to the consideration of the Tramways Committee the question of policy to be pursued by the Corporation in relation to its tramways. The results of the deliberations of this committee have been embodied in a lengthy report prepared by the town clerk, Mr. T. Hunter, in which the powers and obligations of the company are fully set forth and the whole situation exhaustively dealt with. At the outset, Mr. Hunter states that it is not desirable that an independent body, whose main object is the acquisition of gain, should possess any permanent exclusive rights in or over the streets of a large city where the local authority is able to take up the service. He strongly insists, however, upon the undertaking, if controlled by the municipality, being managed with prudence and on sound business principles, otherwise the results are likely to be disastrous. The whole history of the tramways undertaking is described, and it is pointed out in the report that the Corporation, by their actions, have virtually accepted the position as owners of the city tramways. At present the lines are leased to a private company, and the lease does not expire until 1919, so that, unless it is sooner terminated by agreement or otherwise, the question of the Corporation working the trams will not arise until. The report, however, urges the Corporation to take into consideration the course which should be followed by them at the termination of the lease, and make such arrangements as would tend to secure efficiency during the lease and continuity of traffic on its termination. Lengthened consideration is given as to the relative merits of the cable and electric systems, and the advice of Prof. Kennedy has been sought on the matter. He is of the opinion that Edinburgh is not a place in which the overhead traction system can be worked advantageously. He avers that the severe gradients, with its necessary limits of speed, would militate considerably against the electric system, and that under the circumstances the working costs per car mile will be probably considerably lower if a well-designed cable system is adopted. The cable system is at present in vogue in the city, but it may be expedient to adopt electric traction for future lines. The Edinburgh tramways are a profitable concern, and yield a net profit of £100,000 per annum. Out of the rent paid by the lessees, the Corporation, besides meeting the interest and providing a sinking fund for the redemption of the tramway debt, apply £5,500 per annum to the relief of the city rates. The result of past years' workings attest that the undertaking has capacity for expansion of traffic, and forms a valuable asset.

Phasemeters.—In a paper which he delivered to the members of the Physical Society on Friday last, entitled "The Theory of Phasemeters," Dr. W. E. Sumpner elaborated the results of some mathematical investigations and laboratorial experiments which he had conducted concerning the nature of these instruments. His study resolved itself into an examination of the behaviour of multiple magnetic circuits when actuated by independent currents, and his main conclusions may be thus summarised: Phasemeters for multiphase circuits are all equally accurate on balanced loads provided they have been correctly calibrated and possess no faults due to purely mechanical causes. Their accuracy is not affected by variations in wave-form or in current frequency. The calibration of the scale is affected by the number of coils used in the instrument, by the ratios of the ampere-turns used with these coils, by the distribution of the windings, and by the magnetic nature and properties of the magnetic circuits, especially if these contain iron; but the accuracy of the indications is not dependent upon any of these considerations if the working of the instrument is satisfactory from a mechanical point of view. Phasemeters can be simply and accurately calibrated for balanced loads by means of a direct-current method of test. The error of phasemeters on unbalanced circuits is generally serious for loads which are badly out of balance. The error, like that of a wattmeter, increases rapidly as the power factor of the load diminishes. It can only be reduced at the expense of complication in the instrument, by increasing the number of coils used in the fixed and moving systems, and by arranging the coils and magnetic circuits to be symmetrical in regard to one another. If the true power factor of the load is $\cos\phi$, the reading of the instrument is $\cos\phi + \theta \sin\phi$, where θ is the phase error due to the unbalanced load, and is product of two factors one of which is the maximum value of θ determined by the amount the load is out of balance, and the other may have any value between $+1$ and -1 and determines whether the instrument reads high or low. The maximum value of θ is as follows: (1) For an instrument consisting of a single coil for one-coil system, and of either two or three coils for the second system, $\theta = \epsilon\sqrt{2}$. (2) For a symmetrical instrument containing three coils in one system

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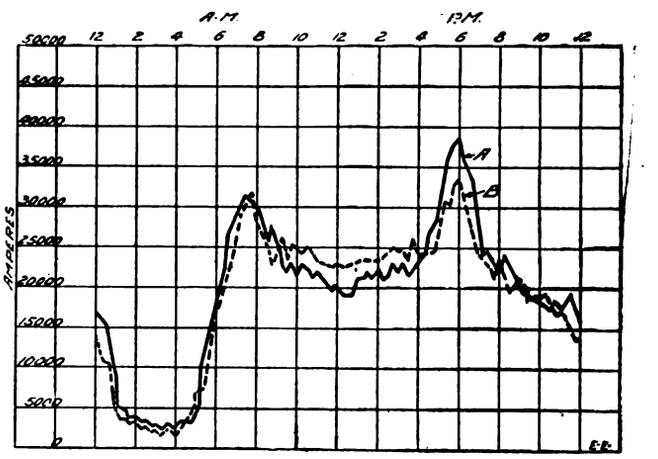
and two in the other, $\theta = \frac{1}{3} \epsilon \sqrt{2}$. (3) For a mathematically symmetrical six-coil instrument, $\theta = 0$, where ϵ is the square root of mean square of the fractions ϵ_1 ϵ_2, ϵ_3, by which the three load currents differ from their mean value. It is also very approximately the arithmetical mean of the quantities ϵ_1, ϵ_2, ϵ_3, or two-thirds of the greatest of these three quantities, so that $\epsilon \sqrt{2}$ is essentially the same as the greatest of the quantities ϵ_1, ϵ_2, ϵ_3.

Central-Station Circuits.—The relative advantages and disadvantages of overhead and underground wires were discussed in the course of a paper delivered at the sixth annual convention of the Illinois State Electrical Association by Mr. H. B. Gear, with especial reference to the conditions in medium-sized towns. In America overhead lines have been employed almost exclusively by central-station companies in all except the large cities, principally because by means of this system a given amount of business can be transacted between generating station and consumer with a minimum investment. The maintenance of overhead lines is comparatively easy, but their exposure subjects them to a high rate of depreciation on account of the action of the elements. The principal advantage claimed by Mr. Gear for the underground conduits is that it is better able to withstand stormy elements, and in this respect is a greater security towards continuity of service. The disadvantage of the system, however, is that the necessity for repairs involves a larger expense and requires a longer time for completion than does the overhead. The failure of joints between overhead and underground lines on cable poles, due to the action of the elements, is a detail which has proved very troublesome. In order that some idea may be had of the elements entering into the cost of underground construction, the example of a system such as would be required for a city of 15,000 to 25,000 in a business district is chosen by the author to illustrate his case. Large manholes are provided at street intersections for the purpose of allowing ample room for the installation of transformers. Smaller manholes are provided at points where laterals are installed for services. Four ducts are provided, although only two of them are occupied by the primary and secondary cables which have been included in the estimate. The average central station has some series arc or 500-volt power service which would occupy the two remaining ducts, and though these were not occupied by such circuits, it would be advisable to instal them for future use. The primary cables are of No. 6, as this is the smallest size which it is practical to use for mechanical reasons. The secondaries have been figured on the three-wire system, the copper being No. 2 B. & S. throughout. Transformers of 15 kw. to 25 kw. capacity are assumed to be required to carry the load, a total capacity of 125 being assumed. The value of transformers is not included in the figures given, as they would be the same for either overhead or underground construction. The cost of installing the system above described, assuming that it were done as a job of under-grounding overhead lines, would be about £1,800. The cost of overhead lines of equivalent capacity to distribute the load provided for in the above-described underground system would not be over £400. The question which confronts the central-station manager is whether or not the income from consumers supplied in the territory would warrant an increase in fixed charges resulting from the adoption of the underground system. The adoption of the latter system in a residential territory would be more expensive, and the cost of current delivered to this territory would be about 3d. per kilowatt-hour more than with the overhead system.

Power-Station Load Charts.—In a paper read before the American Railway Mechanical and Electrical Association, held recently at Philadelphia, Mr. Lawrence P. Crecelius dealt with the question of keeping proper load charts of the loads at the power station. He outlined a method employed by the United Railways Company of St. Louis in increasing the load factors of the main power stations, and showed how the load factor in this case plays a prominent part in the cost of power per car mile. The system he described has in operation four power stations. Two of the larger stations—one of 13,950 kw. and one of 7,000 kw. capacity—are kept in operation continuously, and constitute the main central stations. The two smaller stations are operated on swing on weekdays during peak hours only. 'Bus wires have been run from the larger stations to both of the smaller ones, and there connected through circuit breakers and double-throw switches to either one of the two feeder 'buses with which the stations have been supplied. By installing double-throw switches on both the feeders and 'bus wires it is possible to operate them on one 'bus, to which any number of feeder sections can be connected, and at the same time operate the 'bus wires independent of the station on the other 'bus, to which the rest of the feeder sections can be connected. During busy hours the 'bus wires are connected to the same 'bus on which the stations are operated, thereby becoming equaliser wires. The amount of copper in the 'bus wires is sufficient to carry the load of the smaller stations during the less busy part of the day allowing a reasonable drop in potential. The results which are obtained from this system are shown by the curves on



the diagram, which represents the same curves of the two main stations when working during busy and light periods. Curve A represents the load of the main stations for the same day on which all four stations were in operation all day. Curve B represents the load of the same stations when taking the load of the smaller stations during the lighter part of the day. Thus it is found that in bringing up the load factor of the sum curves of the main stations from 50·23 per cent. in the first case to 57·7 per cent. in the second, and calculating on the basis of 310,000 kilowatt-hours per day, which is the average of these stations during the summer months, there would be a saving of about £38 per day when operating under these conditions.

Silent Electric Discharge.—An interesting paper on "The Synthesis by Means of the Silent Electric Discharge" appears in the October issue of the *Journal* of the Chemical Society from Mr. John Norman Collie. The author claims that to produce synthetically in the laboratory chemical compounds which are found in nature has always been one of the chief aims of the chemist, and more especially so when the compounds so to be prepared belong to the domain of organic chemistry. Prof. Meldola, however, has laid great stress on the fact

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book is lengthy; it contains 12 long chapters, the first three dealing more directly with economics, the last nine with practice. Thus we have in the practical part chapters devoted to overhead, conduit, surface-contact, London deep-level, London surface and shallow, Berlin, Italian direct-current, Elberfeld monorail, Italian high-tension alternating and Swiss three-phase, and Zossen high-speed trials. Now, these chapters are all both difficult and easy to criticise—easy in a way because they describe actual works and the results of actual works; difficult because there is so much necessarily of a tentative character, which to indicate and discuss properly would need a book almost or quite as large as that presented to us by Prof. Smith Throughout he is thorough. His descriptions are clear, and his deductions and comments to the point. We should like, however, to confine our attention more especially to surface-contact work (Chapter VI.), because there seems to be more scope in that direction than elsewhere. In Chapter II., Prof. Smith, with certain exceptions, "The surface-contact system would be the ideal in respect of public convenience, etc.," and "Nevertheless, the surface-contact trams have not so far achieved any striking commercial success." He deals with this part of the subject fully in Chapter VI, where he describes the various systems that have been tried and which so far have not achieved success. Secondary batteries have failed, *vide* Chapters I. and VI.: "A connection capable of transmission of energy is not necessarily a conductive connection: it may be inductive." Most surface-contact systems that have attempted to utilise induction in such work have failed, for hitherto neither cost nor certainty of action have been satisfactory. Prof. Smith will probably take his revenge upon us in introducing the term cost while objecting somewhat to his combination of economy with technics, but we still shall hold to the view we have expressed. At present, cost is the factor decisive as to the use of one system over another Contact systems, however, are not restricted to inductive systems, but, as Prof. Smith says, "All the systems that have yet had any practical success have depended upon conductive contact between roadway and car, the main current along the buried insulated conductor being tapped and led through the car motors and back to the earth rails." But here again cost as against overhead or conduit serves to put the contact system into the background, though time and improvements may bring it into the running. The weak points of the system as described by Prof. Smith are: (1) leakage; (2) wear and tear of parts brought into contact; (3) switch certainty and efficiency; (4) switch arrangement. Each of these is discussed, and, as usual, equations are not lacking to show the student the results due to arrangement. The chapter after this general discussion shows that "the original proposal to employ insulated rail sections thrown into, and cut out of, contact with a main supply cable by a switch operated by an electromagnet carried by the car was made in the patent of Profs. Ayrton and Perry in 1882, so that in Britain since that date nothing but new special methods of carrying out this general idea can be subjects of valid patents" (p. 178) . . . The author goes on to describe the special methods proposed and tried, such as the Diatto, those of Dolter, Thompson-Walker, Claret-Vuilleumier, Vedovelli, and the Schuckert-Paul. The good and the bad points of these systems are emphasised—thus of the Vuilleumier: "If a new car comes in the section, propelled by its own momentum or otherwise, while the previous car has not yet left that section, and is being fed from the distributor, the new car is not only not fed as it comes into the section, but, when once it has entered, it is also out of phase with the distributor, and cannot be put into phase except by being pushed back to the end of the section. This fault is remedied by the Vedovelli system, but the latter will not reverse." Both these defects are avoided in the Schuckert-Paul system. Here we must stop. We have indicated divergence with the talented author, have attempted to indicate the matters with which he so ably deals, and by fuller references to one chapter to show how carefully and fully he treats his subject. Even if Prof. Smith had given us nothing but the description of

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The volume before us is a comparatively small one, comprising about 120 pages, as compared with other books which have been issued on armature windings. The reason for this is that the writers of previous books have been rather too apt to look upon their subject from the mathematical point of view. The result is that a large number of windings are described and illustrated which, though electrically possible, are not feasible from a commercial point of view. Such collections including windings which are not warranted in practice are apt to confuse even the trained designer and to defeat what we take to be the main object of any such treatise. Mr. Cramp in his book has taken the opposite course, and devotes his whole attention to those forms of winding which are met with in everyday practice, and which have proved to have special advantages in various cases. There is no doubt that the student who has carefully gone through the instructions given in this volume will be fully equipped with information which will enable him to deal with special variations which may sometimes be called for. Thus, according to the preface, the book is intended for "those plodding and industrious workers who are not afraid of long hours or hard work, gifted with that all-British combination—*slowness* with *tenacity*." . . . "For such men has this little book been written; for these, and for those others, men who have a love for electrical engineering, yet, lectures or no lectures, are expected to earn their own living from the time they leave school." The subject is divided by the author into six parts, which deal respectively with (1) simple or simplex multiple circuit windings, ring or drum; (2) multiplex multiple-circuit windings, ring or drum: (3) simple or simplex two-circuit windings, drum; (4) multiplex two-circuit windings, drum; (5) two-circuit ring windings; (6) closed-circuit windings applied to alternators. The volume concludes with a summary of rules governing multiple and two-circuit winding, whether of the ring or drum type. We have carefully read through the volume, and find that the author has spared himself no trouble in making his subject clear. Not only are the various forms of winding and their special uses carefully described, but he also summarises from time to time the essential characteristics to be borne in mind of each system, and also the method in which to proceed to lay out the windings on the armature. The result is a book which will commend itself not only to the student, but also to the apprentice who in his workshop training desires to know the reason why the conductors on various types of armatures are connected in particular ways. The matter in the book originally appeared in the form of articles in the *Electrical Engineer*. The illustrations are clear, and leave little to be desired.

Theorie der Elektrizitaet. Part II.: "Elektromagnetische Theorie der Strahlung." By Dr. M. ABRAHAM. B. G. Teubner, Leipzig.

The first part of this work, it will doubtless be remembered, deals with Maxwell's theory of the electromagnetic field—the foundation of the modern theory of electricity. In the second part, now published, the author builds up the electron theory of radiation on this foundation, assuming space to be an infinity which serves as a medium for the electromagnetic effects whose origin is due to electricity. It is further assumed that the latter is composed of indivisible particles called electrons. Every electric current is conceived as a convection current of moving electrons, the cathode rays being composed of negative electrons, which move at great speed along parallel paths. This radiation opposes the wave radiation produced by the oscillations of the same minute particles. The theory

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of both kinds of electromagnetic radiation is discussed in the volume before us. Chapter I. begins with the treatment of the physical and mathematical principles underlying the electron theory. The facts bound up with the acceptance of the theory are reviewed. From the fundamental equations of the electron theory the conception of the electromagnetic unit of motion is derived. General solutions of these fundamental equations are also given with the aid of the "electromagnetic potentials"—that is to say, the vector potentials of stationary magnetic fields.

Chapter II. enters into the theory of the emanation of light from a point charge which can be moved at will. The simplest imaginable electromagnetic model of a source of light is a single electron swinging round its position of equilibrium, but so far as wave radiation is involved it is shown that the electron may be substituted by a point charge in most cases. Thus the development of this chapter is interesting from the dynamic point of view, the more so because it is independent of any hypothesis as to the form of the electron. We see in the succeeding chapter, however, that it is necessary to assume some definite form for the electron in order to fully develop its mechanics. The author adheres to the conception of a fixed spherical-shaped electron, on which he bases the electromagnetic theory of the cathode and radium rays. Chapter III. is entirely devoted to the development in question.

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As the author observes in his preface, the theory of electricity has apparently now entered upon a stage of steady development. The time seemed to him opportune for a halt to review what has been already accomplished, and the work which he has produced is the outcome of that conviction. He has certainly made a valuable contribution to the literature of the subject, and, while the pages of the book before us do not reveal much original thought, they bring us right up to date, and the thoroughness with which the author delves into the theory is deserving of all praise The latter feature, it must be admitted, is characteristic of most works of German origin, being very marked in this latest example, which runs into some 400 pages. We shall look forward to an English translation.

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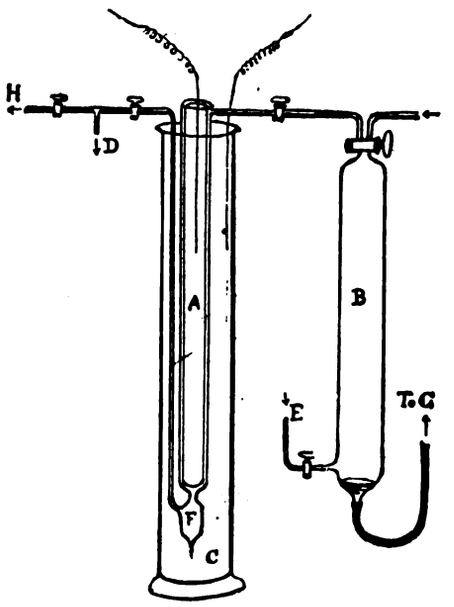
that chemists must not forget that the synthetical methods employed in the laboratory are almost entirely different and are not equivalent to vital methods, and he further points out that the fundamental synthesis *par excellence*—the photo-synthesis which plants are enabled to accomplish—is as yet without a laboratory parallel. To these ideas Mr. Collie called attention some years ago, and since then he has been engaged on various researches where the chief object has always been, as far as possible, to imitate in the laboratory the simple reactions which are constantly occurring in living organisms. But the chemist, by simply supplying energy in the form of heat to a mixture of carbon dioxide and water, cannot imitate the synthetical processes of the plant. By means of the silent electric discharge, however, a mixture of either carbon dioxide or carbon monoxide and hydrogen gives formaldehyde and methane. Experiments were made with carbon monoxide and ethylene. A mixture of these two gases was submitted to the silent electric discharge, and the apparatus



used was that shown in the diagram. A is the apparatus (length 22in., width 2in.) in which the gas was submitted to the silent electric discharge; B, the reservoir for the gas; C, a gas cylinder; D, leading to a gas circulator; E, leading from the gas circulator; F, receptacle for the product of the condensation; G, mercury reservoir; H, leading to mercury pump. From the result of the experiments, it was obvious that condensation to compounds of very high molecular weight could be induced by the silent electric discharge, even when the gases experimented with were surrounded by a freezing mixture. In conclusion, the author pointed out that the synthesis has been effected at the ordinary temperature; also by further oxidation at the ordinary temperature a series of aldehydes and acids can likewise be produced. He hopes to continue this research, as he considers the silent electric discharge eminently fitted for supplying energy to compounds.

Radium Rays.—The *Journal* of the Chemical Society contains the abstract of a paper by Mr. Ernest Rutherford on the charge carried by α and β rays of radium which appeared in the *Phil. Mag.* In order to determine the charge carried by the α particles, experiments were made with radium as nearly as possible in the condition of minimum activity so as to avoid complications arising from the presence of β-particles. A known small quantity of radium bromide was dissolved in water and the solution evaporated uniformly on a polished aluminium or glass plate. The film of radium thus obtained was so thin that only a very small fraction of the α-particles was absorbed by the radium itself. The saturation deposit due to the deposit thus obtained in the condition of minimum activity was measured between the radium-covered plate and a second plate placed above it at a distance of 3·5c.m., the electrodes being contained in a brass vessel, in which a good vacuum was maintained by Dewar's charcoal absorption method. The apparatus was placed between the pole-pieces of a large electromagnet, and the current was measured for various potential differences with and without the magnetic field, the radium-covered plate being in each case made positive and negative alternatively. When the magnetic field had attained a certain strength the magnitude of the observed current was practically unaltered by further increase, indicating that the field was strong enough to prevent all the electrons from reaching the opposite plate. Assuming that each α particle carries the same charge as an ion, then, from the value of the saturation current in the magnetic field and the known quantity of radium bromide employed, it is calculated that the total number of α-particles expelled per second from 1 grm. of radium at its minimum activity is $6{\cdot}2 \times 10^{-10}$, and in radioactive equilibrium four times as many. How speed electrons were emitted with the α-particles and the current conveyed by these is sufficient to mask completely the current due to the α-particles. The fact that the current without the magnetic field is always greater when the radium-covered plate is negative than when it is positive, shows that a greater number of electrons is emitted from this plate than from the other. The observations seem to indicate that these electrons constitute a type of secondary radiation resulting from the impact of α-particles on matter. For the determination of the charge carried by the β-particles, a rod of lead, previously exposed to radium emanation until the excited activity had attained its maximum value, and wrapped in aluminium foil of thickness sufficient to absorb the α-rays completely, was suspended as the central electrode in a metal cylinder which was evacuated The quantity of radium bromide corresponding with the γ-ray activity of the rod immediately after its removal from the emanation was first measured, and then in the above-mentioned apparatus the current due to the β-radiation was determined after a known time interval. From the known decay curve this current was corrected to the original condition of the rod corresponding with the determined quantity of radium bromide. It is calculated that the number of β-particles expelled from 1 grm. of radium per second is $7{\cdot}3 \times 10^{10}$. This result, which is probably a little too high, is in agreement with the theory of successive changes. From the calculated number of α-particles expelled per gramme per second several other constants are deduced. Assuming that only one α-particle is expelled during the disintegration of the radium atom, it follows that in a gramme of radium about 0·5 milligramme disintegrates per year. Assuming that each atom of radium gives rise to one atom of emanation, the maximum volume of emanation obtainable from 1 grm. of radium in equilibrium is 0·83 cm. From the previously determined kinetic energy of the α-particle $= 5{\cdot}9 \times 10^{-6}$, the emission of energy in gramme-calories per gramme per hour is calculated to be 126. The average number of ions produced by each α-particle in air at atmospheric pressure is calculated to be 86,000, or, since the range of particle is 3cm., the number of ions per centimetre of path in air at normal pressure is 29,000. The ionising power of the α-particles appears to be about twice as great as that of electrons. The average energy required to produce an ion is calculated to be $2{\cdot}7 \times 10^{-11}$ ergs.

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TURBINE PLANT IN GLASGOW.

Two years ago it was found necessary to instal a large amount of new generating machinery in the stations of the Glasgow Corporation electricity department, and the then chief engineer, Mr. W. A. Chamen, after visiting several of the large works south of the border, in company with members of his committee, advised that the Port Dundas station (Fig. 1), a third of which was built and housed 10,000 h.p., should be extended, and that the new part of the building should be designed to contain six 3,000-kw. turbo-alternators. The committee decided to order two of these sets and another 1,500-kw. direct-current set to be erected in the St. Andrew's Cross station on the south side of the river.

Considerable difficulty was experienced in getting boilers within the space available and at the same time keeping to the original scheme of bunkers, coal tanks, and stoker arrangements. The boiler units are the largest so far turned out by Messrs. Babcock and Wilcox, of Renfrew,

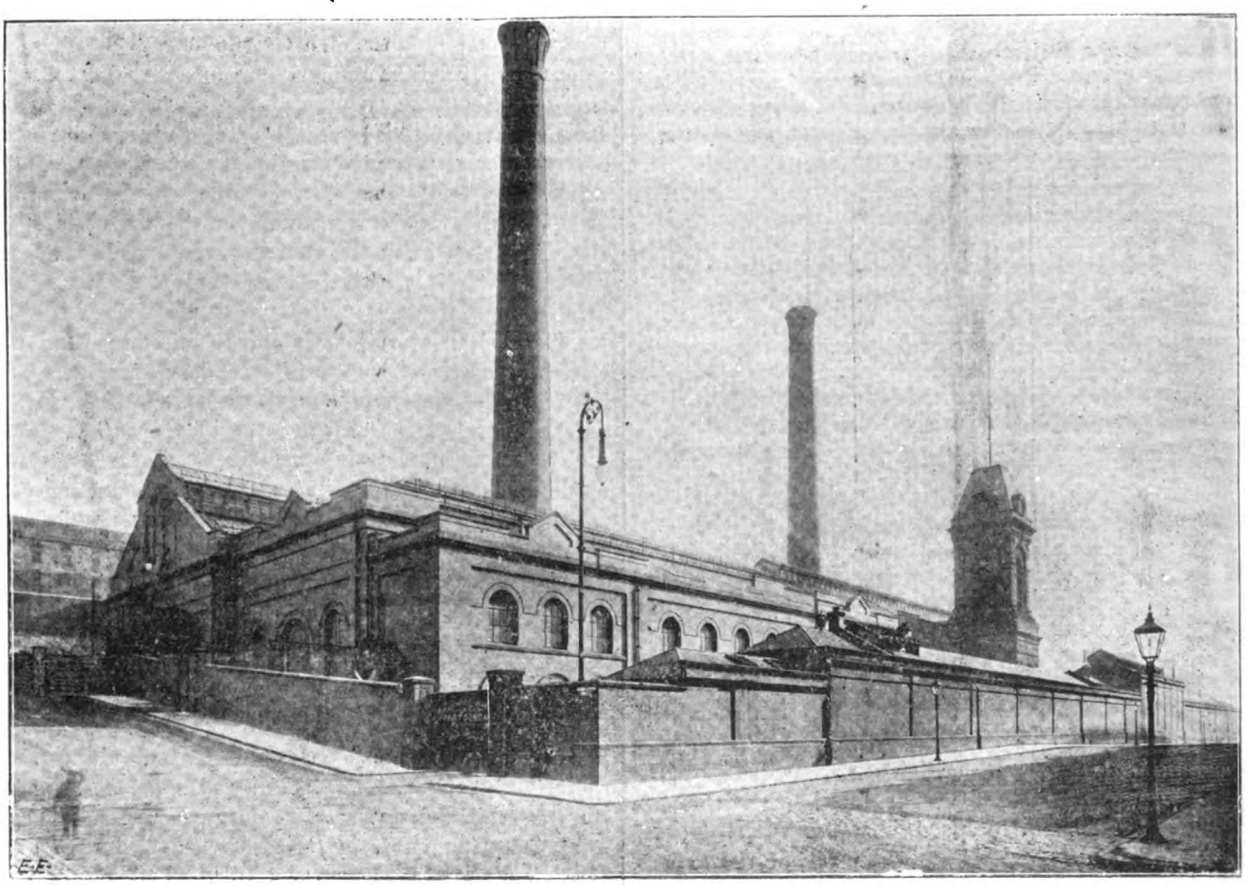

FIG. 1.—General View of the Port Dundas Electricity Works.

in connection with the generation of electricity. The boilers have each 6,182 square feet of heating surface, the grate area being 100 square feet. The working pressure is 200lb. per square inch. These boilers are fitted with superheaters and chain-grate stokers, the coal falling into the hoppers by gravity from overhead tanks through Avery automatic weighing machines. With a view to getting the most out of the boiler installation, Green's economisers and induced-draught fans have been fitted.

The turbines (Fig. 3) are direct coupled to three-phase alternators of 3,000 kw. normal capacity each, and arranged so that they are capable of giving an overload of 25 per cent. for two hours and 50 per cent. for half an hour. They have been made by Messrs. Willans and Robinson, and are of the Parsons type, with improvements which the makers have adopted in the turbines of their manufacture. The speed is 750 r.p.m., which was chosen in preference to the higher speed of 1,500 revolutions, these two speeds being fixed by the periodicity, which in this case is 25. At 750 r.p.m. the turbine sets work remarkably smoothly, and are practically noiseless; and although the turbine itself is of larger proportions than would be necessary in the case of a set built to run at 1,500 revolutions, there is no doubt that the slow speed has been chosen wisely.

The blading throughout the turbine is constructed on the well-known principle of Messrs. Willans and Robinson. The blades are built up in complete half rings before being put into the turbine, the blade rings being protected at their outer ends by means of a channel shrouding strip, which gives the blading a particularly sound and rigid appearance. The whole of the details of the turbine, governor gear, oil-pump, etc., have been placed on the lower half of the casing, and are arranged so that the bearing caps can be lifted and the upper half of the casing hinged back for the inspection of the interior of the turbine or working portions of the bearings and thrust gear.

The exhaust end of the turbine has been arranged so that the exhaust to the condenser is taken down through two pipes, which allows the exhaust end bearing to be rigidly supported close up to the bladed portion of the turbine spindle, thus reducing the length between the turbine end bearings, and making a particularly stiff support for the bearings between the turbine and generator.

The foundations consist of two concrete piers, one supporting the generator bed-plate and the other supporting the oil-tank, on which rests the steam end of the turbine. These piers are tied together with girders, which make the whole foundation arrangement very neat and amply strong. The throttle and by-pass valves are arranged in a separate box bolted to the steam end bearing of the turbine, and the governors are driven through gearing by a small extension shaft, driven in turn from the main turbine shaft. This governor gear and the thrust adjustment are designed so that there is perfect accessibility at all times without the possibility of derangement due to careless handling. The complete units run remarkably well in balance, and when compared with the reciprocating engines installed in the station give a striking example of the amount of power which can be got into small space.

The generators (Fig. 4) were built by Messrs. Dick, Kerr, and Co., Preston, and are of the revolving-field type, with 6,500 volts between terminals, the frequency being 25. The stator can be moved laterally to admit of inspection of the revolving element. At present the neutral point of he winding is not earthed. The surface-condensing plant

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is of Messrs. Allen's manufacture, and arranged to give a vacuum of 2½in. below the reading of the barometer when the turbine is giving its full output of 3,000 kw. The air-pumps are of the three-throw Edwards type, and, along with the circulating pumps, are motor-driven.

The switchboard is of Messrs. Witting, Eborall, and Co.'s make, and arranged to eventually control eight three-phase generators and 20 feeders. The present installation, however, consists of apparatus to deal with two double-current generators, which have been used as direct-current machines for the last five years, and ten feeders. The switchboard is of the remote control type, and consists of two sections—namely, the operating panels and the high-pressure panels. The operating panels are located in the engine-room, and from them the high-pressure switchgear, situated in an adjacent room, is electrically controlled. The high-pressure panels are made of brickwork, concrete, and steel throughout, the open sides being covered up completely by removable screens of sheet metal. The different apparatus and gear contained in the high-pressure panels—such as switches, transformers, 'bus bars, etc.—are sub-divided and isolated, each leg being treated separately by means of vertical and horizontal dividing slabs. Everything possible has been done to make the switchboard fireproof and to avoid all chance of accidental contact with live parts. The 'bus bars are in duplicate, and interconnecting switches at the ends are provided to form a ring main when required. Selector switches are fitted, so that any generator or feeder may be switched on to either 'bus bar. The small wiring is all run in screwed iron pipes, excepting at the back of the operating panels. The generator and feeder switches are arranged with each phase in a separate oil tank and with four breaks per phase. The feeder switches, although normally only carrying 100 amperes as a maximum, are capable of breaking safely the total horse-power of the station. The instruments are worked by low-pressure supply from current and pressure transformers located in the distant high-tension compartment. The relays on the feeder panels are of the three-pole overload time-limit type and those on the generator panels of the reverse-current type without time-limit attachment, and the adjustment is so arranged that the switches will open should a reverse current equal to 50 per cent. of the normal full-load current get into the generator circuit. These relays may be cut out of action while the machines are being synchronised. The general arrangement of the gear is such that (1) accidental contact with any of the high-pressure gear, whether exposed or not, shall be absolutely impossible; (2) should any single piece of apparatus fail or fuse, the damage will be strictly confined to the compartment in which the accident occurs; (3) any panel or portion of the 'bus bars may be completely isolated by means of the section switches, for inspection, cleaning, or repair, without interrupting the supply in any way; (4) apparatus requiring occasional inspection, such as excess pressure dischargers, are placed in a readily accessible position, and proper provision is made for getting out the oil switches for overhauling or renewing the oil; (5) the only fuses used are in the primaries of the pressure transformers. The earthing of the framework, the cases of all transformers and switches, and the secondaries of the transformers and any part of the 'bus bars or high-pressure apparatus which men may require to handle has been carefully carried out.

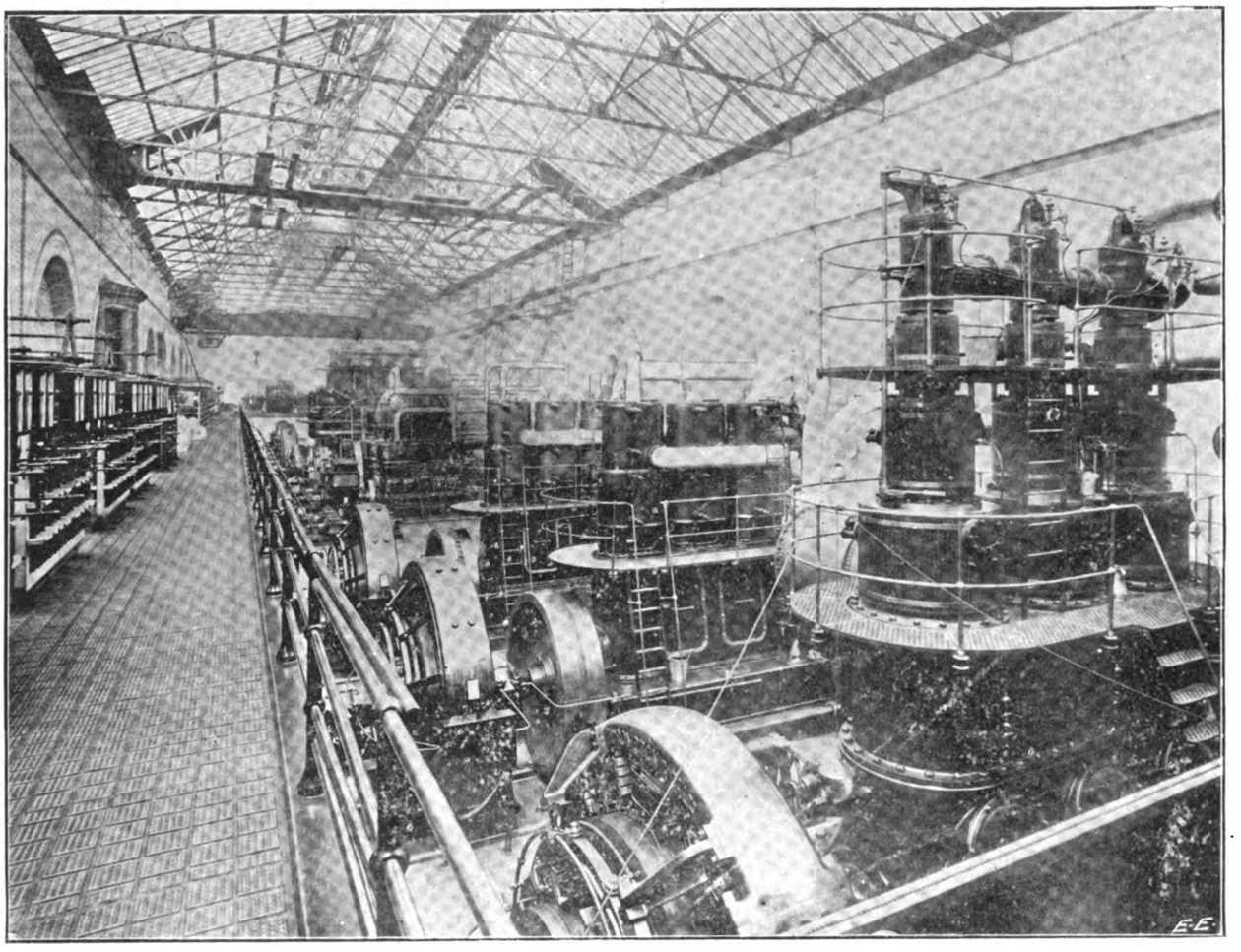

FIG. 2.—General View of the Port Dundas Engine Room.

The interconnecting cables are rubber covered and served with an incombustible double braiding and compound; where these connections pass through partitions or require support they are mounted on porcelain insulators and tubes. The cables from the power station switchboard are three-core, and run to several sub stations throughout the city. In the sub-stations 1,000-kw. and 500-kw. motor-generators are installed, manufactured by the British Westinghouse Company and the Electrical Company. The motors, which are of the induction type, take current at 6,500 volts right on to the stator windings. The direct-current side delivers current either at 250 or 500 volts for consumers' use. The motor-generators are all capable of being started up from the direct-current side, but there is also at least one set in each sub-station which can be started up from the alternating-current side in case of

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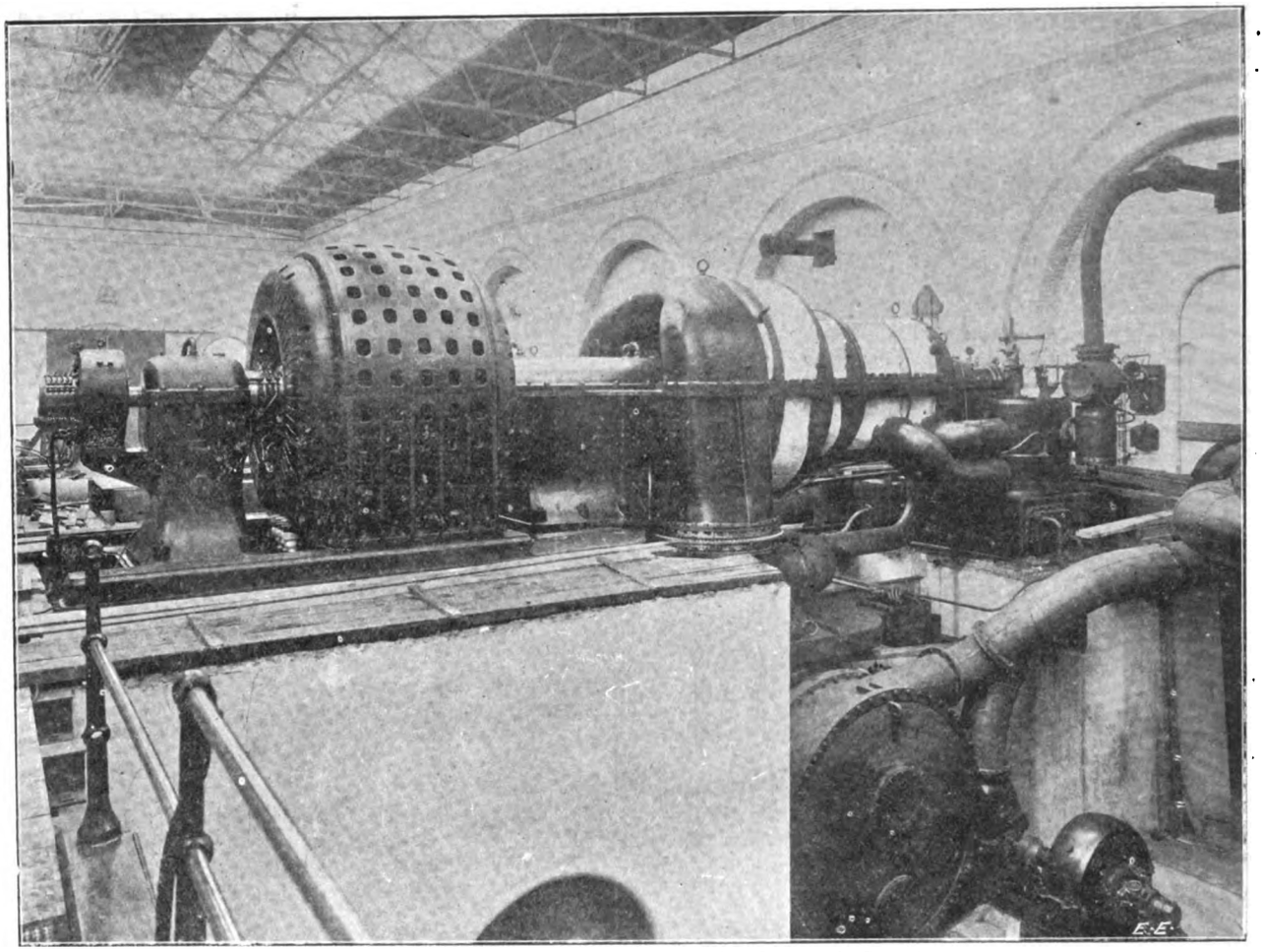

FIG. 3.—View of the Willans-Dick-Kerr 3,000-kw. Three-Phase Turbo-Generator.

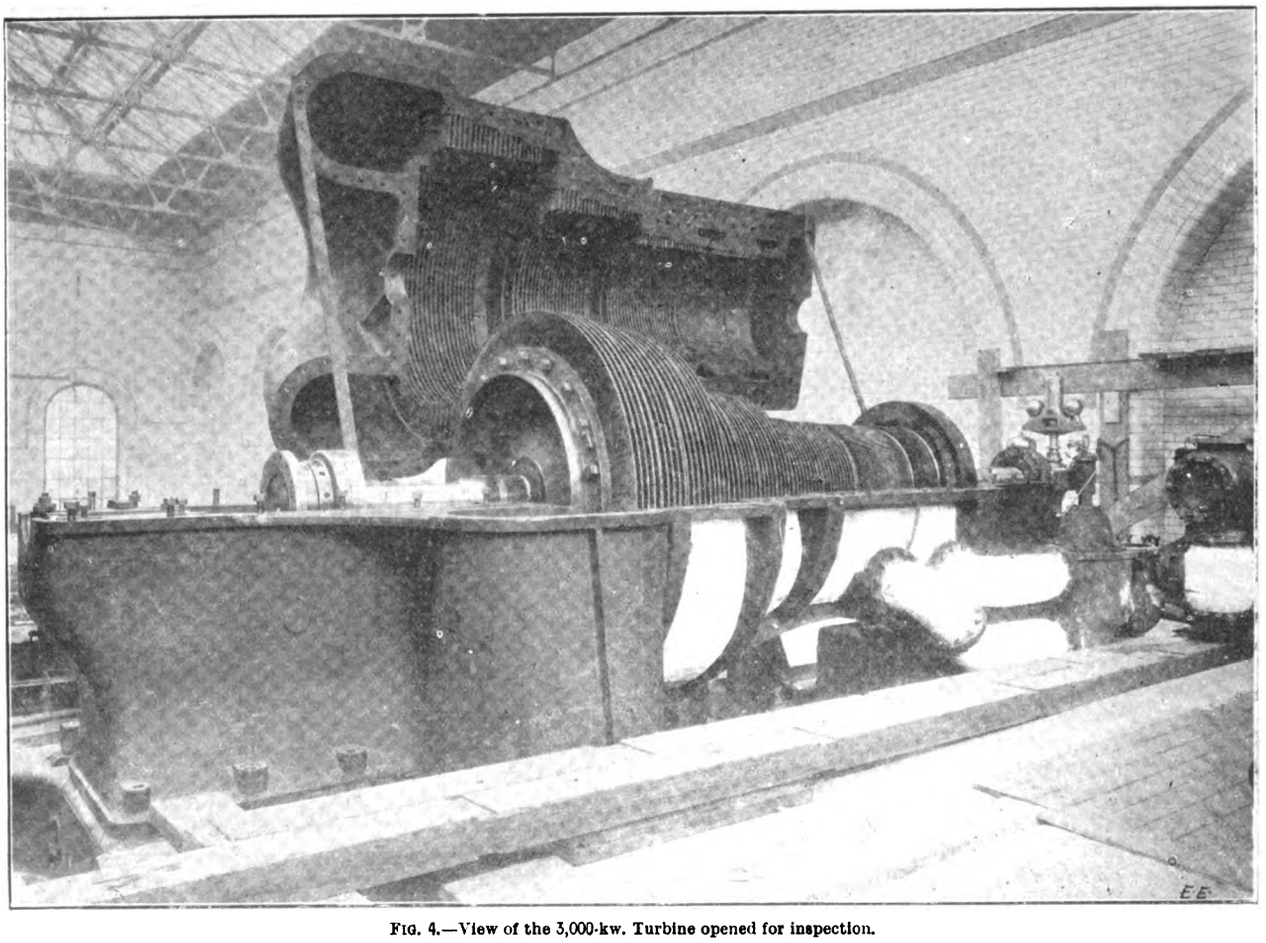

FIG. 4.—View of the 3,000-kw. Turbine opened for inspection.

the direct-current supply failing from any cause. For balancing purposes some of the 500-volt direct-current windings are tapped, the tappings being led to slip-rings and thence to choking coils, the middle wire connection being joined to the centre part of these coils. The starting switches in the sub-stations are all of the water type, and the results

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obtained from these starters have been extremely satisfactory. The high-tension switchgear supplied by the British Westinghouse Company is on the same lines as that in the power station, and the direct-current switchgear consists of automatic non-return circuit breakers on each pole without any fuses, the only fuses employed being on the low-tension feeders.

THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.

BY ALFRED STILL, M I.E.E., A.M.I.C E.

(*Concluded from page 589.*)

Regulation of Pressure at Receiving End.—When the voltage drop is considerable, as will nearly always be the case in long transmission lines, it is necessary to raise it—*i e*, to regulate it so as to avoid variations with changing load. This may be done on a Δ-connected three-phase system by means of two regulators only, as indicated in Fig. 26. Here the points A, B, and C are the terminals of

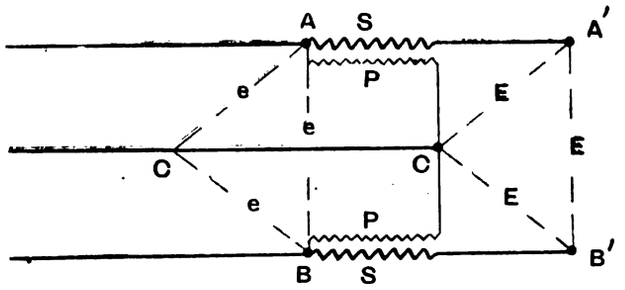

FIG. 26.

the transmission line. Imagine P and S to represent respectively the primary and secondary turns of a transformer. If we connect two such transformers in the manner indicated on the diagram, the effect will be to raise the pressure between *all three wires* to the extent of the volts added by the secondary turns, S Thus, if the pressure *e* = 16,000 volts and the ratio P : S = 4 : 1, the pressures E will be

$$16{,}000 + 40{,}00 = 20{,}000 \text{ volts.}$$

The diagram Fig. 27 will make this quite clear. Here A B, B, C, and C D are the three vectors representing the pressures *e* before boosting up: A A′ and B B′ represent the added volts between A and A′ or B and B′ (Fig. 26).

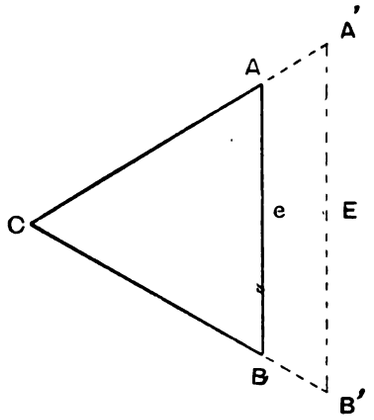

FIG. 27.

These added volts are evidently in phase with the pressures C A and B C respectively, because the potential difference at the secondary terminals of a well-designed transformer is always in phase with the primary E M.F. We have only to complete the triangle C A′ B′ to see that the two transformers, connected up in the manner described, will do all that is required in the way of raising the pressure on a three-phase circuit. It will be understood that regulation of this sort is usually carried out on the secondary side of the step-down transformers, but the principle is the same. Moreover, the transformers shown in the diagram Fig. 26 must be of the variable-ratio type, so that the added volts may be varied (by hand or otherwise) to suit the alterations in the load.

Boosters at Intervals along the Transmission Line.—In the event of a large pressure drop occurring between the generating and receiving ends of a long transmission line, it may be advantageous to provide boosters at one or more points along the line. There would appear to be a certain vagueness in the minds of some engineers as to the real object and possible advantage of using boosters along a transmission line. It is true that the energy put into the line at intermediate points cannot be cheaper—and, indeed, is usually more costly—than the energy supplied to the line at the generating end; but the booster system enables us to *keep up the pressure all along the line*, and hence the economy; provided always that the losses in the boosters themselves, their maintenance, and the necessary allowances for interest and depreciation do not counterbalance the saving.

As an example, consider a single-phase line conveying a current of 100 amperes at an initial pressure of 20,000 volts. Suppose the drop of pressure in the line to be 10,000 volts; this will leave only 10,000 volts at the receiving end.

The power put into line at generating end = 2,000 kw.
The loss in the line = 1,000 kw.
The power available at receiving end = 1,000 kw.

Hence *efficiency of line* = 50 per cent.

Now, imagine a booster to be inserted at a point half way along the line. This booster may be considered as a

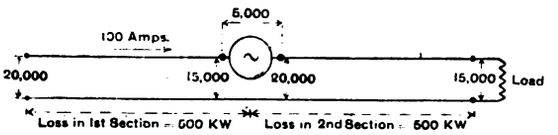

FIG. 28.

highly insulated alternator of 500 kw. capacity, capable of generating 100 amperes at 5,000 volts. The arrangement now becomes as shown in Fig. 28. The drop in the first section of the line is, as before, 5,000 volts, and the drop in the second section is evidently similar—*i e*, 5,000 volts—leaving the total waste of power in the line the same as before the booster was inserted. But by providing this booster at the middle point of the line we have been enabled to raise the pressure here up to the maximum initial value of 20,000 volts, with the result that we now have 15,000 volts (or 1,500 kw.) available at the receiving end. We have certainly not succeeded in obtaining this increased power without having to pay for it, but note that by keeping up the pressure we have been able to obtain it *without increasing the losses in the line.*

If, for the sake of simplicity, we neglect the question of booster efficiency, we now have:

Power supplied to the line = 2,000 + 500 = 2,500 kw.
Power lost in the line = 1,000 kw.
Power available at receiving end = 1,500 kw., and for the *efficiency of the line* $\frac{1{,}500}{2{,}500}$ = 60 per cent.

Boosters are generally arranged so as to take their power from the generating end—that is to say, they take the

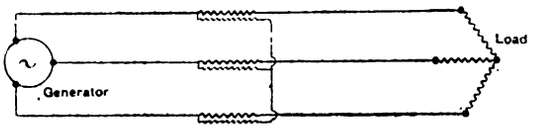

FIG. 29.

form of transformers which provide the extra volts at the cost of a corresponding loss of current. A three-phase transmission line, in two sections, with booster at the end of the first section, is shown diagrammatically in Fig. 29. Such boosters must be of the variable-ratio type, with hand or automatic regulation.

NOTES ON THE RELATIVE ADVANTAGES OF DIFFERENT SYSTEMS OF TRANSMISSION.

By way of introduction it may be mentioned that a comparison of various systems on general lines is not only useless, but impossible; there is no basis of comparison applicable to all conditions of practice, and each particular case must be considered on its own merits. The following

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points should not be overlooked: (1) In comparing the relative cost of conductors necessary for two different systems of transmission, the *efficiency* must be the same in both cases—*i e*, the same amount of energy must be considered as being transmitted the *same distance* with the *same loss*. (2) What is to be understood by the *pressure* must be clearly defined. For instance, when comparing continuous with alternating current transmission, it must not be forgotten that the stress on the insulation is less with continuous currents than with alternating currents at the same $\sqrt{\text{mean square}}$ pressure. In fact, on the assumption of a sine curve wave, it is easy to see that—for the same power transmitted, at the same efficiency, and *with the same maximum stress on insulation*—the weight of copper for a single-phase alternating-current transmission would be *double* that required if continuous currents were used. Again, when considering alternating-current systems, it is necessary to decide whether it is the maximum potential above earth or the maximum pressure between wires which should be taken as a basis of comparison. Assuming the middle, or neutral point, of the various systems to be *earthed*, and allowing for a definite maximum pressure between any wire and earth, the comparison between the different alternating-current systems becomes a simple matter.

Let e and C stand respectively for the voltage and current *per leg* in either of the three systems, shown diagrammatically in Fig. 30. Then, the total power transmitted in each case will be $e\ \mathrm{C} \cos\theta \times n$, where $\cos\theta$, as usual, is the power factor, and n = the number of legs. If r be the resistance of each line conductor, the total line loss will be

$$\mathrm{C}^2\, r \times n,$$

and for the same line efficiency the weight of copper per horse-power transmitted will evidently be the same in all cases. This leads us to the conclusion that, *for any polyphase system*, the power lost in the line depends only upon the joint resistance of the conductors, the power transmitted, and the power factor, *provided the pressure between any wire and the neutral point is constant.*

Let us neglect the capacity and self-induction of the line, and assume that $\cos\theta$ is the power factor of the load at receiving end. Then,

$$\textit{power delivered} = n\, e\, \mathrm{C} \cos\theta = \mathrm{W},$$

and the

$$\textit{power lost in line} = n\, \mathrm{C}^2 r.$$

This last quantity, expressed as a percentage of the power delivered, becomes

$$\textit{percentage power lost in transmission} = \frac{n\, \mathrm{C}^2 r \times 100}{\mathrm{W}}.$$

Let us denote by R_p the joint resistance of all the line conductors in parallel—*i e.*, $\mathrm{R}_p = \frac{r}{n}$. This gives us for the numerator of the above percentage loss the expression

$$n^2\, \mathrm{C}^2\, \mathrm{R}_p \times 100.$$

But $n^2\, \mathrm{C}^2$ is equal to $\frac{\mathrm{W}^2}{e^2\, (\cos\theta)^2}$.

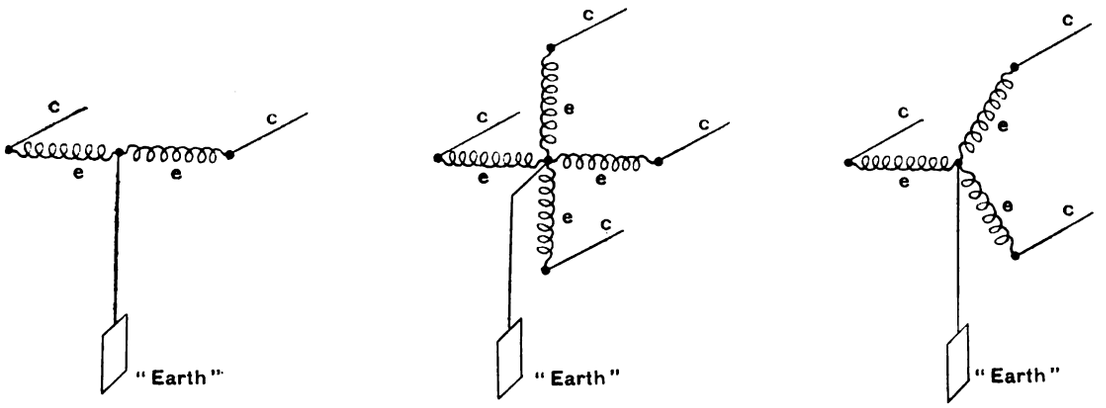
Hence we may write: Percentage power lost in transmission for *any* polyphase system

$$= \frac{\mathrm{W} \times \mathrm{R}_p}{e^2\, (\cos\theta)^2} \times 100.$$

It might at first sight appear as if there was nothing to chose between the various systems shown in Fig. 30, but it must not be forgotten that the potential difference *between the wires* has not been taken into consideration. When this is done, the advantage will clearly be seen to be in favour of the three-phase system; thus the maximum pressure between any two of the line wires will be 1·73 e for the three-phase system and 2 e for the single or four phase systems. Although we have assumed the case of an earthed neutral, there is much to be said in favour of a system without an earthed point, mainly as regards reduced risk of stoppage through a breakdown of insulation.

Where current for power and lighting is to be taken off the same mains, the two-phase system with the phases kept entirely distinct appears to offer some advantages; or the power may be transmitted by three-phase currents and converted into two-phase by a suitable arrangement of transformers as first introduced by Mr. C. F. Scott. In this case the frequency must not be lower than, say, 30 for incandescent lighting or, say, 45 for arc lighting.

If the load consists of small motors and incandescent lamps, a three-phase distribution at a frequency of about 30 will give very fair pressure regulation if the secondaries of the transformers are Δ connected. Even with a difference in load of 25 per cent. between the phases the alteration in voltage between the wires can be shown to be hardly noticeable, and the motor load will always tend to reduce the effects of any differences in the lamp loads.



Single-Phase Two (or Four) Phase Three-Phase

FIG. 30.

Another method applicable to a supply combining power and lighting is to connect all the lights across one phase only of the three-phase supply, and keep the pressure steady on this particular phase, leaving the pressure across the other two phases to adjust itself according to the load. This should not interfere with the running of motors connected across all three phases.

If the power is to be used for electric traction, the frequency must be low, preferably about 15 periods per second. The two-phase system has been advocated for electric traction on the ground that, for a given power, the current in the (two) trolley wires will be less, while the current in the rails will be greater than with the three-phase system, thus effecting economy in the line. (The section of the rails is usually such that their conductivity is higher than that of the trolley wires.) On the Valtellina Railway the transmission from the water-power station is by three-phase currents at 20,000 volts; this is transformed down in sub-stations to 3,000 volts, a lower pressure being, in this case, inadmissible, as it would involve the collection of abnormally large currents from the trolley wires.

For transmission of power to a distance the three-phase system would, on the whole, appear to have certain points in its favour.

Arrangement of Overhead Lines in Practice.—It is not intended to deal with any questions concerning the practical construction of transmission lines, or the calculation of

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stresses and strains in wires or supports; but these articles would not be complete without a reference to various minor matters affecting the design of transmission lines from an electrical standpoint.

Distance between Wires.—The spacing of the wires will depend mainly upon the pressure between them. The formula

$$d = 6 + 1\tfrac{1}{4}\,V,$$

where d = distance between wires in inches, and V = pressure in thousands of volts, will be found to agree fairly well with the average of recent practice.

Height above Ground.—This will depend largely upon whether wooden or iron poles are used. There are many advantages in having high-tension wires a considerable distance above ground, and the practice of using iron poles or light towers spaced about 15 to the mile in place of wooden poles spaced, say, 50 to the mile, is becoming more and more common. Apart from the fact that the iron poles are more durable, the longer spans are an improvement from the point of view of insulation. Moreover, since fewer insulators are necessary, a higher price can be paid for them, and the best possible type adopted. In no case should any but the best and strongest insulators be used, as no ultimate saving will be effected through the use of cheap insulators. The height of the wires above ground when iron poles are used might be from 30ft. to 40ft., or even more in cases where very long spans can be adopted with advantage.

Aluminium Wires.—These are largely used in America for overhead transmission. For the same conductivity as copper their diameter will be about 1¼ times as great, and their weight almost exactly half that of copper: the tensile strength of the aluminium conductor will be greater than that of a copper conductor of equal conductivity. The cost, in practice, works out about the same for either metal, or, perhaps, slightly in favour of aluminium. The effects of snow, ice, and wind on the larger diameter of wires must not be overlooked. Again, since aluminium has a large coefficient of expansion, a greater sag must be allowed for than with copper. It has been noted that the sag in a span of aluminium wire 132ft. long has been reduced from 33in. at 100deg. to 13in. on a cold morning. Aluminium is liable to be attacked and corroded in the neighbourhood of manufacturing centres, and trouble has also arisen through crystallisation, which sometimes results from continuous vibration. Stranded conductors are probably preferable to solid wires. Bronze conductors have been recommended as being preferable to copper.

Protection from Lightning and Abnormal Pressure Rises.—This is a more important subject than can be adequately dealt with in these pages. The practice of running one or more earthed iron wires—whether ordinary or "barbed"—the full length of the line in the neighbourhood of the conductors meets with little approval at the present day, probably owing to troubles caused by falling wires. A good type of lightning arrester should be used at the stations and along the line. The horn type is liable to cause short-circuits during rain and snow falls, and should be covered. This type has also the disadvantage of being liable to set up electrical oscillations. The Wirtz arrester, with resistance in series, or both in series and in parallel, would appear to be fairly satisfactory.

The question of protection from lightning and abnormal pressure rises is one which has not yet been satisfactorily solved. In many cases, static discharges have given more trouble than they have prevented, and there is no doubt that it is advisable to reduce the number of safety devices as far as possible. At the same time, the most elaborate precautions may be found necessary to prevent interruption of supply during thunderstorms. The practice of insulating the beds and frames of alternators and transformers, which is fairly common in South Africa, would appear to have advantages, the principal disadvantage being increased danger to life.

The abnormal rises of pressure which are liable to occur when switching on or off a long transmission line may lead to trouble, in which case some device must be introduced with the switchgear to enable the pressure on the lines to be gradually raised or lowered. This can be done by running up a separate generator connected to the line, and afterwards paralleling with the 'bus bars; or a variable-ratio hand-regulated transformer can be inserted between the 'bus bars and the terminals of the line, this transformer being cut out of circuit after the switch has been closed on to the 'bus bars. In the case of overhead conductors it is not usual to insert any such charging devices, but if the line is a very long one, some method of gradually switching on and off may be necessary; where any considerable length of insulated underground cables is used, the sudden switching on or off of the pressure would almost certainly lead to trouble.

Mutual Induction. — Although the question of self-induction in long transmission lines has been treated at some length, no reference has yet been made to the inductive effects of one line on a second line running parallel with it, as would often occur in actual practice. The reason of this omission is that such inductive effects are generally negligible. In any case, they can be almost entirely avoided by suitably transposing or spiralling the lines. Thus, if a three-phase line be arranged so that each wire occupies the central position for a distance equal to one-third of the entire length, it should have no appreciable inductive effect upon a neighbouring parallel conductor. With two three-phase circuits supported on the same set of poles it is usual to transpose the wires of one circuit in the opposite direction to those of the other, but spiralling should be avoided as far as possible.

The chief trouble is with telephone circuits, the wires for which are frequently carried by the same poles as are used to support the transmission lines. This is not good practice if it can be avoided, seeing that the telephone will generally be needed most at times when there is trouble with the lines—*i.e.*, when possible out-of-balance currents in the overhead conductors are liable to interfere with conversation on the telephone. The wires for the telephone should, when possible, be supported on a separate set of posts. If suitable precautions are not taken, dangerously high voltages might easily be induced in the telephone circuit.

THE DISTRIBUTION OF ELECTRICITY IN MINES.

BY B. C. H. J.

(Continued from page 587.)

The classes of cable used in connection with pitshaft work comprise all known types; but that which should be recommended for the sample job under discussion is a pair of concentric conductor cables, each inner core consisting of ·25 square inch untinned stranded copper wire, paper insulated, the outer conductor also paper insulated, bitumen sheathed, stoutly taped over the bitumen, served with jute, impregnated with preservative compound, armoured with two galvanised iron wires, further doubly served with jute, which is finally impregnated with preservative compound. This may seem to be a somewhat elaborately made-up cable and the division of the total section of copper into two lengths may appear wasteful as to duplicating the armour, etc., required. But protective measures can hardly be carried too far in guarding against the accidents by flood and falls that beset the occupants of colliery pitshafts. In the event of one cable being damaged the other can be worked upon to a current density double that ordinarily used, as the insulation is paper, which prevents heat from affecting the bitumen sheathing.

Reference should be here made to the possibility of danger, in a certain class of paper-insulated multicore cable, from the amount of free oil left in the paper by the manufacturing process being unduly acted upon by gravity so as to pour down the interstices of the cable, with the possibility of bursting through a weak place in the lead sheathing, where the cable bends at the bottom of the shaft. As the buntons are so situated that the cable can be carried close up against the side of the shaft, and as the pit water is not particularly bad, in the instance quoted the two cables can be arranged for merely cleating to buntons side by side, with about 20-yard spans between the 4ft. long cleats.

The depths of pitshafts vary considerably, according to

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the locality. In Scotland, for instance, pits are fairly shallow, being as a rule under 200 yards deep; in South Wales between 400 yards and 600 yards is usual, and in England the depths are mostly between these figures. The question of jointing depends largely upon the matter of depth, and it may here be mentioned that joints in pitshafts should, wherever possible, be avoided. The making of such joints is risky and costly, while the chance of their permanence is a small one unless very special precautions are taken. That joints are inevitable in some cases is evident when it is remembered that cablemakers are tied by practical considerations to a weight of about four tons gross per drum, so that the bigger the cable the shorter is the length in which it can be made. To avoid such joints, the lightly insulated swinging cable system of Mr. Holiday's is a considerable help; as for the size of the cable, the length per drum is greater than with insulated cables, and this practice as regards using long single cables is being appreciated in places where jointing troubles have occurred.

There is an objection to using single-conductor cables with alternating currents, as they are not so electrically efficient as three-core cables, but this is more a theoretical than a practical disadvantage, especially if the cables can be arranged for cleating up together in a bunch the shape of the ace of clubs, and not side by side. The rule (denuded of its mathematical garnishing) is that the closer the three cables are together, with equal distances between each and each, the more electrically efficient the arrangement. If jointing is absolutely necessary in the shaft, the best method is to excavate a chamber in the side of the shaft about 6ft. cube, so that the jointer and his mate may work in comfort and safety; supervision can be easily given, and the joint itself will then be protected in the best manner possible. This may seem an expensive business, but when it is compared with the cost of either rigging up a platform in the shaft, with a roof, or of using the cage exclusively (which is not always a convenient or even a sufficient arrangement), together with the risk of a badly-made joint under the dangerous and possibly damp conditions of working, and the moral certainty that sooner or later something will hit that joint in the shaft with a wallop, to its undoing, it will be seen that there is nothing to lose by making the better job at once.

And here is a fitting opportunity for mentioning to those who may not have had much experience with colliery working—that *the work must not be stopped*. In some mines this principle is so thoroughly understood that the usual mechanical factor safety of 6 is derided, 10 and 12 being considered the least possible figures. This means greater initial capital expenditure, but it is understood that the insurance as to continuous working and lack of accident to life or property is cheap at the price. It will be well for colliery managers if they follow this principle out when arranging for electrical working, and will restrain their lust for buying in the cheapest market. At the worst it is better to overpay one firm for provedly good material than to underpay a competitor for doubtful stuff.

Having cleated our cables, at the sides of the downcast shaft for preference, and made the least possible number of joints in pitshaft alcoves, we terminate mains at the switchboard, either at the bottom of the shaft or in the nearest airway. This switchboard should be in a chamber of its own, and so arranged that, should anyone be killed by contact with it, a verdict of *felo de se* would be returned by the jury. Such an arrangement for securing safety is common enough practice with ordinary electrical work, and it should be borne in mind that danger precautions should be multiplied by a constant of 3 in order to guard against the trebly superior foolhardiness of pitmen.

The runs from the main switchboard to the various points of supply will usually differ considerably in character, and therefore, before deciding on the type of cable, it will be well to go over the ground and to note its peculiarities. As in the case of pitshaft cables, there are in use underground a variety of cables and methods of installation, and every other pit manager or engineer has his own pet idea. The report of the Departmental Committee on the use of Electricity in Mines, published in 1904, says, "There are conflicting opinions about cable-laying. Some want the cables armoured; others think armouring a source of danger; some bury them in the ground; others hang them along the roof and sides; some advocate casing; others prefer to keep them constantly in view"; and it is very clear to one who understands how the varying conditions underground affect cables why these divergencies of opinion are so great.

For instance, the question of armouring a cable depends largely upon the degree of dryness of a mine. If a mine is very wet, then armoured cables should be used: (1) because, in the event of an unarmoured cable being damaged, the damp will make the outside of the cable a dangerous conductor in the neighbourhood of the damage, without giving warning at the switchboard; and (2) because it is easy to make earths in a wet mine for such stray current to go to from the armoured cable, and thus at once to blow the fuse so as to render a dangerous length of cable dead for the time. In dry mines, however, it is so difficult to make an earth connection that a fault upon a cable would only discover itself by a low insulation reading at the switchboard, and would confine its danger to the immediate neighbourhood of the fault. So that unless a man touched the actual "spot" on an unarmoured cable, he would stand no danger from casually handling the faulty cable. And the great and abiding consolation of being able to run the show without a stop would be in the heart of the manager. But faulty cable of the armoured type would as thoroughly shut down the mine, in most cases, as a faulty armoured cable improperly earthed would extinguish the man who came in contact with it. Therefore the decision as to the type of cable protection to be used in the workings should depend upon the degree of humidity prevailing. In some cases where armoured cables are in use, and an efficient earth is difficult to obtain, old wire ropes are buried in the roads or airways for considerable distances, being satisfactorily earthed at one point, and connection made at intervals to the armouring of the cables.

The question as to the style of cable to be used underground is often settled by the type of cable used in the pitshaft, as there is a big advantage in connection with the working and maintenance of electric cables to have them as uniform as possible. So that, as bitumen-sheathed cables were used in the shaft in this instance, and as they are as good as anything else for most situations, we will decide to use them underground.

As regards arrangement of conductors: two singles are preferred for situations where they are of moderate size and where duplicate mains are not used; as, if an accident happens to a concentric cable in most instances, it results in that calamity known as a "dead short." Whereas with single cables (especially when spaced well apart) there is much less chance of one or even two earths resulting in anything of so grave a character. As before mentioned, it is a safe maxim that when in doubt don't use armoured cables, so we will take advantage of it for the underground cables of this mythical installation, and will put in mains to the following specification: Cores consisting of untinned stranded copper wire, paper insulated, bitumen sheathed, stoutly taped over the bitumen, served with jute, impregnated with preservative compound. The method of installing this cable has to satisfy three requirements, if reference is made to the report of the Mining Committee—*i.e.*, liability of shock to workmen; of setting fire to woodwork, etc.; of originating a gas explosion. One simple rule only, however, need be kept in mind in this connection, and that is, permanency of working if necessary. (To this might be added the rider: Simplicity of access for examination and possible replacement, if injured notwithstanding precautions.)

Cables running along haulage roads may usually be laid under the roadway, preferably in a trough, when such roads are permanently arched, or they may be let into a chase in the wall, or they may be cleated to the timbering where such exists, preferably inside, out of the way of danger. If H girder arches are used, with billet packing, there is no other way than cleating the cables outside them, if they cannot be buried. In some mines, however, continual movement of the floor precludes the advisability of burying the cables. Where there is risk of damage in hanging cables up, it is best to run the mains in duplicate, one set on either side of the road upon cleats, and to have

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special protection, such as split hose piping, slipped over them and bound down at intervals.

When laid in trenches, whether cased in troughing or not, it is very necessary that stones are not allowed to bind against the cable, or even to touch it. Many faults in connection with underground cables are caused by sharp pieces of rock being left near the cable and driven into it by the action of the punner, when the dirt is filled in. And this cannot be properly guarded against unless the cable is put into a trough that just fits it, with a properly fitting cover that will not be displaced by the conditions of reinstatement. The use of plain tiles in such circumstances is not advocated, as they are so easily shifted from their sheltering position, when not held in place by melted pitch, as is usual on public electricity mains. The use of such a pitched-in solid system can seldom be arranged for underground, especially in mines where firedamp is prevalent, but, needless to say, this makes a much more reliable system if properly installed. When buried, the depth should be such that a derailed truck will not touch the main.

In airways, which are not so well looked after as the haulage roads, timbering is usually used for supporting the cables, especially as falls of roof frequently alter the level (by as much as 10ft. in course of time), this level changing in somewhat similar style to the Irishman's blanket, when its owner cut off a portion of the head end and sewed it on to the feet end, in order to keep his lower members covered. These cable supports should be attached to the timbers as much out of reach as possible. A common method is to hang the cables by leather suspenders, spun yarn, string, or wire, to clout nails or lewis bolts let into the walling, roof, or timbers, with some slack cable between each support. The idea is that if a fall of roof occurs, the cable is easily borne to earth at the afflicted point by the light supports breaking, and the slack from both ends is pulled up to the point in question by the strain. This give-and-take arrangement acts well in some cases, but at times the binding refuses to give way until such excessive pressure is brought to bear upon it that the insulation is damaged at the obstinate point of support. And it should be remembered that the mining regulations now forbid the use of metallic fastenings for cables that are not sheathed or protected metallically. The most flexible method in present use is that of running the cables on stoneware bobbins which have a deep groove to hold the cable in position. These bobbins are free to revolve on a bolt which is either screwed into the timbering or cemented into the walling, and when going around bends an additional bobbin or guard is put in above the cable to prevent it riding over the flanges when brought into tension.

(To be continued.)

ALTERNATE-CURRENT ELECTROLYSIS AS SHOWN BY OSCILLOGRAPH RECORDS.*

BY W. R. COOPER, M A, B SC.

As the subject of alternate-current electrolysis is again attracting some attention, it may be an advantage to review briefly the views which have been put forward during the last few years. G. Mengarini in 1891 discussed the problem pretty fully, though not very clearly. He laid down the laws that the decomposition is always less than with an equal direct current—that is, equal as regards coulombs per second—the decomposition increasing for the alternate current as the current density at the electrodes increases; that there is a limiting current density (depending on the electrodes and electrolyte) below which decomposition does not take place; and that there is a limiting frequency above which decomposition does not take place. Polarisation is considered as represented by a curve of half the frequency of the current curve, and to have an effect equivalent to self-induction, for which views there does not seem to be much justification. He also came to the conclusion that decomposition cannot take place at an electrode unless the area is small enough to allow the fully-polarised condition to be reached with the current used, and thus it might be that decomposition takes place at one electrode and not at the other, giving rise to rectification. In 1893 Hopkinson, Wilson, and Lydall read a paper to the Royal Society in which a leading current due to polarisation is well shown, and the conclusion is reached that about one-tenth of a coulomb is enough to fully polarise 150 square centimetres of platinum in dilute sulphuric acid. In 1895 Peukert described experiments in which he had been unable to find any phase difference. Dolivo-Dobrowolsky pointed out that these experiments were inconclusive, that he himself had obtained large phase differences, and that polarisation should be equivalent to capacity. M. Wein supposed an electrolytic cell to be equivalent to a resistance in series with a capacity, but he found the

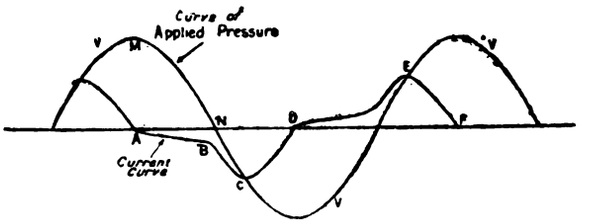

FIG. 1.

resistance required to be higher than that calculated from the dimensions of the cell and conductivity of the electrolyte. Oliveri, by plotting experimental curves, found evidence of various stages of polarisation, and that when the polarisation is slight a voltameter acts like a condenser. Investigations have been carried out by A. Franchetti on polarisation considered as capacity, and by Warburg and Strasser on the behaviour of unpolarisable electrodes. That part of the subject depending on Faraday's laws has been investigated by Malagoli, by E Wilson, and by Le Blanc and Schick.

It is, however, rather with the physical side of the question that we are concerned for the moment. Any experimental curves in the investigations to which we have referred were obtained by a Joubert contact disc. This method is laborious, and of necessity only approximate. It therefore occurred to the author that more exact information might be obtained by oscillograph records, and that some contradictory views might perhaps be cleared up in that way. About a year and a half ago Mr. W. Duddell kindly lent a double oscillograph to the author, and a number of photographic records were obtained, some of which are here reproduced. It has generally been assumed that polarisation is equivalent to capacity, so that it may be worth while to compare briefly the two quantities.

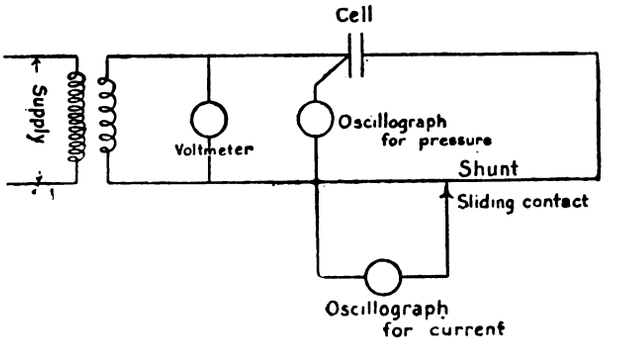

FIG. 2.

Suppose we assume that a sine current is flowing through a resistance, R, in series with a condenser of capacity K. The current, assuming that it is a sine curve, may be expressed as

$$A = A_0 \sin p\ t,$$

in which A is the current at any time t, A_0 is the maximum value of A, and $p = 2\pi n$, where n is the frequency, as usual. In order to find the expression for the volts which must be impressed on the circuit, we know that the component necessary for resistance must be equal to R A, in phase with the current. As to the component necessary for the capacity, we know that if V volts are applied to the terminals of a condenser having a capacity of K farads,

* Paper read before the Faraday Society, Oct. 13.

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the number of coulombs, Q, with which the condenser will be charged is given by the equation

$$Q = K V \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

from which we have, by differentiation,

$$\frac{dQ}{dt} = K \frac{dV}{dt}.$$

Since $\frac{dQ}{dt}$ is the number of coulombs per second, it is the current that is flowing, or A, so that we have

$$A_0 \sin p t = K \frac{dV}{dt} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Hence if the pressure at the terminals of the condenser is to be a sine function like the current, we have the current derived from the first differential of the pressure, so that one must be in quarter phase with the other. By completing the investigation we know that this component is a quarter of a period behind, so that the resultant is displaced in the same direction and the current appears to lead

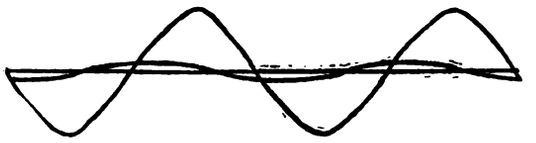

FIG. 3.—Applied Pressure, R.M.S., .03 Volt

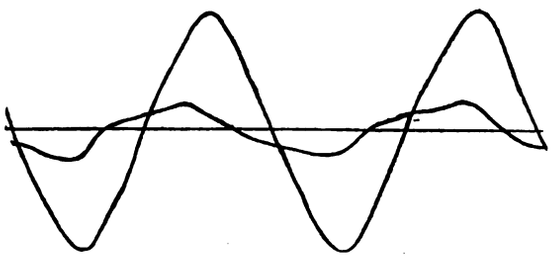

FIG. 4.—Applied Pressure, R.M.S., 0.5 Volt

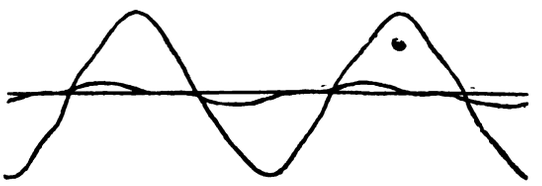

FIG. 5.—Applied Pressure, R.M.S., 0·65 Volt.

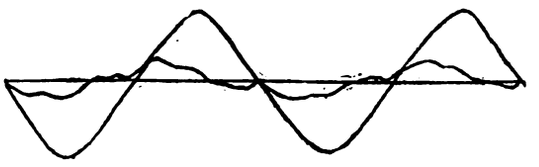

FIG. 6.—Applied Pressure, R.M.S., 1·0 Volt

If, now, we turn to polarisation, we have electrodes, each of a certain area, a, and if it is assumed that the products of decomposition are not removed by diffusion or otherwise, we may say that the polarisation is proportional to the quantity of electricity passing from the time that the current is zero up to a certain limit, and that a back E M F. of one volt results when a certain quantity, q, per square centimetre has passed, this quantity depending, of course, on the nature of electrodes and electrolyte. If, now, a pressure, V, is applied to the terminals of a voltameter, such pressure being below the limit of polarisation, then the quantity of electricity, Q, which passes is given by

$$Q = q a V,$$

which is an equation of the same form as equation (1) for capacity. Further, if it can be assumed that the behaviour is the same for a falling as for a rising current, we have

$$\text{current} = \frac{dQ}{dt} = q a \frac{dV}{dt},$$

which is of the same form as equation (2), and shows that this component is in quadrature with the current. This might be put otherwise. If P is the polarisation in volts and a current $A_0 \sin p t$ is flowing, then, since P is proportional to the quantity of electricity passing as the current rises, we have

$$P = - b \int A_0 \sin p t,$$

in which b is a constant, or

$$\frac{dP}{dt} = - b A_0 \sin p t,$$

so that the component for polarisation is in quarter phase with the current.

Unfortunately, we have no right to assume that the current is given by a sine curve, and we think this assumption has led to wrong conclusions in some of the investigations referred to. The applied pressure may be a sine

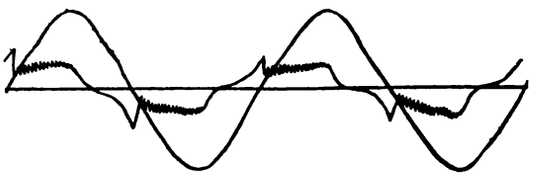

FIG. 7.—Applied Pressure, R.M.S., 1·15 Volts.

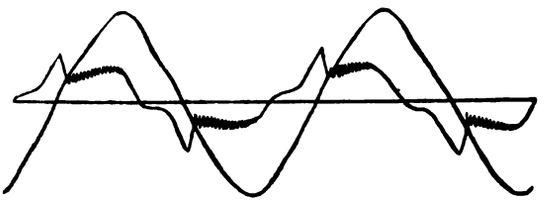

FIG. 8.—Applied Pressure, R.M.S., 1·3 Volts.

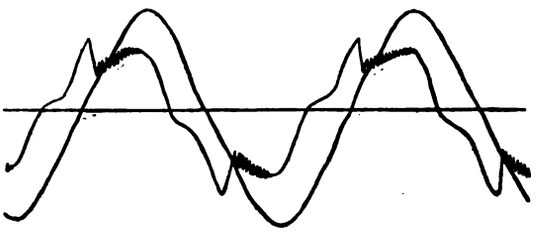

FIG. 9.—Applied Pressure, R.M.S., 1·5 Volts.

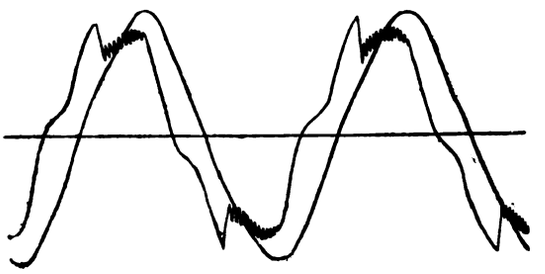

FIG. 10.—Applied Pressure, R.M.S. 1·8 Volts

curve, and if polarisation acted like capacity the current might also be a sine curve. But although polarisation may rise as rapidly as the current giving rise to it, in the same way as a condenser is charged as rapidly as the potential difference applied to it rises, there is not a corresponding behaviour as the current falls. In the case of a condenser the discharge follows the fall of the potential difference—there is no lag for all practical purposes. But in the case of a voltameter the polarisation does not discharge itself rapidly; in fact, it is a slow process. Consequently, when the applied potential difference fails, the E M.F. of polarisation remains and falls but slowly, because its fall depends upon voltaic action such as occurs in a gas cell, and this can only take place slowly under the circumstances. Therefore, polarisation acts as a sort of one-sided condenser, which is normal in charging, but refuses to discharge, except slowly, until forced to by a reverse charge. Moreover, it acts as a leaky condenser; the higher the applied potential difference the greater the leakage, until

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finally the back E.M.F. rises no further, and visible decomposition takes place.

It is, therefore, evident that we should not be justified in assuming a sine curve for the current under circumstances where much phase difference is to be expected. Perhaps the simplest course is to assume a sine curve for the applied pressure and then to construct a curve for the current. In order to simplify matters we will assume that the resistance is negligible, so that any pressure in phase with the current may be neglected, and we will take the case in which the maximum value of the applied pressure is below the limit of polarisation, and in which the electrodes are proportioned to get polarised up to the applied pressure. Let V (Fig. 1) be the sine curve of applied pressure. Then a current will flow as V rises, but it will become less and less as the maximum is approached, and will become zero when V is a maximum, because V will be balanced by the polarisation. Thus the current will be zero at the point A. As the pressure falls from M to N it will be below the E M.F. of polarisation; there will be excess of E.M.F. in the reverse direction to the applied pressure, and, therefore, a negative current will flow, but as it depends on voltaic action the current will be small, and indicated in the figure, we will suppose, by A B. But when the applied pressure becomes negative after the point N, it will be acting in the same direction as the residual polarisation, and there will be a rapid rise of current. This will wipe out the residual polarisation, after which the polarisation will reverse, and the current, after rising to a maximum, will fall to zero when V reaches a maximum negative value, so that this part of the current curve is something like B C D. The curve is then repeated in the positive sense, giving the curve A B C D E F for a complete wave. It will be seen that the curve is not a sine curve, and that it is leading by a quarter of a period. If the resistance of the cell is important, the phase difference is, of course, less than a quarter period. This is equally so if the applied pressure exceeds the back E.M.F. of polarisation, for the current then is not zero when the applied pressure is a maximum.

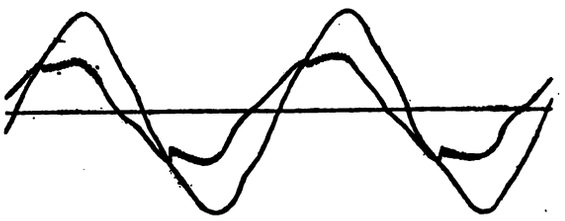

FIG. 11.—Applied Pressure, R.M.S., 2·2 Volts. A small bubble of gas noticeable on each electrode.

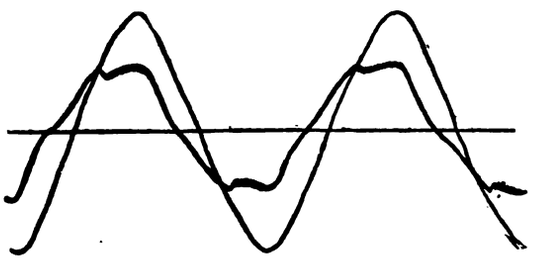

FIG 12.—Applied Pressure, R.M.S., 2·6 Volts.

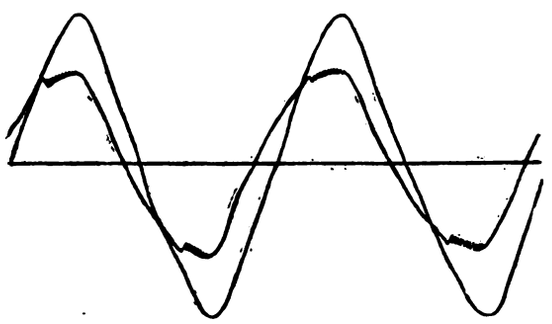

FIG 13.—Applied Pressure, R.M.S., 3·2 Volts.

In the oscillograph experiments the apparatus was connected up as shown in Fig. 2. An adjustable transformer was used so that the required pressure could be obtained by a simple adjustment without inserting any resistance. Current was taken from the mains of the London Electric Supply Corporation, so that the frequency was about 83 per second. A non-inductive shunt, consisting of a length of manganese wire, was used for varying the sensitiveness of the oscillograph for current, and this was adjusted by a sliding contact. As a large phase difference was desired small electrodes were used, so that they would be rapidly polarised. They consisted of platinum wires, 0·18mm. in diameter, projecting out of glass tubes into which they were sealed. The wires projected (and were, therefore, immersed) 2cm., and they were placed 3·2cm. apart. The electrolyte was dilute sulphuric acid of specific gravity 1·130. The results obtained are reproduced in Figs. 3-16, in which the larger curves refer to pressure and the smaller to current. From these it will be seen that the current curves are of the general form arrived at in Fig. 1. At very low pressures this is not so noticeable, although the phase difference approaches a quarter period. But in Fig. 5, referring to a pressure of 0·65 volt, the smaliness of the current in the first and third quarters of its period is clearly seen. In Fig. 6 it is still more marked. At higher pressures there is a very marked variation of the current as the pressure passes through the zero value, the cause of which is not clear. It may possibly have something to do with the fact that the surface of the electrodes was very small, and that in such a case the polarisation would reverse very soon after the pressure, or it may be that there is a sudden increase of resistance due to a layer of gas on the electrodes (abnormally high resistance was noted by M. Wien). This effect does not begin to disappear until products of decomposition are apparent, as in Fig. 11, with a pressure of 2·2 volts. As the pressure is further increased the current curve becomes more and more like a sine curve, and the phase difference diminishes as would be expected.

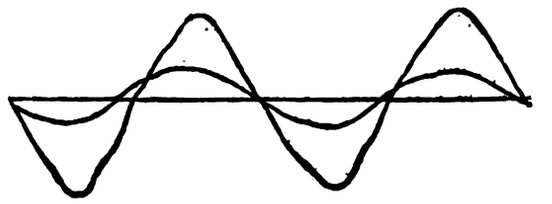

FIG. 14.—Applied Pressure, R.M.S., 3·85 Volts. Gassing just noticeable.

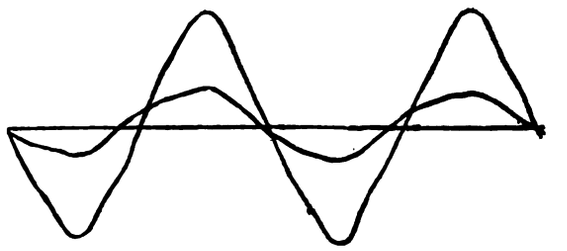

FIG. 15.—Applied Pressure, R.M.S. 5·0 Volts.

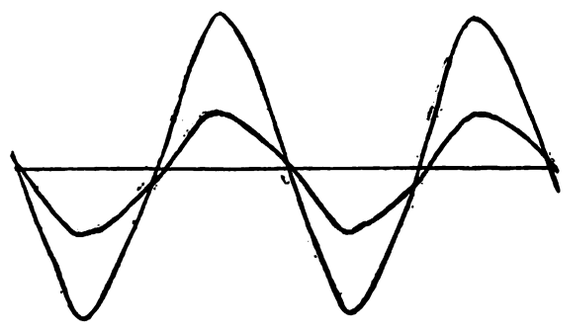

FIG. 16.—Applied Pressure, R.M.S. something above 5 Volts (too high for Voltmeter to be left in circuit). Gassing freely.

The same experiments repeated with platinum sheet electrode, each with an exposed area of about 110 square centimetres (the backs were varnished), gave current curves

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which were much more regular and more like sine curves, though with some phase difference. It is, therefore, evident that experiments on alternate-current electrolysis are not necessarily comparable unless the electrodes are similar. The author also obtained records when a small induction coil was used as a source of current, from which it appears that phase difference may be produced. This is of some importance because a coil is used in measuring electrolytic resistance by Kohlrausch's method, and if there is phase difference an error will be introduced.

CONSTRUCTION OF CANADIAN NIAGARA POWER COMPANY'S 100,000-H.P. HYDRO-ELECTRIC PLANT AT NIAGARA FALLS, ONT.*

BY CECIL B SMITH, MA.E, M CAN SOC C E.

(Concluded from page 601.)

Transformer Station, etc.—On the tableland, immediately west of its works, the company has acquired a large tract of land, and on it has been built a transformer station of 25,000 h.p. capacity, 80ft. wide by 120ft. long, having a main central room 38ft. wide equipped with a 15-ton Whiting electric travelling crane, copper oil tank, suction pump and motor, and cast-iron jack rails, resting on concrete foundations. On these rails there has been installed, for the present, 12 transformers of 15,000 kw. total capacity, fully equipped with water-cooling, drainage, and lead-lined oil drainage systems. These transformers are for 40,000 or 60,000 volt transmission, and are separated from the low-tension and high-tension switchboards by solid brick curtain walls, the cables being brought to the transformers through passages underneath the concrete floors and carried from them through overhead arches in the curtain wall, thence to the high-tension switches, from which the wires will pass out of the building through specially designed windows. The building itself is of pressed brick, with stone sills and Ludowici tile roof, and is entirely fireproof, except window frames It has a central monitor roof for light and offices near the front entrance, which is a door of capacity for fully loaded freight cars to enter far enough to transfer loads to the crane. Adjacent to this station has been built a stand-pipe 30ft diameter by 116ft. high, which is connected to the main water system, from wheel-pit to transformer station, and the flow of water from which is controlled by a motor-driven valve operated from the transformer station, the object of which is that in case of fire the stand-pipe can be cut out, and the two pumps at the wheel-pit, by working tandem, can raise the pressure of water to 120lb. at transformer station floor line during the fire period. The function of this stand-pipe, however, is purely one of reserve in case of a breakage of the pumping and pipe systems supplying the transformers with water for cooling, in which event the stand-pipe capacity is estimated as being sufficient for 50,000 h.p. for 24 hours, or for 48 hours for the present station. In view of the importance of continuity of operation, this safeguard, although costly, was considered necessary; indeed, speaking of the equipment in general, every effort was made to design the plant so as to obtain a maximum of reserve in cases of breakdown.

Power-House Machinery.—For handling materials two 50-ton four-motor electric travelling cranes were installed, which, by working with a carrier, can together handle practically 100 tons. These cranes operate with 125-volt direct current, and have auxiliary five-ton hooks for fast service and light loads. The Sellers cranes, which are the ones here used, have, as a distinctive feature, fixed drums, the carriage only travelling. The speed requirements with full loads were: main hook, 10ft. per minute; auxiliary hook, 50ft. per minute; trolley travel, 25ft. to 50ft. per minute; and bridge travel, 200ft. per minute. The main turbines have twin draught tubes emerging into the sides of the pit immediately above the invert, and, owing to the great depth of water which there will be normally in the pit with the whole plant in operation, not to speak of the effect of back water during high water in the lower river, it was necessary to locate the turbines about 47ft. above the invert of the tunnel, and although air pressure is equivalent to about 33ft. water head, it has not been found practicable to operate safely with more than 25ft. of draught tube effect, which necessitated some artificial means of creating a pondage in the wheel-pit with only a few wheels in operation. The result was obtained by installing a huge regulating lift gate at the extreme lower end of wheel-pit, where connection is made with the tunnel, and operating the same by lift screws, overhead girder, and 85-h.p. 125-volt direct-current motor (a second motor in reserve. The water will pass under the gate, and in order to resist the constant vibration very heavy cast-iron grooves grouted and bolted into the brick lining walls of the wheel-pit rest against masonry specially cut and built into these walls to receive the grooves, and the gate is equipped with an oiling system fed from a flexible piping. The 10,000-h.p. turbines are described as twin inward discharge, Francis type, operating at 250 r.p.m. under 136ft. net effective head, and have solid bronze runners 5ft. diameter, and cylinder gates, controlled each by four racks and pinions. The racks move on opposite sides of the pinions, so that one gate rises as the mate to it lowers, the whole movement for each unit being controlled by a connecting road from the Escher-Wyss governor situated on the power-house floor.

The revolving parts of a turbine and generator, and the shaft connecting them, are supported as follows: in addition to the upward thrust on the lower runner, there is a balancing piston located immediately above the wheel case, and the piston for each unit is directly supplied with water from the forebay by a 12in. pipe, but as a reserve, in case of accident, there is also a connection with each penstock. In addition to this there is attached to each main shaft immediately beneath the generator a thrust bearing, capable, when operated with high-pressure oil, of carrying the whole weight of the revolving parts of a unit, which amounts to about 243,000lb. This bearing is fed from the oil chamber with oil, which is raised to a high pressure by a pump located immediately alongside on the thrust deck; after leaving the bearing the oil flows back to the chamber to be cooled, clarified, and pumped back again to the thrust deck. The turbine shafts are hollow seamless cylinders 40in. in diameter, with weldless flanges, which connect by couplings to nickel steel bearing shafts 14in. diameter, bored out 8in., at the various bearings and connections, there being two intermediate bearings for supporting the shaft between the thrust bearing and balancing piston. The main penstocks each consist of a lower cast-steel elbow in two sections, weighing 49 tons, which sits astride of the pit and carries the weight of the penstock and the water contained therein; above this are five straight sections of riveted pipe 10ft. 2½in. in diameter, having weldless steel flanges, and an expansion joint connecting to the cast-iron mouthpieces in wheel-pit wall by a steel upper elbow. The calculated speed of the water with full load on a unit is about 11ft. per second. Five units of 7,500 kw. output each makes the present installation, but the plant is built for 11 such machines, the eleventh being counted a spare, and in order to increase the present output it will only be necessary to extend the power-house building and install such machinery as may be required.

For supplying the various water-driven machines in the chambers, an independent water system has been installed, which consist of a 36in. riveted main with weldless flanges along the rack deck, fed from the canal by two 36in. and five 24in. vertical pipes. Of these one 36in. and two 24in. pipes are in the first installation. From this main, which is sub-divided by valves at various points, rising pipes enter the chambers, and after operating the machines, the water passes by draught tubes into the tailrace below. In one chamber is located an exciter plant making 125-volt direct current, which is used not only for excitation of large generators, but for operating cranes, switches, various gate and pump motors, and lights, etc. This plant consists of three vertical direct-connected units of 332 h.p. each, the turbines being single, spiral case, inward and downward discharge, running at 600 r.p.m. under 131ft. head, and controlled by Lombard governors. These units have oil bearings, sup-

* Abstract of paper read before the Canadian Society of Civil Engineers.

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plied with low-pressure oil from the oil chamber, and are each quite independent, so that any unit can run with the other two shut down for repairs. In a second chamber are located two pump units. Each unit consists of a horizontal turbine direct connected to a centrifugal pump of 3,000,000 gallons per 24 hours capacity. These pumps can, as before remarked, be run in tandem in case of fire so as produce a fire pressure at the transformer station of 120lb., with a pressure at the pump of 210lb. per square inch. The turbines are driven from the 36in. auxiliary main and discharge into the tailrace by draught tubes built into the brick wheel-pit lining, while the pumps draw their water from one of the 24in. supply pipes from the canal, and discharge by a 24in. pipe up the wheel-pit, and thence out and to the transformer station, a half-mile distant, by a 12in. water-main. In a third chamber there is a very complicated system of motor and Pelton driven Quimby screw oil-pumps, oil-tanks, filter tanks, and cooling tanks, all so interconnected as to produce necessary circulation, which consists, briefly, in there being two circuits, one for low-pressure and one for high-pressure oil. The oil traverses from a machine back to the cooling and filter tanks, thence to the suction tanks, from which it is again pumped back to the machine. The high-pressure oil is handled in the same manner, except that a special pump is located at each thrust bearing, and raises the oil pressure at these bearings, after which this oil also flows back to the oil chamber to be cooled and clarified. In this chamber is also a specially designed Pelton-driven air-compressor, and in a chamber on the upper level adjacent to the main subway are located storage tanks of large capacity for storing oil, while a pressure oil tank is also located in the roof of the power-house.

The main power-house floor will contain only three items of equipment—namely, the 7,500-kw. generators, the turbine governors, and the main switchboard. So that the view from the visitors' gallery will be one of extreme simplicity, as the armatures of the generators are external and stationary, and the governors are very innocent-looking machines in line with the generators, and not observable from the north end of the power-house. The generators are about 18ft. in diameter, with internal revolving fields, and deliver three-phase 25-cycle current at 12,000 volts, which was adopted in order to enable local distribution for several miles to be made without transforming. As these generators were both too large and too heavy for transportation, it was necessary to have them completely assembled at the shops, then taken apart and packed in hundreds of boxes, and shipped knocked down to the works, where it took several months to rebuild the fields and armatures piece by piece, there being, it is understood, 47,000 punchings in each armature. There are two subways just below the power-house floor, one to the right being for cables, and the main one to the left for cables and for the substructure of the main switchboard, which for each 50,000 h.p. is about 150ft. long. The subway itself runs the full 600ft. length of the plant, and has a series of chambers opening off to the left, one at each inlet breast wall, which will be devoted to miscellaneous purposes, such as location for small transformers, etc. The main switchboard consists of a lower part in the subway, made up of 'bus-bar compartments, divided up vertically by brick walls and horizontally by soapstone slabs, and containing motor-operated oil switches, and above the power-house floor the switchboard proper, from the gallery of which a full view of the power-house is had, and which is equipped with switches necessary for full control of the station. Cables leave the power-house by three manholes—one situated at each end and one at the west side—from whence they pass through conduits, already described, either to the transformer station or to Niagara Falls, N.Y., to deliver current supplementary to that generated by the Niagara Falls Power Company. These cables are lead covered, 2½in. diameter, and contain three-phase 19-strand copper conductors, each ½in. diameter, which are insulated by paper and gum wrappings, the whole three being again insulated by similar wrappings beneath the lead covering.

The ground for this plant was broken in September, 1901, although the tunnel and cofferdam had been nominally commenced somewhat earlier, and water was turned into the forebay Nov. 9, 1904, the exciter chamber was ready for operation Nov. 24, 1904, and the first 10,000-h.p. unit Dec. 23, 1904—while two 10,000-h.p. units were ready for operation Jan. 1, 1905. The third unit will be put in operation in a few months, and the fourth and fifth units during the summer of 1905, while the extension of wheel-pit complete, brick lined, and ready for the machinery of the remaining six units should be completed during 1905. It will be appreciated that during this period Queen Victoria Park, with two other large and one smaller plant under construction, was in a state of great chaos, and this is largely the case at the present time, but the companies are under obligations to place their respective areas in good condition as soon as construction is finished, and when this has been done the southern part of the park, which was always in a state of nature, will be vastly improved. The Canadian Niagara Power Company, in process of construction, filled in the foreshore of the river for about 100ft. in width from the Horseshoe Falls southward for over half a mile, and this will be also sodded and added to the park area.

The principal contractors connected with the works were: James Barry, cofferdam; Dawson and Riley, wheel-pit and canal; Queenston Quarry Company, arch bridge; A. C. Douglas, tunnel and portal; Wm. Grace Company, power-house; Brass Bros., transformer station; Escher, Wyss, and Co., turbine units Nos. 1, 2, 3; I. P. Morris Company, turbine units No. 4, 5; General Electric Company, generators and main switchboard; Jenckes Machine Company, exciter turbines; Westinghouse Electric and Manufacturing Company, exciter generators; Canadian General Electric Company, transformers; Canada Foundry Company, various lift gates, etc.; Hamilton Bridge Company, power-house steelwork; in addition to which a great many contracts were placed in Canada and United States for various pipings, steel floors, smaller machinery, etc. The policy was at once established of having continuous and thorough inspection in keeping with the rigid specifications and high class of work demanded, and a large number of inspectors were employed, who were located at the various manufacturing centres and on the works itself. As these men were all the best that could be found for the various classes of work being done, it is believed that the results warrant the large attendant expenditure. For mill material the Pittsburg testing laboratory did the inspection.

For the complete study, design, and execution of such an undertaking as has just been described the engineering department was necessarily somewhat complex, there never having been any chief engineer, either nominal or actual, the organisation being as follows: chief mechanical engineer, Dr. Colman Sellers; consulting hydraulic engineer until Dec. 31, 1903, Clemens Herschel; consulting engineer until March 1, 1904, W. A. Brackenridge; resident engineer in charge of construction, Cecil B. Smith; electrical engineer, H. W. Buck. Speaking generally, the designing was done under the direction of consulting engineer Brackenridge and by the designing staff of the Niagara Falls Power Company, in charge of A. H. Van Cleve, until March, 1904, since which time the writer assumed Mr. Brackenridge's functions; but the liberal policy of the company was that all the main points of design were determined after full discussion by the various engineers mentioned.

In carrying on the work of construction the company allowed the writer full choice of whatever staff was considered necessary, and to employ also such inspectors in different branches as were needed. The chief assistants were as follows: principal assistant engineer, G. A. McCarthy; assistant mechanical engineer, C. C. Egbert; assistant electrical engineer, G. E. Brown; assistant engineer of wheel-pit and canal, Wm. Macphail; assistant engineer of tunnel, L. Sherwood. To these gentlemen the writer wishes to here tender his extreme appreciation of those qualities which made it possible to carry on such an extensive work with satisfactory results, and in that harmonious spirit which prevailed from the commencement of the work until the time (December, 1904) when the writer completed his engagement with the company.

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TO CORRESPONDENTS.

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THE L.G.B. AND ELECTRICAL UNDERTAKINGS.

Government in this country is a mysterious matter, whether it concerns Imperial or local affairs. The latter is the concern of the moment. Broadly speaking, it is based upon the idea that those who pay the piper may call the tune, and it is difficult to improve upon that idea. That idea, however, is merely in the abstract; when we come to consider actualities the case is altogether different. Many good reasons can be assigned for the anomalies which exist, though some of these anomalies are so atrociously bad that no possible reason can be given for their existence. To follow the question of local self-government through all its phases would require an encyclopædia, hence we shall refer only to what concerns us at the moment. Legislation compels local authorities to do certain work, it permits them to do other work. Of late years, as our readers well know, local authorities have largely embarked in work of a trading or semi-trading character. If the authority likes to raise money by, say, increasing the rates so that the income from that source is always sufficient to meet the expenditure involved the Local Government Board have no finger in the pie, but if the undertakers want to borrow money—that is, to contract a loan—the Local Government Board has its say in the matter. Roughly, the course of procedure followed is that a majority of a council becomes convinced that it will be for the benefit of the constituency to embark in certain operations, say the installation of an electrical undertaking. This majority having carried their point in council, the matter is put into the hands of a committee. Investigation as to how the thing will be taken up by users is made, plans are prepared, the cost is estimated, the plans are submitted to the Local Government Board for approval, and sanction is also sought for the loan required. Assume for a moment that the very best advice is sought and obtained by the committee. The engineer who advises has to consider immediate requirements, and immediate future requirements. He must look ahead, but not too far ahead. If he does the latter, and in his plans provides for a quarter of a century in advance, he is uncertain whether improvements will not come along before that period has more than partly elapsed to render nugatory a part or the whole of his design, and so he may saddle the authority with a huge expenditure that acts like a nether millstone round the neck of a drowning man. On the contrary, he may be too nervous to look enough ahead, and his designs may very soon prove defective because of their inflexibility to cope with the demands made upon them. Fortunately or unfortunately, just according to the man and from the point of view the matter is considered, many of the undertakings of local authorities have been installed under the condition of too little looking ahead, hence extensions and alterations have soon become necessary. Of course, extensions mean more expenditure and further recourse for the approval of the Local Government Board. The engineer is not always—indeed, not often—to blame in this matter, because the moment any section of a council suggests a certain course of action the opposition is up in arms, hence compelling a very close attention to what is spent, and too frequently partly spoiling the ship for a ha'porth of tar. So far we have touched upon the local authorities' share of the business. We have now to refer to that of the Local Government Board's. In the first place, it has to agree as to the suitability of the plans for the proposed work; secondly, to sanction the loan required. Generally, an inspector of the Board makes a local inquiry to hear opinions for and against the scheme, and after due consideration of all that has been heard sanction is given or withheld. We

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are not trying to devise a better system. We are not even criticising the system adversely, but after this brief history of the system we are going to condemn root and branch the view which seems to have lately taken root in the minds of some inspectors, that it is their duty to consider the question municipality *v.* company, or to base their decisions upon other phases of work that at the moment are not forward for consideration. The number of cases in which it is deliberately stated that inspectors are hardly considering the question upon its merits is becoming alarmingly great. Let us just refer to one or two. Take Torquay. In our issue of March 25, 1898, and p. 366 is this sentence: "Outside observers, however, while acknowledging that the engineer has made the best of the site at his disposal, are inclined to the opinion that, if the demand increases as the speakers expected, troubles about extension would arise from the constricted area." At that time electric trams were not on the card. Since then they have come on—demand has increased, and extensions are wanted. Again, because of the constricted site, outsiders think no tinkering with the present station will be satisfactory. The Council were prepared to spend some forty odd thousand pounds on a new station elsewhere. The loan required by the Council did not obtain the approval of the Local Government Board. The present question is as to its attitude regarding a smaller loan for some nine thousand for tinkering with the works upon this constricted site. A report of the inquiry elsewhere in this issue shows that the work contemplated would only tide over the demand for a few years. The inspector suggested that the alternative of selling the whole undertaking to the Dolter Tramway Company should have been considered. Now take Rochdale. Here the inspector took exception to the granting of borrowing power for the electricity works because the tramways were not financially successful. What that had to do with the inspector is a mystery. The tramway undertaking is a separate undertaking, though belonging to the Council. Then the tramways were in process of conversion, and the question of financial success or otherwise could not possibly be known. The electricity undertaking wanted a loan for extensions to supply the trams at a price we are credibly informed would have paid the electricity suppliers. In the end the loan has been granted, but we are told not till the Local Government Board had written the Rochdale Corporation suggesting the consideration of taking supply in bulk. Is that a suggestion that should emanate from the Local Government Board? Must we understand that the Rochdale advisers had not considered the point before giving their advice, and is it not a fact that even had the Corporation sold their tramway undertaking to a company the supply must have been from the electricity works, because the feeders are designed and laid for that purpose, or all that expenditure wasted? In view of the above facts, and of troubles over loans at many other places, we question how far the opinions expressed at these inquiries are those of the Local Government Board and how far they are the personal and, in our opinion, mistaken view of the gentleman occupying the inspector's chair as to the scope of his powers.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

N.E.R. ELECTRIFICATION.

SIR,—As several misleading reports have appeared in various newspapers with regard to the fire at the North-Eastern Railway Company's transforming station on Saturday night last, we beg to give you below a copy of the official report of the occurrence supplied to the local Press by the North-Eastern Railway Company:

"The North-Eastern Railway transforming station at Wallsend, at which a small fire occurred on Saturday night, was running again first thing yesterday morning, though this was not necessary to enable the trains to run, as these were running from the other sub-stations an hour after the breakdown, and as soon as the cause of the trouble was discovered. The total time of failure of the train service was about an hour. The accident at the transforming station at Wallsend occurred in the following manner: The contractors to the railway company for the erection of the sub-stations were making preparations for some final tests on the machinery which they had supplied. In order to carry out these tests they erected some temporary cables. During the progress of preliminary tests these temporary cables fused and set fire to several other cables which were used for feeding the railway. The actual damage by the fire is insignificant, and none of the machinery was burnt in any way. The train service would not have been delayed even for an hour if it had not been that, unfortunately, the telephone box was the chief thing that caught fire, and could not be used. It was rumoured on Saturday night that the fire had occurred at Carville power station, but this was incorrect."—Yours, etc.,

M. SHORT, Secretary,
(For the Newcastle-upon-Tyne Electric Supply Company).

COLNE AND TRAWDEN LIGHT RAILWAYS.

SIR,—In your issue of the 20th inst. you refer to the above company's undertaking under the title "Nelson Light Railways," and say, "the Burnley Corporation run through cars, *and now that the Colne and Trawden Light Railway Company have completed their lines* the Nelson Corporation have again approached the company with a view to inter-running." So far as the Colne and Trawden Light Railways Company having completed their lines, the statement is not correct, as there is still a section of railway incomplete, but it is under construction, and with favourable weather and circumstances it should be completed within the current year. Kindly correct the statement in a future issue.—Yours, etc.,

J. H. RHODES (the Company's Engineer).

A PLEA FOR ENLIGHTENMENT.

SIR,—It seems to me time is ripe for a discussion on the relative merits of the different types of tramcars now in vogue. The tendency in this country since electric traction was introduced to increase the carrying capacity per car has been very marked, but it is open to question whether there has been a proportionate gain. Is not the two-deck covered-top monstrosity of to-day rather a huge mistake? True, the earning capacity of this type of car is greater than that of the single-decker during periods of maximum traffic, but the extra dead weight which is involved at all times tends to balance matters. Moreover, increased initial expenditure is necessitated by the use of these heavy cars. The rails must be heavier in proportion, and the whole permanent way of more solid construction. Then there is the extra wear and tear of the track to be considered, and the greater stresses which the car trucks are called upon to withstand, not to mention the increased vibration and consequent noise due to concentrated weight at yielding joints. It is significant to note that Continental engineers have not followed this country's lead. On the contrary, they have, for the most part, adopted a type of motorcar differing little in size from the single-deck horse cars displaced, the necessary extra seating accommodation during periods of heavy traffic being provided by trailers. Thus the carrying capacity of their systems can be varied within wide limits without altering the frequency of the service. At the same time it must be admitted that these small single-deck motorcars and trailers entail the provision of increased car-shed accommodation, and more of them being required to deal with a given number of passengers, the initial cost of the rolling-stock is also greater. I have

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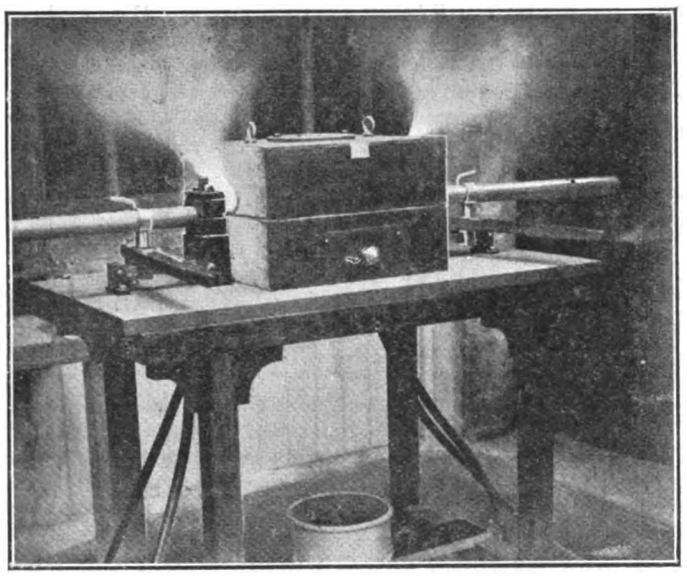
had no experience with the two deck covered-top type of car, and, therefore, venture to ask those of your readers who have had opportunities of comparing the results obtained in actual practice to state their conclusions. A little more ventilation of the subject would certainly be widely appreciated. Many, I feel sure, like myself, are open to conviction that the two-deck, top-covered type of car is well suited to the conditions here prevailing, but lack reliable data on which to base their judgment.—Yours, etc.,

DUBIOUS.

ELECTRICAL FURNACES—MOISSAN.

The electrical furnace which attracted so much attention at the Olympia Exhibition is, as was announced last week, to be used for educational work at Glasgow. The illustration which we give of this furnace herewith will remind our readers of the Marryat and Place interesting experiments. For this furnace a special 200-kw. service was laid to the exhibition. For most of the experiments shown a current of 50 amperes is sufficient, but for some as much as 1,000 amperes 200 volts is employed. The furnace is of the Moissan type, and permits of easy modification in various ways for different classes of experiment. The lining is of magnesia and carbon, and is renewed daily. The electrodes are of round carbon, 2in. by 36in, and a convenient arrangement of the holders allows the arc to be instantly extended from contact to 14in. Temperatures can be obtained up to 4,000deg. C. (7,232deg. F.), at which point all known substances volatilise. A Féry pyrometer has been



fitted up for checking the temperatures between 1,600deg. and 4,000deg. C. A feature of this type of furnace is the ellipsoidal roof cavity, which acts as a reflector, condensing the heat rays from the arc upon the crucible below. Even though the roof may be fusing rapidly, the fused material runs down the sides, and does not drop into the crucible, and the shape of the reflector remains the same long enough for the experiment to be performed.

GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Glasgow Local Section of the Institution of Electrical Engineers had their fourth annual dinner in the Grosvenor Restaurant on Friday, Oct. 27. The chairman, Mr. J. M. M. Munro, presided over a company numbering fully 200. There were present, among others, Sir John Ure Primrose, Lord Kingsburgh, Sir John Shearer, Dr. Murray, Prof. Magnus Maclean, Ex-Bailie Mackenzie, Messrs. Neil Munro, W. W. Lackie, R. Kaye Gray, Wm. Wallace, LL.D., G. C. Lloyd, W. C. Warden, W. R. Copland, James Alexander, Thomas Wright, E. H. Parker, F. A. Newington, Colonel Young, etc.

After the usual loyal toasts, the CHAIRMAN called upon Sir John Shearer to propose "The Imperial Forces." He said that in the modern battleship practically all the machinery was electrically controlled. In spite of the many critics that their army had, he was sure that what had been done in the Peninsula and at Waterloo would be repeated if the occasion ever arose. He thought that if the Volunteer forces were to be efficient, the Government was in duty bound to see that adequate finances were forthcoming for that purpose. He did not think that conscription was necessary, but they should have a system of compulsory training.

The toast was coupled with the name of Lord KINGSBURGH, who, in reply, said that he expected to find the Glasgow Local Section a small and struggling body, and was agreeably surprised to find himself in such a large assemblage, composed as it was of gentlemen who seemed to be very successful in their profession. He himself was an old member of the Institution of Electrical Engineers. He remembered reading an article in his youth in which the idea of getting power for industrial purposes from electricity was denounced as preposterous. He was told that Liebig had said so. No; it was Bunsen that had said so, and he had proved conclusively that electricity could never be commercially successful because zinc cost so much a pound. With regard to the toast, he was reminded that the first invention in the way of electricity was offered in 1816 by Ronald to the War Office of the day. It was an electric telegraph, but the reply of the War Office was that a telegraph was of no use in times of peace, and in war the semaphore was quite sufficient for all practical purposes. What had they come to now! What changes had taken place in the battleship during the last 100 years. What would Nelson say if he could be asked to step on board a modern warship? The speaker did not think he would care for it at all.

Ex-Bailie MACKENZIE, of Edinburgh, in proposing the "Lord Provost and Corporation of Glasgow," said that while the various undertakings of the Glasgow Corporation were the objects of admiration and even envy, he could not endorse some of the proposals which had been recently made, such as the purchase by the Corporation of a few coalpits, some quarries, and some brickfields. He was glad these proposals were only supported by 13 and opposed by 35. They hoped that something would be left to the individual to do besides paying rates. There was a danger that if they had 15,000 to 20,000 Corporation employés with votes, such voters might some day return men to the Council who would give them the highest wages for the minimum of work. It had been proposed that the Corporation should take over the public-houses. There would be no want of deputations then, for the members of the Town Council would need to see that the liquors kept in stock were of the proper quality.

Sir JOHN URE PRIMROSE, in reply, said that if the Corporation were to be precipitated into what was designated as a works committee to undertake all contracts, then they opened the possible door of Tammany, they limited individual effort, and inaugurated a system of collectivism that was not progress, but the destruction of progress. They would be well advised if they saw that they had men in the Town Council who recognised that they had an orbit of administration, and that did not include the carrying out of contracts which, in his opinion, a governing body should never undertake. He had been entrusted also with the duty of proposing the toast of "The Institution of Electrical Engineers." He would take the opportunity of warning them against one of the drawbacks of competition—the danger of sacrificing durability and the margin of safety to the demand for cheap work. They should try to establish and to justify public confidence by making all their work thorough, even though they lost an occasional contract thereby.

Mr. R. KAYE GRAY, of the parent institution, in reply, said that the President of the Institution of Electrical

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Engineers was unable to be present, as he had just returned from South Africa. The president-elect also regretted his inability to be present with them. He thought the electrical industry in Glasgow was greatly indebted to the liberal spirit with which electrical enterprise had been treated by the Corporation. He had to propose the toast of "The Glasgow Local Section," which was recognised by the Council in London as one of the best local sections The papers sent in by its members were generally of a high order, and the Council had recognised their merit by awarding premiums for the best of them from year to year. He hoped that the Glasgow Section would persevere in its endeavour to form a students' section. They were aware that their Institution had a membership of 7,500, and surely it was very gratifying to know that such a large number of men should find employment in their profession in their restricted island home.

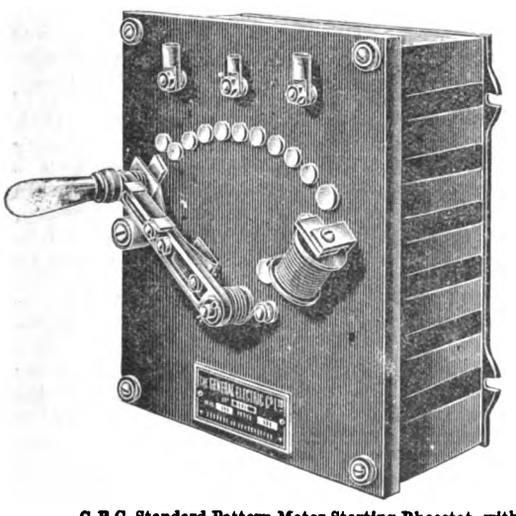
Mr. J. M. M. MUNRO, in reply, said that while hitherto they had had no lack of papers, he would like if everyone connected with the section would send in a paper to the secretary at the earliest possible moment. As the field of electrical engineering widened with the progress of science, until it seemed as if it would include everything that man may know of Nature and everything that he can accomplish in making use of the forces of Nature, it was obvious that they could accept compliments only in a spirit of humility, but that spirit, like another spirit with which they were familiar with in Glasgow, should not be taken in a form which paralysed, but in a form which stimulated.

Songs, etc, were contributed during the evening by members of the company.

TRADE NOTICES AND NOVELTIES

Engineering Supplies.

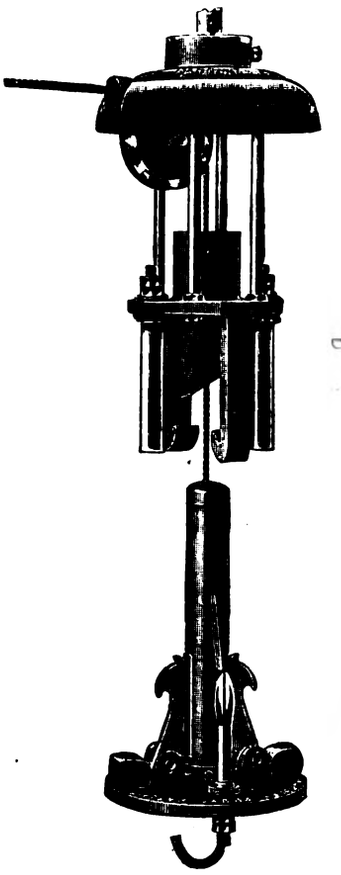
The new catalogue (Section E) of engineering supplies recently issued by the General Electric Company, Limited, Queen Victoria-street, E.C., deals with electric fans, blowers, small motors, motor starters, transformers, portable electric drilling machines, pumps, accumulators, traction supplies, etc. The pages devoted to small motors will be found especially useful, particulars of both continuous and alternating current types being given, also of small motor transformers for voltages varying from 100 up to 500. Full particulars and dimensions are given of several types of motor-starting rheostats to suit practically any condition of working. We have selected the firm's standard pattern with automatic no-voltage release for illustration herewith. Another item worthy of attention is the portable electric drilling machine, various patterns of which are illustrated, one being shown with flexible shaft. Polishing and grinding machines are also shown; these can either be fixed to the wall or bench. A pattern fitted with flexible shaft is also included. Accompanying is an illustration of this. Among the further contents of this catalogue are particulars and illustrations of reversible automatic lift controllers, including push-button controllers. The latter apparatus can be arranged for any number of floors, and dispenses with the lift attendant. The last pages are devoted to traction supplies of every description for the overhead system.



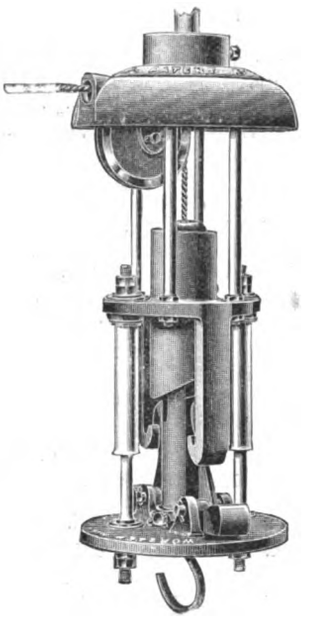
G.E.C. Standard Pattern Motor-Starting Rheostat, with Automatic No-Voltage Release.

Verity's Specialities.

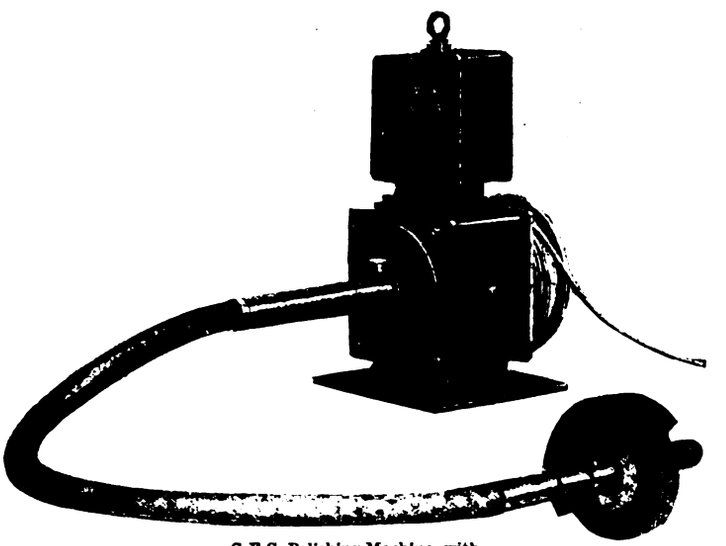
Accompanying are illustrations of the Aston-Worsley automatic clutch and contact. This device is designed for the easy manipulation of arc lamps suspended from brackets or lofty ceilings, so that by means of a winch and suspension cord they may be lowered to the ground to be trimmed and hauled up again into position without an unsightly festoon of cable. The contact gear is made to support a weight of over 1cwt., and is so arranged that when hauled up into position the whole weight of the lamp is taken off the cord and supported by hooks provided in the gear. The latter, it will be seen, consists of two parts—the upper part with a hooded dome, from which the supporting hooks depend, and the lower part on to which the lamp is attached. All the movable parts are contained on this lower half, so that should anything go out of gear at any time it can be lowered for attention at ground level. The device for hooking is very simple, consisting of two large hooks, which by gravity come into contact with two other hooks hanging from the top part, and a small catch-piece which is



The Aston-Worsley Automatic Clutch and Contact, showing the Top and Bottom Contacts about to engage.



The Aston-Worsley Automatic Clutch and Contact, showing the Clutch and Contact in use, the weight being taken off the cord.



G.E.C. Polishing Machine, with Flexible Shaft.

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loosely fixed midway between the two movable hooks. This catch-piece only comes into play when the lower part of the contact gear is hauled up into position. When the gear is required to be lowered, a slight turn of the winch in the direction of hauling up is made, and then the hooks disengage, and the lamp or other article can be lowered to the ground. The contacts are specially large, and are of the plug type and self-cleaning. A neat cylinder effectively protects the gear from the weather. There are no springs or delicate parts in this gear to get out of order. The manufacturers are Messrs. Verity's Limited, of Aston, Birmingham, and Deansgate, Manchester, from whom we have particulars also of their various arc lamps. These include the Aston-Worsley enclosed type, which we understand has already established a good reputation, although quite a recent introduction.

Catalogues, etc., Received.

ENCLOSED ARC LAMPS.—The British Thomson-Houston Company, Limited, Rugby, have recently issued a new pamphlet dealing with their several types of enclosed arc lamps for continuous and alternating current circuits. The good qualities of these lamps have won for them an extensive demand, as is apparent from the illustrations included of a few installations put up.

ELECTRO-MEDICAL APPARATUS.—The General Electric Company, Limited, Queen Victoria-street, E.C., are issuing a neat little pamphlet containing particulars and illustrations of some of their electro-medical apparatus for hairdressers, chiropodists, manicurists, etc.

NOVELTY.—From the last-mentioned firm we also have samples of an attractive little novelty which they have brought out to advertise their "Robertson" Wytelite lamps. It takes the form of a whist-marker, and should be widely appreciated by lovers of the game.

FORTHCOMING EVENTS.

FRIDAY, NOV. 3.

Junior Institution of Engineers.—At 8 p.m. (at the Westminster Palace Hotel), presidential address by Mr. Dugald Clerk, M.I.C.E., on "The Problem of the Gas-Turbine."

Dr. Gisbert Kapp.—At Imperial Restaurant, dinner.

SATURDAY, NOV. 4.

Birmingham Electric Club.—At 7.30 p.m., "Electric Furnaces," by Mr. J. H. Stansbie.

MONDAY, NOV. 6.

Society of Engineers.—At 7.30 p.m. (United Service Institute). "The Metallic Preservation and Ornamentation of Iron and Steel," by Mr. Sherard Cowper-Coles.

TUESDAY, NOV. 7.

Institution of Civil Engineers.—At 8 p.m., inaugural address by Sir Alexander Binnie and presentation of awards.

THURSDAY, NOV. 9.

Institution of Electrical Engineers.—At 8 p.m., installation of president (Mr. J. Gavey, C.B.), who will deliver his inaugural address.

FRIDAY, NOV. 10.

Physical Society.—At 8 p.m., "Temperature and Efficiency of Thermal Radiation," by Mr. J. Swinburne; "Note on Constant-Deviation Prisms," by Mr. T. H. Blakesley.

Institution of Civil Engineers.—Nov. 14, at 8 p.m., "Waterways in Great Britain," by Mr. J. A. Saner, M.I.C.E.

APPOINTMENTS VACANT.

Electrician, Burnley Union. Wages, £2. 2s. per week. Applications by Nov. 15.

Premium Pupil, Electricity Works, Canterbury. See advertisement in last issue.

Switchboard Attendant, Southend Town Council electricity works. Salary, £1. 1s. per week.

Assistant Lecturer and Demonstrator in Electrical Engineering. Leeds University. Salary, £175 a year.

Wireman for electric light and power plant. Applications to Box 29, *Electrical Engineer* Office. See advertisement.

Representatives for an electrical contracting firm. Applications to Box G 33, *Electrical Engineer* Office. See advertisement.

Canvasser for a firm of electrical contractors in London. Applications to Box No. 514, *Electrical Engineer* Office. See advertisement.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office. See advertisement in last issue.

TORQUAY EXTENSIONS.

Second Local Government Board Inquiry.

On Tuesday last Mr. H. Ross Hooper, C.E., conducted a Local Government Board inquiry at Torquay into the application of the Town Council for sanction to borrow £9,500 for the extension and improvement of the electric lighting and power station on Beacon Quay, with the object of providing additional current for the working of the tramways. Mr. Percy T. Pearce (Plymouth), instructed by the town clerk (Mr. F. S. Hex), appeared for the Corporation.

The TOWN CLERK estimated the population at from 34,000 to 35,000, and the annual assessable value £179,573. The balance of outstanding debt was £532,888. Under the local Acts the Council were entitled to deduct loans to the extent of £275,251. The amount to be calculated in respect of two years' assessable value was £257,637, thus leaving the margin of borrowing power in favour of the Corporation £101,509, with £71,909 in the sinking fund. The total of the rates from 1904-5 was 7s. 6d. in the £, and from 1905-6 it was 7s. 5d., showing a decrease of 1d., which represented £690. For the repayment of the loan of £9,500 he asked for the longest period that the Local Government Board would allow the Corporation. The usual period was 25 years.

The INSPECTOR said the period of repayment was likely to be somewhat under 25 years, as only expenditure upon plant was being proposed, and it was not to be expected that plant would last a quarter of a century. Referring to the present inquiry, the inspector said it was more or less the outcome of the inquiry which he held in January in connection with the proposed scheme of constructing a new electrical station at an estimated cost of £42,000. He took it that the matter had been reconsidered, and that the result was the present suggested loan of £9,500 for utilising the present station. He wanted to be quite sure that the Corporation had in view only the one object of making money for the ratepayers, that it was not a question of any sentiment, but one of plain, hard business, and that it was a matter of absolute indifference to the Corporation whether they provided the current or not, unless they were assured that the undertaking would in every sense be a sound business enterprise.

Mr. PEARCE remarked that under the Tramway Act an obligation to supply current was imposed upon the Council.

The INSPECTOR asked if Mr. Pearce referred to the agreement which the Council required the Dolter Tramway Company to enter into with them for the supply of the current.

Mr. PEARCE replied that he was referring to the section of the Act bearing on the point which imposed an obligation on the Council, and which was accepted by them in the belief that it would be beneficial to the ratepayers. It was, perhaps, a mutual obligation which was created by the Act, instead of imposed. Negotiations between the Dolter Company and the Corporation had been going on for a very considerable time. Both parties had been anxious, as far as possible, in consideration of the interests which they severally had to study, to carry out in a reasonable and proper spirit the provisions of the Act, which gave rise to the necessity for the present application. The scheme in principle was approved by Mr. Manville (of the firm of Kincaid, Waller, Manville, and Dawson), who, after working out the same very carefully, would state that, if carried out, it would yield an annual profit of £640. Under these circumstances the Corporation asked for sanction of a scheme which would enable them to discharge their obligations and at the same time give them an opportunity of securing a very profitable daytime consumer, with a result which would be very advantageous to them in every respect. The matter was one of very great urgency. The Corporation were very desirous that everything should be done to enable the Tramways Act to be carried out to its legitimate end, but they could not discharge their obligation satisfactorily unless they could expend the sum asked for to enable them to cope with the demand that would be made under the Act of Parliament.

Mr. MANVILLE stated that he had been appointed by the Corporation to carry out the extension works, assuming that the loan was granted. He produced detailed estimates of the new plant that would be required, and said that when the outside sections of the tramways were eventually completed the profit from the supply of current would probably increase from £640 to £1,100 or £1,200 a year.

The INSPECTOR subsequently referred to the fact of the Dolter Company having offered to annul the agreement and to supply the current themselves, and also to take over the whole of the electricity works. Therefore, as far as the legal position was concerned, the agreement did not now exist.

The TOWN CLERK, however, said this was not the case, and proceeded to explain how the Dolter Company's proposals were received by the Council.

The INSPECTOR said the question was whether it was possible that the present station could be so altered as to supply all the

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current that would be required for the tramways when constructed. The first section was 4¼ miles, and then another 4¼ miles could be laid down.

The TOWN CLERK said the Corporation could reserve their consent to the second 4¼ miles. The Dolter Company had power to construct 8½ miles, and the Corporation had undertaken to supply current for the whole, with certain reservations as to routes and when they should be commenced.

The INSPECTOR said the Corporation could not unreasonably withhold their consent. There were 8½ miles of tramways to be constructed—4¼ on the consent already given, and 4¼ on consent to be given when they had seen the working of the first section. The first lines of tramways refers to 4¼ miles, but Mr. Manville was making provision for the 8½ miles.

Mr. MANVILLE: That is so.

The INSPECTOR: What position would the Corporation be in if they failed to supply the current.

Mr. MANVILLE: There would be a penalty.

The TOWN CLERK, reverting to proposals received from the Dolter Company, explained that the company offered to provide their own electricity station on certain conditions, one of which was that they should be allowed to run the trams along Torbay-road, and should not be required to have their car-sheds on the Corporation site in Upton Valley.

The INSPECTOR asked if the Corporation had considered the point from its financial position, so that they could say that what they were now doing was for the best. There could be no doubt that the agreement to supply the current to the tramway company was made by the Corporation without any regard to their financial position. If they had regarded it from the proper financial point of view, they would have found that the agreement, which they desired to have embodied in the Act, was not such a very favourable undertaking for them after all, and that the benefits were extremely doubtful.

The TOWN CLERK said with the information then before the Council they were under the serious impression that the price they were going to receive for the current would be a very good paying one.

The INSPECTOR observed that it was no good making a general statement on that score; these were technical matters. It was enough that what was proposed would not have the profitably satisfactory results that the Council anticipated. What became of the other proposals of the Dolter Company, as to taking over the whole of the electricity undertaking and working it on a profit-sharing basis? Were these proposals ignored?

The TOWN CLERK replied that they were not. The Council could not come to a conclusion in the first point until they had Mr. Mitchell's figures before them, and those of the expert (Mr. Manville), whom they had consulted, to see whether, as had now been shown, the scheme would show a profit.

The INSPECTOR: The question is whether the other proposals would not have shown more profit.

The TOWN CLERK said the question of profit-sharing was not entered into. All three proposals were considered, but only one was dealt with and adopted.

The INSPECTOR said before considering Nos. 2 and 3, the Corporation decided to have a report on No. 1, and when they had that they considered it sufficiently satisfactory, without considering Nos. 2 and 3. However, in the absence of any seriously-considered proposition, he did not see how this could be taken farther.

Mr. PEARCE contended that, because the Corporation agreed to the first proposal, it could not be said that they did not do their duty in regard to the other two proposals.

In reply to a question, Mr. MANVILLE said the plant now proposed to be put in the electricity station would carry them on for three years.

The INSPECTOR: What will be the position then?

Mr. MANVILLE: I don't know.

After further evidence and speeches on both side, the INSPECTOR remarked that it seemed clear that the Corporation had made for themselves serious difficulties by entering into an agreement without really considering the financial position they were in to carry it out. That agreement, which bound them to supply current, was made when the Act was passed, because they thought they were getting a very good thing. Many of the difficulties that had arisen appeared to be due to the Corporation entering into an agreement to carry out works for which they had no power and no sanction to raise money. There was an insufficient appreciation on the part of the Corporation of their financial position; they were not in a position to meet the agreement, and hence the difficulties that had arisen during the last 12 months.

The TOWN CLERK asked that the Local Government Board would convey their decision as quickly as possible, having regard to the urgency of the case.

The INSPECTOR said he would do the best he could, but he had several other applications which were represented as of equal urgency. There could, however, be no harm in asking for tenders to save time.

[We are indebted to the *Western Morning News* for the report of the inquiry from which the above is abstracted.—ED. *E. E.*]

PHYSICAL SOCIETY.

At a meeting of the society on Oct. 27, Prof. J. H. Poynting, F.R.S., president, in the chair,

A paper on "*The Theory of Phase Meters*," was read by Dr. W. E. SUMPNER. Phase meters are instruments of the dynamometer type for indicating the phase relations of the currents and potentials in alternating-current circuits. With few exceptions, they are made for use on multiphase circuits. Such instruments consist essentially of two sets of coils, of which one set is fixed, and the other forms a single moving system which is not provided with any form of control. The currents in one set of coils are determined by the voltages of the main circuits, while those in the other set are produced by the circuit currents. With rare exceptions the magnetic circuits of phase-meters are air circuits, containing no iron, so that the magnetic fields associated with them are weak, and the instruments in consequence are of somewhat delicate construction. There, however, appears to be no reason why the use of iron should be avoided in these instruments, and the author shows in the paper that the theory of the instruments is the same whether they contain iron or not, and however the coils may be arranged; that they can be calibrated by direct-current methods, although for use on alternating-current circuits; and that a new type of instrument, containing iron, conforms to the theory given. In all the cases considered, it is assumed (1) that the induction density at any point to the current, A, in a fixed coil is represented by A F, where A is the instantaneous value of the current, A, and F is a quantity dependent merely on the coil and the position of the point considered; and (2) that the principle of superposition holds—viz., $B = A_1 F_1 + A_2 F_2 + A_3 F_3$, where A_1, A_2, A_3 are the currents in the three fixed coils, and the quantities F are functions of the position of the point corresponding to these fixed coils. The author shows that these assumptions hold good even when the paths of the lines of force lies partly through (suitably laminated) iron, and it is necessary to consider the effect of varying permeability and hysteresis. The main results of the investigation are: (1) Phase-meters for multiphase circuits are all equally accurate on balanced loads, provided they have been correctly calibrated and possess no faults due to purely mechanical causes. Their accuracy is not affected by variations in wave form or in current frequency. The calibration of the scale is affected by the number of coils used in the instrument, by the ratios of the ampere-turns used with these coils, by the distribution of the windings, and by the magnetic nature and properties of the magnetic circuits, especially if these contain iron; but the accuracy of the indications is not dependent upon any of these considerations, if the working of the instrument is satisfactory from a mechanical point of view. (2) Phase-meters can be simply and accurately calibrated for balanced loads by means of a direct-current method of test. (3) The error of phase-meters on unbalanced circuits is generally serious for loads which are badly out of balance. The error, like that of a wattmeter, increases rapidly as the power factor of the load diminishes. It can only be reduced at the expense of complication in the instrument, by increasing the number of coils used in the fixed and moving systems, and by arranging the coils and magnetic circuits to be symmetrical in regard to one another. If the true power factor of the load is $\cos\phi$, the reading of the instrument is

$$\cos\phi + \theta \sin\phi,$$

where θ is the phase error due to the unbalanced load, and is the product of two factors, one of which is the maximum value of θ determined by the amount the load is out of balance, and the other may have any value between $+1$ and -1, and determines whether the instrument reads high or low.

The Secretary read a letter from Mr. A. RUSSELL referring to one of the fundamental assumptions made by Dr. Sumpner. The magnetic force, B, at any point on the conductor of the moving coil had been represented by $A_1 F_1 + A_2 F_2 + A_3 F_3$, where F_1, F_2, and F_3 were considered constant. The instantaneous value of the magnetic force at any point was the resultant of the three magnetic forces, $k_1 A_1$, $k_2 A_2$, and $k_3 A_3$, acting in fixed directions at that point. At any instant, therefore,

$$B = k_1 A_1 \cos\phi_1 + k_2 A_2 \cos\phi_2 + k_3 A_3 \cos\phi_3,$$

where ϕ_1, ϕ_2, and ϕ_3 are the angles between B and $k_1 A_1$, $k_2 A_2$, and $k_3 A_3$. As A_1, A_2, and A_3 are not in phase with one another, the direction of the resultant magnetic force is continually altering, and thus ϕ_1, ϕ_2, and ϕ_3 are functions of the time. Hence also the author's factors, F_1, F_2, and F_3, are not constants but functions of the time, and thus the conclusions arrived at in the paper must be modified. Dr. Sumpner's method of calibrating by means of direct currents was novel and valuable, but little confidence could be placed in the readings of phase-meters when the applied waves of potential difference did not follow the harmonic law.

Mr. A. CAMPBELL, referring to the stepped nature of one of the calibration curves obtained by the author, asked if the use of a smooth-core instead of a channelled one would result in a smoother curve.

Mr. K. EDGECUMBE expressed his interest in the paper, and said it was valuable because phase-meters were coming into general use and the literature on the subject was small. Dr. Sumpner had stated in his paper that previous theories had neglected the question of the currents being unbalanced, but he pointed out that Punga in 1902 had described power factor indicators and showed how they could be used with unbalanced loads. It was important to define exactly what is meant by average power factor. The author had given a mathematical definition, but a simpler definition would be that the average power factor is that quantity which multiplied by the phase voltage and the sum of the three currents gives the total power supplied to the line. A disadvantage of power-factor indicators was the difficulty of testing them.

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Mr. W. DUDDELL asked if the author had assumed that the three voltages were in symmetrical phase relation, and pointed out that in practice differences of as much as 10deg. might occur.

Dr. SUMPNER, in reply, said that in the proof of the paper B was not the maximum flux but the effective part of it, that at right angles to the direction of motion of the conductor. He was aware that it was possible to obtain smoother curves, and had partially done it by a suitable distribution of winding giving a gradually varying flux. In reply to Mr. Duddell, he said he had assumed equal voltages and equal phase relations.

PERSONAL.

Mr. Theodore Rich, lately with Bruce Peebles and Co., and also well known as an officer in the Electrical Engineer Volunteers, has taken up a position in the Soudan Public Works Department. Mr. Rich carries the best wishes of many friends both in London and the provinces.

Mr. W. J. Bache, late city electrical engineer at Gloucester, and now electrical engineer for the borough of Cheltenham, was last week presented with a self-adjusting reading chair, handsomely upholstered and with suitably inscribed plate, by the combined staffs at the works and the guildhall. The presentation was made by Alderman James Fielding (chairman of the Electricity Supply Committee) in the presence of the town clerk (Mr. G. Sheffield Blakeway), the city surveyor (Mr. R. Read), and a large number of the members of the staff and others.

The governing body of the Battersea Polytechnic have appointed Mr. E. G. Tottle, M.I.M.E., to the post of superintendent of the drawing office and workshops in their department of mechanical engineering. Mr. Tottle has had considerable experience as mechanical and electrical engineer both in workshops and drawing offices, and has been for some years superintendent with an important firm of engineers and printing-machine makers. He is at present on the teaching staff of the Chiswick Polytechnic and the Welcome Institute, Deptford.

Mr. Francis H. Davies is leaving the Westinghouse Co. to take up an appointment in the electricity department of the St. Marylebone Borough Council.

We noticed last week the appointment of Mr. R. Hugh Seabrook, of Barking, as electrical engineer to the West Ham Corporation, and we understand that he will take up his duties at the end of this month. Mr. Seabrook is an associate member of both the Institution of Electrical Engineers and the Institute of Mechanical Engineers. He served his time at the works of Messrs. Crompton and Co., Chelmsford, and was by that firm employed in the starting up of the electric power station erected by the firm for the Great Yarmouth Corporation. On the completion of the contract he was offered and accepted the position of assistant engineer to the Corporation. In 1898 he was appointed from some 150 applicants to the post of assistant engineer to the Hampstead Borough Council electricity undertaking. He remained at that place until January, 1901, when he was selected from about 100 applicants to fill his present position at Barking. There he rendered an unprofitable concern into an highly profitable one, reducing the works cost from nearly 3·5d. to 1·5d. per unit.

At the annual meeting of the Provident Society of the London United Tramways Co. on Tuesday, Sir Clifton Robinson, managing director and engineer, was presented with an address in recognition of the knighthood recently conferred on him, and at the same time Lady Robinson received a handsome writing-table equipment.

Mr. J. Archibald Kyle, A.I.E.E., wishes it to be known that he is shortly leaving Aron Electricity Meter Limited, where he has held the position of assistant engineer and technical representative for the last three years.

Mr. J. Allward, senior shift engineer, has been appointed station superintendent at Islington on probation for six months at a salary of £180 per annum, and the temporary appointment of Mr. T. Margery to superintend the mains work has been made permanent at a salary of £200 per annum.

Mr. Albert Moorhouse, formerly secretary of the Blackpool Engineering Works, and who two years ago was appointed engineer at the Burnley workhouse, has been appointed engineer at Willesden infirmary, at a salary of £200 per annum.

HACKNEY ELECTRICITY ACCOUNTS.

The accounts of the Hackney electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £273,897. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	5,529	6	2
Distribution of electricity	573	8	3
Attending and repairs to public lamps	1,132	7	8
Rents, rates, and taxes	1,256	6	10
Management expenses, salaries, insurance, etc.	1,977	19	0
	10,469	7	11
Amount carried to net revenue account	20,224	9	5
	£30,693	17	4

Cr. Income.	£	s.	d.
By sale of current per meter, less discounts	21,171	0	1
Public lighting	5,473	17	10
Energy supplied to refuse destructor	3,460	5	3
Rental of meters and other apparatus	385	16	11
Sale and repairs of lamps, etc.	203	14	3
Miscellaneous rents receipts	9	3	0
	£30,693	17	4

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	266,890	0	0
Sundry creditors	6,034	10	6
Treasurer—overdraft	972	12	9
	£273,897	3	3

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	273,897	3	3
	£273,897	3	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			2,915,867
Quantity sold	Private consumers by meter, etc.	1,360,144	
	Power	398,033	
	Public lamps	634,440	
	Refuse destructor	156,186	2,548,803
Quantity used on works	Lighting and power	168,795	
	On accumulators	72,831	
	On distributing system	125,438	367,064
Maximum supply demanded (kilowatts)			1,678
Load factor			17·34
Number of 8-c.p. lamps connected			111,437

EXETER ELECTRICITY ACCOUNTS.

From the accounts of the Exeter electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounts to £88,470. Abstracts of the revenue account and balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	3,495	18	6
Distribution of electricity	512	7	6
Attending and repairs to public lamps	163	4	4
Rents, rates, and taxes	838	15	8
Management expenses, salaries, etc.	1,261	2	9
Law expenses	5	10	0
Insurances, etc.	42	10	3
	6,319	9	0
Amount carried to net revenue account	4,238	19	9
Balance to provide for bad debts	38	0	3
	£10,596	9	0

Cr. Income.	£	s.	d.
Balance from last account, less written off	38	0	3
Sale of current per meter	8,481	2	8
Public lighting	942	9	3
Under contracts	147	5	1
Rental of meters and other apparatus	236	14	10
Sale and repairs of lamps	516	7	2
Rents receivable	17	0	0
By Exeter Gas Co.	241	11	8
Stores on hand	175	18	1
	£10,596	9	0

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
District fund—capital account	5,478	0	0
District fund—income account	1,642	0	0
Sundry creditors	522	14	1
Amount provided for bad debts	38	0	3
Reserve fund account	275	15	6
	£7,956	9	10

Cr. Assets.	£	s.	d.
Balance in hands of treasurer	1,191	7	4
Accounts outstanding for current	5,719	17	4
Stores in hand	416	2	8
Sundry debtors	0	10	0
Rents receivable	6	2	6
Plymouth Corporation stock	622	10	0
	£7,956	9	10

Islington.—With regard to the application for the loan of £15,500 for turbines, which the London County Council first refused to sanction, allowing only £13,000, we are informed that the Council intend to take up the lesser sum on condition of being allowed to borrow the difference if required.

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LEGAL INTELLIGENCE.

WORKMAN'S COMPENSATION.

In the Appeal Court last week, before the Master of the Rolls, Lord Justice Romer, and Lord Justice Mathew, the hearing was continued of the appeal in the case of Rogers *v.* the Cardiff Corporation. Rogers was the driver of a trolley used for the repair of the electric tramway. The horses becoming restive he was thrown off and sustained severe injuries. The county court judge made an award in favour of the man under the Workmen's Compensation Act. The Corporation appealed on the ground that the man was not engaged at the time of the accident "in or about engineering works."

The MASTER OF THE ROLLS, in his judgment, held that the engineering works were coextensive with the tramways.

Lord Justice ROMER said it was impossible to sever the going of a man from one place to another to make repairs, bringing him under the Act at one point and leaving him out of it at another.

Lord Justice MATHEW said a zone could not be drawn around a particular point where repairs happened to be executed.

The appeal was dismissed with costs.

TRAMWAY ADVERTISING CONTRACT.

An action was heard in the Lord Chief Baron's Court, Dublin, last week in which Griffiths and Millington, a firm of advertising contractors, sought to recover damages against the Dublin Tramways Co. for breach of contract. The plaintiffs entered into a contract with the defendant company in June, 1900, to rent a certain number of the ends of the tramcars, to which were to be fixed advertising plates, and the plaintiffs claimed that they had the option to renew the contract. Certain alterations were made in the terms and conditions, and in the number of ends that were rented. In June, 1904, the tramway company handed over their advertising business to a contractor named Courtenay, and they referred the plaintiffs to him for future dealing. The plaintiffs averred that this was a breach of contract, and the defendant company replied that there was no right of renewal, and that, therefore, there was no breach of contract. The case turned mainly on the legal point as to whether the plaintiffs exercised their option to renew within a reasonable time before or after the determination of the first specified period of three years.

The Lord Chief Baron after hearing the arguments felt bound to enter judgment for the defendant company, with costs. The judge allowed the plaintiffs 14 days in which to consider whether they will carry the case to the Divisional Court.

CORPORATION'S LIABILITY.

At the Salford Court of Record last week an action was brought before his Honour Judge Shee, K.C., and a jury, by Dr. Mitchell against the Bury Corporation for £32. 16s. damages for injuries sustained in a collision between his brougham and defendants' tramway. The case had additional importance inasmuch as it also decided the question of liability between the Corporation and the representatives or relatives of the driver of the brougham—Chadwick—who was fatally injured. Negligence was alleged on the part of the tramcar driver, and the defence was that the accident was due to the negligence of the driver of the brougham.

Mr. WM. CLOUGH, tramways manager, said a more competent man than the driver of the car in question was never given charge of a car. He agreed that it was impossible for a car travelling at five miles an hour to be pulled up in a yard or so, and suggested that when the driver stated at the inquest he did so he was labouring under a wrong impression and was upset by the accident. If a car was pulled up in its own length it was good work. It was impossible to utilise the magnetic and hand brakes at the same time, and the driver did the right thing in further applying the latter brake.

For the defence it was submitted that had Chadwick, the driver of the brougham, not crossed to the wrong side of the road the accident could not have happened.

The jury found for the plaintiff, and judgment was given accordingly for £30. An application for a stay of execution was granted.

UNDERGROUND WIRES.

Before the deputy stipendiary (Mr. Milner Jones) at Cardiff on Saturday last an arbitration was held with reference to an application by the Postmaster-General to lay telegraph wires under a portion of North-road.

For the postal authorities it was explained that they desired to erect a new trunk overhead wire for telephone purposes between Cardiff and Pontypridd, and to place several of the existing telegraph wires underground. It was explained that the efficiency of trunk telephone wires was impaired by the interposition of short sections in underground cable, and it was, therefore, desirable that telephone wires should be carried above ground.

Major O'MARA, C.M.G., late of the Royal Engineers, assistant engineer-in-chief for the Post Office, who has charge of the whole of the telephonic arrangements outside London, gave evidence in support of the application. He said that in America they could speak 12,000 miles over the telephone on account of the overhead trunk wire system, while in England they could only speak about 700 miles owing to the trunk wires in some towns being underground.

On behalf of the Cardiff City Council it was submitted that the Corporation were desirous of giving every facility to the Post Office, but they thought that the time had come when the whole of the telegraph wires in the city should be laid underground, and they, therefore, desired the court to impose that condition. It was also submitted that the contention of the Post Office as to impairing the efficiency by placing the wires underground was exaggerated, and that the facilities which had already been granted to London and Birmingham and other large towns ought to be conceded to Cardiff. It was further pointed out that the objection could not be a very serious one, as the National Telephone Company were at present pressing the City Council to allow them to place their wires underground.

Mr. W. Harpur, city engineer, gave evidence on behalf of the Corporation.

The Deputy-Stipendiary reserved his decision.

TRAMWAY INJURY.

The Leicester Corporation were sued in the county court on Saturday last by H. J. Dawes for the recovery of £100 damages for personal injuries sustained by reason of the alleged negligence of an electric car driver.

Plaintiff stated that he was in the act of crossing the road and waited till a car going up the road had passed, and then attempted to cross the rails behind it when he was knocked down by one coming in the opposite direction. He was rendered unconscious, and was taken to the infirmary, where it was found that his right arm was broken at the elbow and his right eye injured.

For the defence it was stated that the driver used all necessary precautions to avoid an accident, and the car was only travelling at average speed.

The jury found for the plaintiff, awarding £47. 10s. damages.

Leave to appeal on the ground that the verdict was against the weight of evidence was refused.

His Honour entered judgment for the amount, but granted a stay of execution.

ELECTRICAL FRAUDS.

At the Guildhall, before Alderman Sir John Bell, William Leslie, Alice Frances Cheesman, George Webber, and Richard Thomas Rosenberg were again charged on remand with conspiring together to defraud various firms dealing in electrical apparatus, and were committed for trial.

DUFFY v. DUBLIN UNITED TRAMWAYS CO.

An application was made in the Dublin High Court on Tuesday last on behalf of the defendants in the case of Duffy *v.* Dublin United Tramways Co. to have the action remitted for trial to the recorder. The action is for the recovery of damages for injuries sustained by the plaintiff in being run over by one of the defendant company's tramcars. The Court decided to remit the action.

COMPANIES' MEETINGS AND REPORTS

BUENOS AYRES GRAND NATIONAL TRAMWAYS.

The report of this Company for the year ended March 31 last, to be submitted at a meeting to-day, states that the gross receipts of the Grand National lines have amounted to £176,897, as compared with £172,654 for the previous year. The working expenses amounted to £130,997, as compared with £128 140. The Company's share of the profits derived from the working of the joint lines under the agreement has amounted to £40,386, as compared with £40,117. After payment of the London administration expenses and interest on the debentures, there remains a balance of £10,652, from which £3,789 has been transferred to debenture reserve funds and £3,726 to income bondholders' interest account, leaving £3 187 to be carried to a contingency fund. The amount at the credit of income bonds interest account is £5,320. It is proposed to pay interest at the rate of 5 per cent. per annum for the year on these bonds (this will absorb £3,726), also to pay 2 per cent. on these bonds out of the amount (£1,563) transferred from suspense account (this will absorb £1,490), leaving £104 to be carried forward. Satisfactory progress has been made with the work of converting for electric operation the joint system consisting of the lines of this Company and those of the Buenos Ayres New Tramways Company. Twenty-four miles have been opened to public service by electricity. In view of the improvement in the Company's position expected from the electrical operation of its lines, the directors have felt the urgent necessity of dealing with the capital and revenue accounts so as to enable the shareholders to reap the benefit of the improvement without undue delay. They have, with that object, been in constant consultation with many of the largest holders of the various securities and stocks of the Company. Acting upon the recommendation of their legal advisers, they have decided to proceed by a Bill in Parliament for the reorganisation of the Company's capital and revenue accounts upon a basis the details of which will in due course be submitted to all the various security holders for their approval, and it is proposed to deposit a Bill with this object in the course of next month.

CAPE ELECTRIC TRAMWAYS.

An extraordinary general meeting of this Company was held last week for the purpose of passing, or otherwise, a resolution giving the directors power to rise £200,000 by the issue of fresh debentures. Sir Charles Euan Smith presided.

The CHAIRMAN, in moving the resolution, explained that the

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meeting was necessary because the existing borrowing powers of the Board had been exercised to the full. The present debenture obligation of the Company was an issue of £286,800 in bonds of £100 each, bearing 6 per cent. interest per annum, and £140,000 in bonds of £100 each, bearing 5 per cent., on the general security of the assets of the Company. The debentures which it was now proposed to issue would be termed "B" debentures, bearing 5 per cent. interest. The reason for the issue of the debentures was the necessity of providing further capital for expenditure already incurred, and still to be incurred, over and above the existing cash resources of the Company, for the following objects: For some years past the Company's representatives in Cape Town had been negotiating with the municipal authorities to extend the system through the important thoroughfare of Buitengracht-street. A satisfactory agreement was some months ago finally concluded with the municipality, and the work of this important concession was now being actively proceeded with. For the renewal of the rails and the relaying of the track over nearly the whole of the system. The Cape electric tramways had now been running in Cape Town since 1896, and the nine years' heavy and continuous traffic on the badly constructed roadways of Cape Town had rendered this measure absolutely necessary, notwithstanding the sums yearly expended on the ordinary maintenance and upkeep of the lines and of the rolling stock. Other extensions and improvements had also been found requisite to bring the whole system into a thoroughly efficient condition. The whole of the reserve fund (£154 000) had been invested up to date in the extensions of the system that had been sanctioned from time to time, and to this extent the necessity of issuing fresh capital had been avoided. For the construction of extensions and renewals the expenditure to date had crept up to £150,000. Against this the Company held £40,000 Consols and other assets, estimated together roughly at £80,000, leaving the sum of £70,000. The construction work yet to be completed was estimated to cost £50,000, leaving the sum of about £120,000 to be provided for. The directors hoped that the issue of £100,000 of these debentures would be sufficient to meet their financial requirements.

Mr. L. BREITMEYER seconded the resolution.

Replying to a question, Mr. W. B. ROMMEL, managing director, stated that the total expenditure for track renewal was £95,000.

After a long discussion, during which the management came in for criticism, the resolution was carried with one dissentient.

WESTMINSTER ELECTRIC SUPPLY.

An extraordinary general meeting of the preference shareholders of the Westminster Electric Supply Corporation, Limited, was held on Tuesday last at the registered offices of the company, Lord Suffield presiding.

Mr. HAYES FISHER, M.P., moved a resolution to obtain power to enable the company to raise such additional capital as may be required during the next 26 years. He said that the present expenditure of capital was roughly a million pounds. They contemplate the expenditure of a further £1,000,000. Of this sum one-fourth, or a quarter of a million pounds, will be spent during the next few years. This it is proposed to issue at once in preference shares. Mr. Fisher sketched the growth of the concern, and explained that the borrowing powers which they now sought was to enable the Company to meet the growing demand for current, which was utilised for many varying purposes. Other sources of demand are also anticipated, and to be able to cope with these two more transformer stations of about the same capacity as Duke-street will be eventually required, part of which must be put in hand almost immediately. Provision has also to be made for the mains department within the next few years, in connection with which it is suggested that stores should be erected at Eccleston-place. There is still a considerable balance on account of Duke-street to be paid. The other two stations will probably cost very much less than Duke-street, but taking it all round it can hardly be said that less than £150,000 will be required for land and buildings by the end of our term. Plant and machinery to equip these three transformer stations would cost approximately £200,000. The Board, therefore, recommend that the authorised amount of share capital be increased to £2 000 000, divided into £1,000,000 cumulative preference share capital and £1,000,000 ordinary share capital. The above £1,0.0,000 preference capital to carry a preferential right over the ordinary shares of the Company in the distribution of the assets in the case of the winding-up of the Company, and a *pro rata* share of any surplus after the repayment of ordinary capital at par. That the preference shares of the Company for the time being issued should carry a cumulative preference dividend of £4. 10s. per cent. per annum, instead of £5 per cent. per annum, and that the holders of the £140,755 of 5 per cent. preference shares be allotted an amount of £15,640 in 3,128 preference shares of £5 each to be paid for by a bonus free of income tax out of the reserve fund of the Corporation.

Lord KINNAIRD seconded the motion, and it was carried unanimously.

BRAZILIAN STREET RAILWAY.

The directors' report for the sixth year's working of this Company, to be presented at the meeting on the 7th inst., states that the gross receipts were £22,802, as against £24,107 in the previous year. The total expenditure was £17,445 against £18 203, leaving a balance of £5,357, to which is added £1,079 gain in exchange and £410 brought forward from last year, making together £6,846 After deducting £3,297 for debenture stock interest, and placing £410 to the credit of renewals account, there remains a surplus of £4,149, out of which the directors recommend a dividend of 5 per cent., less income tax, being paid on the preference shares for the year ended July 31 last, amounting to £1,475, and a dividend of 2½ per cent. on the ordinary shares, free of income tax, amounting to £2,172, carrying forward £500.

ROSARIO ELECTRIC.

The third annual meeting of this Company was held in London on Tuesday last.

Mr. W. F. LEESE presided and moved the adoption of the report, a copy of which appeared in our last week's issue. He stated that during the 12 months the number of their consumers had advanced from 837 to 1,325, and at the end of August they had put on another 112 new consumers, making a total of 1,437. One of the most valuable of the branches of trade that an electric company could do was that of motors. On June 30, 1904, they had 38 motors, on June 3, 1905, they had 113 motors of 545 h.p., so that that part of the business was increasing satisfactorily. Their business had so steadily increased that they had no proper reserve of batteries, and the £40,000 additional capital authorised last year had been overspent.

The report was adopted.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

An extraordinary meeting of this Company was held on Monday last in London.

Mr. H. WOLFENDEN, who presided, moved the confirmation of a resolution passed at a former meeting reducing the capital from £941,090 to £888,071 by cancelling paid-up capital which was lost or was unrepresented by available assets to the extent of £2. 5s. per share on the 23,564 B shares, and by reducing the nominal amount of these shares to 5s. each.

The motion was carried, and a further resolution was approved to the effect that irrespective of any remuneration to which the directors might be entitled they should receive for their services during the year ended June 30 last the additional sum of 750 guineas, such amount to be divided among them as they might agree.

WESTERN TELEGRAPH.

The ordinary half-yearly meeting of this Company was held on Wednesday.

Sir JOHN WOLFE BARRY, in moving the adoption of the report and accounts (copy of which we published in our previous issue), said it afforded him great pleasure to call the shareholders' attention to the continuance of the prosperous condition of affairs in South America. Their message receipts for the period under review amounted in round figures to £253,000, and for the corresponding period in 1904 to £216,000, being an increase of between £37,000 and £38,000. During the current half-year this improvement was maintained, and although the prospect was encouraging, they must be prepared for times of depression and slackness of trade, which appeared sooner or later to every community. Their revenue had not been obtained without some increased expenditure, but a large proportion of the extra working cost was accounted for by the enhanced value of Brazilian currency, which, while augmenting the value of their remittances, caused a corresponding increase in the necessary expenditure in Brazil.

A dividend of 3s. per share, making, with the interim dividend already paid, a total dividend of 6 per cent. for the year, and also a bonus of 2s. per share was declared.

The report was unanimously adopted.

MONTE VIDEO TELEPHONE.

Mr. FRANK W. JONES presided at the annual meeting of this Company, and, in moving the adoption of the report, said that since the rearrangement of the Company in 1898 their position had continuously and steadily improved. The net profits increased from £6,826 in the year named to £15,473 in 1905, after providing for all working expenses in Monte Video and London, and although there had been a civil war it had interfered but little with their business, and they had now practically no indebtedness, while holding securities of the value of over £12,000. Altogether the prospects of the Company were excellent, and the period had arrived in their history when increased dividends might with certainty be looked forward to.

The report was unanimously approved.

EASTERN TELEGRAPH.

The half-yearly ordinary general meeting was held on Wednesday in London, under the presidency of Sir John Wolfe Barry, K.C.B.

The CHAIRMAN, in moving the adoption of the report (a copy of which appeared in our issue last week), said that a portion of the increase in revenue was attributable to the war in the Far East. Since the conclusion of peace a falling off had been noticeable in the China and Japan traffic.

The MARQUIS OF TWEEDDALE seconded the motion, which was carried unanimously.

ELECTROLYTIC ALKALI.

The report of the directors of this Company for the year ended Aug. 31 states that the net profit is £4,745. To this is to be added the amount brought forward from last year—namely, £1,374—making a total of £6,120. The directors propose that this amount be applied in paying, on account of the arrears of dividend upon the cumulative

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preference shares, the amount of one year's dividend, at the rate of 7 per cent. per annum, on all the preference shares issued prior to April, 1902, and a dividend at the same rate upon all the preference shares issued since that date, calculated, as regards all instalments paid on such shares since Aug. 31, 1902, from the several dates of payment of such instalments up to Aug. 31, 1903. This will absorb a sum of £5,601 and leave £519 to be carried forward to the next account. The process, state the directors, continues to work satisfactorily, and there is a good demand for the Company's products. Towards the close of the year the erection of additional manufacturing plant was continued, and the Company is now in a better position for dealing with an increased volume of business.

BRITISH THOMSON-HOUSTON.

The report of this Company for the year ended March 31 last, to be submitted at the meeting on the 8th inst., shows a trading profit for the year of £29,026, to which must be added £2,822 brought forward together £31,848. After allowing for depreciation, writing £1,944 off goodwill, and £8,000 off suspense account, there remains to be carried forward £1,696. At Rugby the buildings and machinery of the Company have been maintained in first-class condition during the year. During the period under review the Company secured contracts for the electrical equipment of all the remaining trains on railways controlled by the Underground Electric Railways Co. of London, including its various tube railways. The system is the multiple-unit system, similar to that heretofore furnished to the District Railway, the Central London Railway, the Great Northern and City Railway, and the North-Eastern Railway. The electrical equipments furnished are operating satisfactorily. The manufacture of Curtis turbines has progressed satisfactorily, and a number have been built in the Rugby works, all of which are giving excellent results. The directors believe that the Company has good value in the enterprises in which it has investments. Since the closing of the books on March 31 the Company has disposed of a large amount of these securities and reduced proportionately its liabilities. As shown by the balance-sheet last year the excess cost of manufacturing incident to the establishment of the manufacturing business of the Company amounted to £63,326, of which amount £20,000 was at that time written off. There has been added to this account during the year the sum of £3,934, and there has been written off a further sum of £8,000, leaving the balance of the account £39,261, from which further amounts will be written off from time to time until finally disposed of.

NEW COMPANIES REGISTERED.

A. W. Penrose and Co., Limited.—Capital, £40,000. Object: to acquire and carry on the business of A. W. Penrose and Co. at 109, Farringdon-road, E.C., as manufacturers of and dealers in all machinery, apparatus, material, and appliances used in connection with photography or other graphic arts, manufacturers of electric cranes and hoists, makers of printing-machine motors and gears, electrical and general engineers, etc. Registered office: 109, Farringdon-road, E.C.

West African Rubber Plantations, Limited.—Capital, £25,000. Object: to acquire any concessions, grants, rights, powers, privileges, lands, hereditaments, or property in Africa or elsewhere; to develop and turn to account the same; and to carry on the business of African merchants, traders, planters, cultivators, manufacturers, importers and exporters of and dealers in rubber, guttapercha, gums, and other produce, plantation owners, etc.

Light Railways Company of Sicily, Limited. — Capital, £12,000. Object: to acquire any railways or tramways, electric lighting works, plant and machinery in Sicily or other part of Italy or elsewhere, and to carry on the business of railway and tramway proprietors, etc.

Liens Registered.

Improved Electric Supplies, Limited, Westminster.—Lien registered Oct. 18 for £2,500 6 per cent. second debentures. Holder: W. Chamberlain, of Cobham. Charged on the undertaking and all the property, present and future, including the uncalled capital.

Engineering Instruments, Limited, Islington, N. — Lien registered Oct. 20 for £2,000 5 per cent. debentures, part of £3,000 authorised. No trustees. Charged on the undertaking and all the property, present and future, including the uncalled capital for the time being.

Newcastle and District Electric Lighting Co., Limited. Discharge registered Oct. 18 of debentures dated Sept. 9, 1903, for £11,085.

Chepstow Electric Lighting and Power Co., Limited.—Lien registered Oct. 20 for £1,000 5 per cent. debentures, part of £3,000 authorised. Holders: India Rubber, Gutta Percha, and Telegraph Works Co., Limited. Charged on the undertaking and all the property and assets, present and future, including the uncalled capital.

CONTRACTS FOR ELECTRICAL SUPPLIES.

ermondsey.—Tenders for new plant will shortly be advertised for.

Vienna.—The Government Railways require tenders for telegraph tape. Tenders by Nov. 10.

Genoa.—The Artillery Workshops require tenders for copper wire and bars. Tenders by Nov. 9.

Wimbledon.—We understand that tenders will be called shortly for electric pumps for the sewage works.

Porto.—The Municipality require tenders for a concession for working the electric tramways in the town. Tenders by Nov. 8. Preliminary deposit, 100 contos de reis.

Algiers.—The Inspector-General of the Post Office, Rue Dumont d'Urville, requires during the next two years 48,550 impregnated telegraph poles. Tenders by Nov. 10.

Belfast.—Electric light and fittings are required in the Scottish Temperance Assurance Buildings, Belfast. Tenders to Mr. Henry Beaver, architect, 22, Donegall-place, Belfast, by Nov. 3.

Shoreditch.—The Borough Council invite tenders for the extension of plant at their Whiston street generating station. Tenders to the Town Clerk by Nov. 7. See advertisement in last issue.

Edinburgh.—The Parish Council invite tenders for an installation of intercommunication telephone system throughout the offices, Castle-terrace, Edinburgh. Tenders to the Clerk by 10 a.m. on Nov. 7.

Sao Luiz.—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 16. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Macroom (Ireland).—The Urban District Council invite tenders for lighting the streets of the town by electric light or acetylene gas. Tenders and specifications to Mr. T. Murphy, clerk, by 8 p.m. on Nov. 10.

Brisbane.—The Postmaster-General invites tenders for 150 branching system table telephones. Tenders by Dec. 1. Particulars may be obtained from the Postmasters-General at Sydney, Melbourne, Brisbane, and Adelaide.

Altrincham.—The Altrincham and Bowdon Administrative Sub-Committee for Education invite tenders for the electric wiring and fittings required for the Stamford Park new Council schools. Tenders to the Clerk by noon on Nov. 3.

Manchester.—The Tramways Committee invite tenders for the supply of (*a*) tramcar trucks, (*b*) electrical equipments for cars. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by 1 p.m. on Nov. 11.

Harrogate.—The Directors of the Frederick Hotels Co. invite specification and tenders for laying down electrical plant at the Hotel Majestic, Harrogate. Further particulars on application to the Secretary, 8, Bloomsbury-square, London, W.C.

Clacton-on-Sea.—The Urban District Council invite tenders for the supply and erection of (Section A) gas-engines and dynamos; (B) switchboard; (C) underground mains; (D) accumulators; (E) meters; (F) crane; (G) buildings. Tenders to Mr. G. T. Lewis, clerk, by 3 p.m. on Nov. 6.

Barrow-in-Furness.—The Corporation invites tenders for the supply and erection of a 500-kw. combined steam-engine and generator, balancer booster, switchboard, water-tube boiler, mechanical stoker, economiser, travelling crane, cooling tower, pipes, etc. Tenders by 12 noon on Nov. 13. See advertisement.

Cape Town.—The Cape Post and Telegraph Office invite tenders for telegraph and electric light material. Tenders will be received by the Chairman of the Tender Board, Control and Audit Office, Parliament-street, Cape Town, up to noon on Nov. 22. Samples may be inspected and forms of tender, copies of specifications, together with any other information required, may be obtained on application to the Controller of Stores, General Post Office, Cape Town.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension of that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Netherlands.—The Board of Trade have been notified by the acting British consul at Amsterdam (Mr. F. A. Chambers) that the Zuid-Hollandsche Electrische Spoorweg-Maatschappij (South Holland Electric Railway Co.) will be prepared to receive tenders for the making of ground works, engineering, and additional works between the Ceinturbaan and "piket 1[illegible]0 by 70" (in connection with the works of Contract No. 14), the laying of rails and switches, and the supply and use of gravel ballast, as well as some works in connection with the railway, in accordance with Contract No. 17. The estimated cost of the work is 936,000fl. (£78,000). On Oct. 25, at 10.30 a.m., an explanation will be given, meeting place Café, "Plaats Lommerrijk," on the Bergweg, near Hillegersberg. Copies of the contract, with drawings, may be obtained from Messrs. Beversen and Van Hoorn Heerengracht, 38, The Hague, at a cost of 12·20fl. (£1. 0s. 4d.). Tenders should be written on stamped paper, and received before 1.15 p.m. on Nov. 2.

RESULTS OF TENDERS.

Islington.—The Council have accepted a tender of Messrs. Phillips and Co. for 5,000 tons of coal at 2s. 6d. at pit's mouth and 9s. 3d. delivered.

Leek.—The Urban District Council have decided to purchase an earth recording ammeter from Crompton and Co. at a cost of £34. 5s., and two maximum and reverse current breakers at a cost of £26.

Southgate.—The following tenders have been received for the work and materials required in the construction of the permanent way

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(for electric traction), bridge work, road widenings, etc., for Contract No. 14; railway No. 2 (order 1900)—a line of double track (with crossovers, contingent works, etc.) to be laid along Bounds Green-road, in the district of Wood Green, and High-road, in the district of Southgate, in the county of Middlesex, to a length of 1 mile 5 furlongs 1 chain, or thereabouts, for the Light Railways and Tramways Committee of the Middlesex County Council:

T. Adams	£39,818	3	2
G. Bell	40 235	0	0
British Electric Equipment Co.	37 488	5	8
Dick, Kerr, and Co.	38 386	19	2
C. Ford	38,387	0	0
W. Griffiths and Co.	37,980	10	0
Grounds and Newton	41,873	0	6
G. Hay and Co.	40 833	13	7
G. Holloway	39 800	0	0
Mowlem and Co.	42,024	0	0
F. Osman	38 500	0	0
Pethick Bros	39 777	0	0
J. Strachan	50,700	0	0
C. Wall Limited	44,319	0	0
Wimpey and Co., The Grove, Hammersmith (accepted)	35,884	2	7

London County Council.—The following tenders have been received (1) for the supply of about 4 210 tons of acid-steel track rails and fastenings to be used in the reconstruction of the first section of the Council's (northern) tramways:

Lorain Steel Co., U.S.A.	£27,121	10	0
Bolckow, Vaughan, and Co., Middlesbrough (accepted)	31,131	15	0
Barrow Hematite Steel Co., London	32,249	5	0
P. and W. Maclellan, Glasgow	32,813	2	6

Note.—The tender of the Lorain Steel Co. was not in accordance with the specification.

(2) For the reconstruction of the tramways from North-street, Wandsworth, to Westminster Bridge, and for the execution of paving works, etc., in Nine Elms-lane, York-road, and Battersea Park-road, as follows:

Tramways work.

J. G. White and Co., London (accepted)	£163,874	11	2
Dick, Kerr, and Co., London	169 736	8	0
W. Griffiths and Co., London	173,830	4	1
G. Law, Kidderminster	177 284	19	6
Muirhead, Greig, and Matthews, London	175,548	12	4

Engineer's revised estimates, £165,491. 4s. 10d.

Paving works for street widening.

J. G. White and Co. (accepted)	35,371	3	4
Dick, Kerr, and Co.	30,483	2	3
W. Griffiths and Co.	30,547	14	2
G. Law	27,370	0	6
Muirhead, Greig, and Matthews	35,066	9	7

Engineer's revised estimates, £33,491. 14s. 7d.

BUSINESS NOTES.

TRACTION.

Perth.—The new electric car service was inaugurated on Tuesday last.

Leigh.—The Town Council have granted permission to the electrical engineer to take on an articled pupil.

Rotherham.—The question of ½d. fares has been again considered by the Tramways Committee, but no decision arrived at.

Mnotothal Valley.—Electric railways are to be constructed in the Swiss Caverns, and a company is being formed in Brussels for the purpose of developing them.

Croydon.—The November municipal elections were fought on the question of the working of the tramways, and in the wards candidates who supported the Corporation working them as against the British Electric Traction Co. were returned.

Brighton.—The Brighton Town Council have adopted the recommendation of the Tramways Committee to discontinue the running of tramcars to the top of Elm-grove during the winter months. A rearrangement of fares was also decided upon.

West Ham.—We understand that Mr. J. H. E. Blain, the tramways manager, is in future to supervise the overhead equipment instead of the electrical engineer. The Corporation have also reduced the price of current for tramway purposes to 1d. per unit.

Trafford Park Estates.—In presenting their report, the directors of this company state that traffic arrangements have been made with the Lancashire and Yorkshire Railway Co. and the London and North-Western Railway Co. which will result in additional income.

Switzerland.—The *Feuille Federale Suisse* publishes a decree granting to the Alioth Electric Co., of Bâle, and Messrs. Vallière and Simon, engineers, of Lausanne, a concession for the construction and working of an electric railway from Sépey to Ormont-Dessus.

Barnsley.—In reference to the Town Council's complaint regarding the condition of a portion of the track, it was announced at the last meeting of the Council that the electric traction company had ordered setts, and that the work of repair would be gone on with as soon as they arrived.

North-Eastern Railway.—A fire broke out at the company's transforming station at Wallsend on Saturday last. The fire is due to the fusing of some temporary cables during the progress of preliminary tests. There was a stoppage of the electric train service for about one hour.

Fareham.—While four men were engaged at work on the overhead wires a large wooden pole by which the trolley wires are suspended broke in the centre. Two of the men were thrown violently to the ground, one sustaining a fracture of the left leg, while the other was injured about the body.

Swindon.—The Council have resolved to purchase three additional tramcars, the type to be settled at the next meeting of the Council, whilst extensions to the car-sheds have been decided upon. The Tramway Committee's recommendation that it was inadvisable to make a junction between certain lines was adopted.

Hammersmith.—The Works Committee of the Borough Council have been informed that the Postmaster-General cannot accept the Council's refusal of consent to the placing of overground telegraph lines along several streets in the borough, but the committee recommend to the Council that their former decision be adhered to.

Bolton.—At last week's meeting of the Town Council, the Chairman of the Tramways Committee stated that the through route between Tonge Moor and Great Lever had not been a great success. They had run 170 miles extra on the through route during the last fortnight, and the receipts had been actually less than under the old conditions.

Bethnal Green.—The General Purposes Committee of the Borough Council recommend that the Council concur in the action of the Borough Councils of Hackney, Lewisham, and Camberwell, and that the London County Council be requested to reintroduce a Bill similar to the (Tramways and Improvements) Bill rejected last session by the House of Lords.

Stourbridge.—It was reported at a meeting of the District Council that the British Electric Traction Co. intended to apply to the Board of Trade for their approval to a transfer of the Kinver light railway undertaking to the Dudley, Stourbridge, and District Electric Traction Co. A sub-committee was appointed to consider any representations to be made on the subject.

Chester.—The Postmen's Federation have been inquiring whether postmen were not entitled to the same privileges as workmen when travelling by workmen's cars, and the Tramways Committee have decided that in future all persons travelling by cars labelled "workmen's cars" shall be entitled to the privileges of the ½d. stages, and that on these cars only tickets for ½d. stages be issued.

Wigan.—At the last meeting of the Electric Light and Tramways Committee it was resolved that notice be served upon the South Lancashire Tramways Co. requiring them, in accordance with the agreement between the company and the Corporation, to transfer their rights, powers, and obligations to the Abram District Council in regard to the tramway situated on the north side of Dover Bridge.

Torquay.—A meeting of the Town Council was held last Monday, when the present position of the Corporation in connection with the tramway undertaking was discussed at some length. We called attention last week to the differences which had arisen between the Corporation and the contractors (the Dolter Co.). The Council have now decided to hold a conference with the company with a view to effecting an arrangement.

Poole.—With regard to the proposed light railway extension to Swanage, the Harbour Commissioners, at a meeting held last week, decided to support the scheme provided adequate means were taken to prevent hindrance to navigation, and they recommend that consent be given to the scheme only on condition that the clear span of the waterway be 670ft., and that the span of the bridge be from shore to shore, with no columns in the water.

Cleckheaton.—A meeting of the Council was held on Monday last, at which a letter was read from the town clerk of Bradford inviting the Council to be represented at a conference on the subject of the proposed linking-up of the Spen Valley and Bradford tramways at Oakenshaw. It was decided to take no action pending the receipt of a reply from the British Electric Traction Co., who work the Spen Valley lines, and who have been written to on the subject.

Heywood.—It was reported at the last Council meeting that an agreement had been come to with Bury Corporation for the starting of tramcars. About the middle of this month the tramway track would have been laid with the exception of the crossings in the Market-place leading to Hopwood and the Hopwood length. Work was well forward, and the machinery had been tested. If the cars earned 10d. per car mile on a 10 minutes' service, the tramways undertaking would be profitable.

Hanley.—The Finance Committee have recommended the purchase of property in the vicinity of Snow-hill for improvements to be made, allowing for the running of trams. The Town Council have approved of the proposal of the Finance Committee that the Potteries Electric Traction Co. be permitted to extend the loop at Howard-place, so as to enable a double line to be laid in the centre of the road. The Council have further agreed to contribute £250 towards the cost of the extensions.

Underground Fares.—The Metropolitan Railway Co. announce an important reduction of fares between the West-end and Paddington and the City, reaching as far as Aldgate. The reduced fares, which came into force on the 1st inst., enable the public to travel from Paddington to the City, either to Moorgate-street, Bishopsgate, or Aldgate, for 2d. third-class and 3d. first-class. The company are retaining the 1d. and 1½d. fares for shorter distances and are continuing the issue of workmen's tickets.

Bonnyrigg.—The members of the Town Council met the ratepayers at the annual meeting which usually takes place before the election. Provost Gilchrist was able to inform the meeting that he had it on the authority of the engineer that the tramways would be running by April next. Negotiations with the tramway syndicate had resulted in a reduction of fares over some of the routes. Several members expressed themselves strongly against the running of Sunday cars, and deprecated the action of the Council in granting their permission.

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Hastings.—In view of the winter season the tramways company have reduced their service of cars except on the Old Town route, where the service has been accelerated. The claim of Messrs. Breeds and Co. against the Hastings Tramways Co. for £1,604 in respect of certain land and for damages for injury to their property through the erection of a tramway in close proximity to it was submitted to arbitration. The inquiry was conducted in London, and at the close the umpire announced that he would deliver his award in due course.

Traffic Returns.—The receipts of the North Metropolitan Electric Tramways for the past week show a decrease of £561. Returns from the Buenos Ayres and Belgiano Electric Tramways for the week ended Oct. 29 show a decrease of £420. The total receipts of the Buenos Ayres Electric Tramways for the week ended Sept. 30 amounted to £1,223. The gross receipts of the Natal Zululand Railway for September were £5 less than those of the previous month, whilst the Havana Railway receipts for the week ended Oct. 15 increased £1,887.

Batley.—Progress is being made with the electrification of the Bradford-road tramway system, and the Dewsbury-to-Batley section is now complete. The trial trip was held last week and the route between Dewsbury and Batley was traversed in less than 10 minutes. The journey was accomplished without a hitch, and the service opened to the public on Friday last. It is hoped that the section between Birstall and Birkenshaw will be ready for opening shortly, but the portion from Batley to Birstall, it is understood, will not be completed until the end of this month.

Edinburgh.—The tramways company are stated to be willing to agree to the closing of the tramways capital account at the present figure, £1,290,000, upon certain conditions, and to pay by longer instalments the sum of £22,500 earlier than they would have done under the old lease. Under the new proposals the company are granted a reduction of £10,000, with the stipulation that if within the last six years of the lease they pay a dividend of 5 per cent. to their shareholders they will pay interest on an additional £6,000 to the Corporation. The maximum rent is fixed at £95,000.

Woolwich.—At a meeting of the Borough Council held last week a report was presented by the General Purposes Committee in the form of a history of the Plumstead tramways scheme. Public feeling in the borough is strongly in favour of electric tramways, and the Borough Council are willing to supply the London County Council with all the necessary motive power. A deputation waited upon the Improvements Committee of the London County Council last month, and they report that favourable consideration will be given to the suggestions of the Borough Council for an extension of the electric system.

Wednesbury.—A special meeting of the Town Council was held last week, at which it was proposed and carried that, in accordance with the provisions of the Tramways Act, notice be given to the South Staffordshire Tramways Co. requiring them to sell the section of the tramway between Wednesbury and Walsall, other portions having been purchased from time to time as occasion arose, with the result that only this part of the lines within the borough remained to be acquired. The Corporation would then be in a position to pay to the tramway company the sum agreed upon as the purchase price of the undertaking.

Tramways and Light Railways Association.—Some of the members visited the power station of the North Metropolitan Electric Electric Power Supply Company at Brimsdown on Tuesday last and inspected the equipment of that establishment. After having viewed with great interest the boilers, turbines, and the three three-phase generators, capable of generating 10 000 volts at 1 500 revolutions per minute, the members of the association paid a visit to certain of the four sub-stations scattered over the company's district, at which the high-tension current of 10,000 volts is converted into continuous current at 550 volts for line work, and they also travelled over portions of the tramway, which is operated by overhead equipment, and forms an important addition to the means of locomotion in North London.

Exeter.—At a meeting of the City Council, the Mayor, in moving the adoption of the report of the Tramways Committee, said the estimate for the whole of the tramways mentioned in the Act was £95,000. The Council had spent up to the present £67,489. Deducting £7,852 for the purchase of the old horse undertaking that made £59,637. If they constructed the whole of the rest of the tramways upon the estimate that was given, the total cost would be £31,800. Adding that to the sum already spent that would make a total of £91,437, instead of the estimate in the bill of £95,000. They had in the past six months carried two million persons, and taken close on £19,000. That had exceeded expectations and left a good margin for any falling-off in the winter. The report was adopted.

Ipswich.—We understand that the tramway receipts for the past six months have totalled £12,758, against total working expenses of £8,437, leaving a gross profit of £4,318. After paying interest on loan and apportioning money for the repayment of loan, the profit is reduced to £1,540. To this figure must be added £660 voted to the tramways as part of a rate in aid, leaving £2,200 as the total sum available to the committee, which, applied to the reduction of the total deficit of March 31 last (£2,742), brings the total deficit down to £542. The average weekly working expenses for the past six months, compared with the average weekly expenses for the year ending March 31 last, show a decrease of £38 per week. The average receipts per car mile during the past six months stand at 8·86d., against 8·92d. for the same period last year, and the average passengers per car mile similarly compared are 8·29, against 8·92.

Elland.—An important letter was read at the monthly meeting of the District Council on Tuesday bearing upon the question of tramways to Elland. The National Electric Construction Co., who are the promoters, state in their letter that it was proposed to join the Halifax system at West-vale and proceed by way of Long Wall and Victoria-road through Elland to the bottom of Ainleys, thence along the hill-side by a new road between Elland Upper Edge and Elland Lower Edge, across to Fartown, with a third rail and running powers over the Huddersfield tramways into the middle of the town. Running powers are also being sought over the Halifax system from West-vale, so that there might be through traffic between Halifax, Elland, and Huddersfield without change of car. It is also intended to take over the authorised tramways through Rastrick into Brighouse from the Huddersfield Corporation. The Council provisionally approved of the scheme, but reserved the right to discuss it when it came before the Council.

Jarrow.—At a meeting of the Town Council a letter was read from the British Electric Traction Co., asking the consent of the Council to their proposal to allow the Albert-road section of their scheme to drop. The letter stated that the Albert-road railway was of little importance to the scheme, and was only included in the provisional order with a view to possible extensions. That was found to be impracticable, as the crossing of the railway line at the termination of the section was one which neither Parliament or the Board of Trade would sanction. The consent of the Council was all that was required before proceeding with the remainder of the work, as they had already provisionally accepted a tender for the construction of the permanent way. The Tramway Committee recommended that the company be asked to carry out the scheme of the Light Railway Act, and that no further delay be consented to. This was approved by the Council.

Kirkcaldy.—In connection with the Wemyss tramway scheme the District Committee had before them at their meeting on Saturday last the opinion of a King's counsel, who advised that they could not sanction the laying of the tramway on any part of the public roads other than on the metal bed. The committee recommended that the promoters should widen the road where it was desired to utilise the portion of the road at present occupied by the waste or grass margin for the tramways, so as to make the metal bed of the road sufficiently wide to permit of the tramways being laid according to the promoters' plans. A letter was read from Mr. Sellon, engineer for the tramways, stating that material to the value of several thousand pounds had already been purchased, and with a view to the forward state of the promoters' preparations, and in order to save further time, he had submitted the matter to the Board of Trade. The committee agreed to inquire from the Board of Trade whether that body had power to deal with the matter.

Newcastle.—At a meeting of the Tramways Committee held last week the town clerk presented a letter he had received from the Newburn Urban Council, to the effect that they would like to have an interview with the committee respecting the possibility of extending the tramlines to Newburn. A sub-committee was appointed to talk over the question with members of the Newburn Council. The sub-committee of the tramways reported that they had had a long interview with Colonel von Donop, representing the Board of Trade, who had been in Newcastle for the purpose of meeting the committee and going into the question of making the Newcastle tramways down Fisher-hill, where the line belonging to the Newcastle Corporation adjoins that of the Tyneside Tramway Co. The hill has a very steep gradient and an acute curve at the bottom. A number of experiments had been made by the committee to see if the traffic could be conducted safely. Four cars had been fitted with special brakes, and several times made to work the gradient and the curve. On every occasion the cars had got away in spite of the brakes, and on the return journey each failed to take the gradient. Colonel von Donop had informed the committee that he had never liked the line and had never approved of it. In its present dangerous state the Board of Trade would not allow it to be worked. A deputation from the Newcastle and District Tramway Workers' Union waited upon the committee with a request that motormen and conductors be paid time and a half for Sunday and overtime. The Tramways Committee promised to give this and other questions their careful consideration.

Bradford.—The report of the Tramways Committee for the year ended Aug. 31 states that the route mileage now worked by the Corporation is 55¾ miles. The car mileage has increased from 4,856,023 miles to 4,975,080, and the receipts have increased by £8 117. A department was inaugurated for the receiving and despatching of parcels on Jan. 1, 1905, and from that date to the week ending Aug. 31, 1905, about 300,000 parcels have been carried, which works out to a total for 12 months of 450,000, an average of 8,654 parcels per week. During this period the department has received altogether for carriage, storage, etc., £2 375. 12s. An arrangement has been made between the Yorkshire Woollen District Electric Tramways Co. and also the Halifax Corporation Tramways for the interchange of parcels. Between 300 and 400 parcels are dispatched weekly between these systems and the department, and which system is working admirably. The department has been very successful in the collection and delivery of parcels, as up to date only one parcel has been lost. Claims have been met for for damage to parcels to the extent of £5. The departmental accounts published with the report cover the period from April 1, 1904, to March 31 last. These show a revenue from traffic of £223,541, advertisements, parcel traffic, and other sources making the total income £230 085. Traffic expenses absorbed £67,226, general expenses £20,221, general repairs and maintenance £32 177, and power expenses £39,196. The balance carried to net revenue account was £70,228, of which £23 942 was applied to meeting interest on capital, and £24,491 contributed to the sinking fund, £15,623 being carried to reserve or renewals fund.

Tramways over the Bridges.—At a meeting of the Court of Common Council yesterday an important report was presented by the Bridge House Estates Committee on the question of overbridge tramways and the widening of Blackfriars Bridge, recommending that the

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structure should be widened to the extent of 40ft. The committee also recommended that the following conditions should be imposed: (*a*) that the proposed widening of Blackfriars Bridge is conditional on the London County Council obtaining powers to run trams over Westminster and Blackfriars Bridge *viâ* the Embankment, otherwise the Corporation may abandon the scheme; (*b*) that the cost of any widening that may be required on the southern approach to the bridge shall be paid for by the London County Council out of tramways account, and not out of improvement account; (*c*) that the London County Council agree to construct and pay the cost of a subway for foot passengers under the roadway at the northern end of Blackfriars Bridge, the site thereof to be settled by the Corporation, such subway to belong to, and be maintained, lighted, and policed by the Corporation; (*d*) that the London County Council agree to pay an annual rent, the amount of which shall be mutually agreed upon, for a way-leave over the widened bridge; (*e*) that the City police shall have complete jurisdiction and control of the tramway traffic within the City boundary; (*f*) that the trams shall not stop on the bridge, nor within 25 yards of the ends thereof, to set down or pick up passengers; (*g*) that the London County Council regulation of 60ft. between each tramcar shall be maintained; (*h*) that no responsibility whatever shall attach to the Corporation for or concerning cables, rails, or cars, nor for any accidents that may occur in connection therewith.

Belfast.—At last week's meeting of the Tramways and Electricity Committee the question as to the charges which might be made upon the tramway undertaking by other spending departments was discussed. The General Manager explained that the late tramway company paid to the general fund of the Corporation the annual sum of £3,961. 14s. 2d. as rent for that portion of the Belfast tramway system known as the Corporation tramways. For this consideration the Corporation undertook to maintain in repair and good working order the paving, rails, sub-structure, and other works, conveniences, and parts of the tramway. The tramway department still continued to make their annual payment of £3,961. 14s. 2d. to the general fund of the Corporation, and he considered that the repairs of this portion of the system should be carried out by the Works Committee, and the cost charged to the general fund of the Corporation and not to the tramway department. With respect to the harbour tramways, it was resolved that the Harbour Commissioners be informed that the committee are prepared to recommend the Council to enter into an agreement with the Commissioners for the working of the proposed tramway, paying to the Commissioners by way of rent a sum equal to 3¾ per cent. on the cost of the construction of tramway No. 23 which has been estimated at £16,000, the tramway to be constructed and maintained by the Commissioners, and the agreement to be for a term of 15 years. The city surveyor reported that the work of which he had charge was progressing favourably, and he hoped that the opening of the greater portion of the electric tramway system would take place on Nov. 18. It was resolved to inform the Board of Trade that the committee would like to have the lines inspected this month.

Stalybridge.—The formal opening of the Stalybridge, Hyde, Mossley, and Dukinfield joint tramways took place last Monday, when members of the four Corporations, together with the chief officials, made a thorough inspection of the plant and car-sheds, and then traversed a portion of the tramway route. The total route length of track is 21 miles 390 yards, of which 6 miles 667 yards is double line. The gauge is the standard 4ft. 8½in., uniform with the gauge of the adjoining tramway systems. The length of line constructed is about 25 miles, and a further two miles is authorised. The system of generation comprises a main generating station and four sub-stations. Electricity is generated at 6,000 volts three-phase alternating current at 40 periods. This is transmitted to each sub-station, at which it is transformed, and then distributed as direct current to lighting and tramway feeders. Each of the four towns has a complete lighting network of mains. The scheme has cost £430 000. The general contractors for the main generating station were Storrs, Sons, and Co., and for the car-shed Saxon Bros. and Co., both of Stalybridge, while the whole of the steelwork for both was carried out by E. F. Blakeley and Co., Liverpool. The four sub-stations—one at Hyde, Mossley, Dukinfield, and Stalybridge, each about 93ft. long by 25ft. broad (Hyde and Mossley having small car sheds attached)—have also been designed and carried out to match the main generating station, and with similar materials. The whole of the work has been carried out from the plans and under the supervision of Messrs. Huon Matear and Simon, architects, Liverpool. Mr. Ralph Lawton, Stalybridge, was clerk of the works for the main buildings and offices, and Mr. H. Merritt for Dukinfield and Hyde sub-stations. The offices in Waterloo-road, Stalybridge, were built by Messrs. Shuttleworth Bros., Stalybridge.

London County Council.—At the usual weekly meeting of the Council, held last Tuesday, the Highways Committee submitted a report, which will be considered next week, recommending: (*a*) that the capital vote of £10,000, approved on July 18, 1905, in respect of the supply of stoneware ducts for electric cables, required in connection with the reconstruction of the first section of the Council's (northern) tramways be cancelled; (*b*) that the estimate of expenditure on capital account of £112 000, submitted by the Finance Committee, be approved in respect of the erection of the car-sheds and sub-stations required for the electric working of the first section (equivalent to about 22½ miles of single line) of the Council's (northern) tramways, including expenditure incidental thereto; (*c*) that the estimate of expenditure on capital account of £26.000, submitted by the Finance Committee, be approved in respect of the necessary reconstruction of bridges in connection with the reconstruction of the first section of the Council's (northern) tramways: (*d*) that the estimate of expenditure on capital account of £665,600, submitted by the Finance Committee, be approved in respect of the reconstruction and equipment for electrical traction of the first section (equivalent to about 22½ miles of single line) of the Council's (northern) tramways—namely, trackwork, including rails, etc., £415 600, rolling-stock, cables, cable ducts, machinery, plant, etc., £250,000; (*e*) that the Highways Committee be authorised to obtain tenders and to take the other steps preliminary to the execution of the several works referred to in the foregoing resolutions (*b*) and (*d*). The total estimate amounts to £803,600. The County Council have completed the agreement with the North Metropolitan Tramways Co. for the acquisition of the remaining interests of the tramways lease. The Highways Committee proposes that the work of reconstructing the first section of the lines (22½ miles in length) shall be proceeded with as soon as the lines are acquired in April next. This section comprises the following lines: (*a*) Theobald's-road terminus, *via* Clerkenwell-road, Old-street, Great Eastern-street, Commercial-street, and Leman-street, to near the London Docks; (*b*) Norton Folgate terminus, *via* Shoreditch, Kingsland-road, High-street, and Stoke Newington-road, to Stamford Hill; (*c*) Aldgate terminus, *via* Commercial-road, Commercial-road East, and East India Dock-road, to Poplar; (*d*) Moorgate-street terminus, *via* Finsbury pavement and City-road, to junction with Old-street; (*e*) Holborn terminus *via* Gray's-inn-road, to junction with Theobald's-road; and (*f*) along Old street, between Great Eastern-street and Shoreditch. It is hoped to complete the reconstruction of this section of the tramways by Christmas 1906. The bridges which will require reconstruction or alteration are the following: (*a*) the bridge carrying Clerkenwell-road over the Metropolitan Railway, (*b*) the bridge carrying Commercial-street East over the Great Eastern Railway, (*c*) the bridge carrying East India Dock-road over the North London Railway, and (*d*) the bridge carrying High street, Kingsland, over the North London Railway (docks line). In view of the approaching completion of the new tramways from New Cross-road, *via* Lewisham High-road and Loampit hill and vale, to High-street, Lewisham, the Highways Committee propose to fix the undermentioned fares: ½d. fares between the Marquis of Granby public-house and Tanner's-hill between Tanner's-hill and Lewisham-road Station (S.E. and C. Railway), between Lewisham-road Station and the Obelisk, Lewisham; 1d. fares between New Cross-gate and Lewisham-road Station, between the Marquis of Granby public-house and the Obelisk, Lewisham; 1½d. fares between Rye-lane and Lewisham-road Station, between New Cross-gate and the Obelisk, Lewisham; 2d. fares between Camberwell Green and Lewisham-road Station, between Rye-lane and the Obelisk, Lewisham; 2½d. fare between Camberwell-gate and the Obelisk, Lewisham; 3d. fare between Westminster Bridge and the Obelisk, Lewisham. The committee have also recommended to the Council the acceptance of Messrs. Bolckow, Vaughan, and Co.'s tender of £31,131. 15s. for the supply of track rails and fastenings in connection with the reconstruction of the first section of the Council (northern) tramways,

LIGHTING AND GENERAL.

Willesden.—An inquiry has been held into the application for sanction to borrow £20,000 for electricity purposes.

Gelligaer.—The Rural District Council are discussing an electric lighting scheme and the question of appointing a consulting engineer.

Cumberland.—The County Council have received sanction to borrow £5,300 to defray the cost of the electric installation at Garlands Asylum.

Change of Address.—The office of Mr. J. Wilkinson, tramways electrical engineer, Hull, has been removed to Queen's Dock-chamber, Alfred Gelder-street.

Dewsbury.—The Local Government Board have declined to allow a longer period than 18 years for the repayment of the loan of £9,762 for electric lighting purposes.

Bexhill.—The Town Council at their last meeting rejected a resolution moved by a member of the Electricity Committee of the Council, that gas should be used in lighting one of the streets.

Chelmsford.—The Town Council's contract with the Chelmsford Electric Lighting Co. has expired, and the Lighting Committee have decided to recommend the Council to renew the agreement.

Bethnal Green.—It is reported that the Borough Council propose to obtain their electricity supply from either Shoreditch or Hackney, or both, instead of having an independent supply of their own.

Calcutta Electric Supply Co.—The number of units delivered to consumers during the five weeks ending Sept. 29, 1905, were 546,086, compared with 433,985 in the corresponding five weeks of the preceding year.

Elgin.—A resolution to the effect that the Council apply for a provisional order for the introduction by the Council of a system of electric lighting has been deferred until the receipt of the engineer's detailed report.

Easthampstead.—A deputation of the Rural District Council is about to confer with the Camberley Electric Supply Co. with reference to their proposed application for a provisional order to supply electric light in the district.

Pontardawe.—The Council last week discussed the report of Mr. John Morgan, Cardiff, on the lighting of the Pontardawe area with electricity. Mr. Morgan's estimate is £32,000. A resolution to apply for a provisional order was lost.

Ipswich.—The units generated during the past six months amount to 564,428, against 537,732, and a much increased proportion of this current has been supplied for lighting purposes, the total number of consumers having increased from 165 to 258.

Swanage.—The special committee on the question of electric lighting in the Swanage district reported at the last District Council meeting that they had decided not to make any formal report to the Council until after they had met Mr. Renwick.

Torquay.—The inquiry announced in our issue of Oct. 27 into the application of the Corporation for sanction to a loan of £9,500 for the

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extension of the existing electricity station, to supply additional current for working the tramways, was held on Nov. 1.

Hull.—The chairman of the Telephone Committee (Councillor Brown) on Tuesday, in submitting a statement of the receipts and expenditure connected with the telephone undertaking for six months ending Sept. 30 last, stated that this was now a paying concern.

Brynmawr.—The District Council have decided that before proceeding further with the proposed electric lighting scheme for the district, the Nantyglo and Blaina Council be invited to attend a joint conference as to the undertaking of a joint scheme for these two areas.

St. James's and Pall Mall Electric Light Co.—The amount of electricity sold by this company for the quarter ended Michaelmas is stated at 1 375,210 units, estimated to produce £20,055, as against 1,238,880 units, which produced £19,306 for the corresponding period last year.

Bolton.—We understand that at the last Council meeting an amendment rejecting the application of the Co-operative Society for permission to lay an underground electric cable for their premises in Bridge-street to Bark-street—a matter to which we have already referred—was lost.

Agency.—Mr. Jens O·ten-Böving has opened offices at 72, Victoria-street, Westminster. S.W., as consulting engineer and representative of leading engineering firms, and has secured the agency of the large and well-known firm of Escher, Wyss, and Co., Zurich, for the United Kingdom and Colonies.

Cheshunt.—The request of the North Metropolitan Electrical Supply Co. that the Council consent to an application for a new provisional order constituting the company the undertakers instead of the Urban District Council is under consideration, and a modified agreement is being drawn up.

West Hartlepool.—An inquiry has been held into the Town Council's application for sanction to borrow £5,000 for the extension of mains to enable them to provide power for various works, and in particular to the Seaton Carew Ironworks, with which an arrangement has been made for the supply of 300 h.p. or 400 h.p. per annum.

Barking.—We learn that great progress has been made in this district with regard to the supply of electricity for power purposes, as owing to the fact that the Council have been able to offer current at 1d. per unit, no less than 90 per cent. of the power users in the district have adopted electric motors for driving their machinery.

Swindon.—The electrical engineer's last report shows that the number of consumers connected on Oct. 15 was 398, as compared with 245 a year ago. The number of street lamps converted to date was 187, as against 157 at this time last year. The engineer has been authorised to purchase a water-tight disconnecting box at a cost of £7. 10s.

Mynyddislwyn.—The District Council have adopted a resolution in favour of the application of a private company for authority to supply electric light in the district provided that a clause be inserted in the private order reserving to the Council the right to purchase at the end of either 7, 14, 21, or 28 years from the date of confirmation of the order.

Dunfermline.—The Town Council have passed a resolution to apply to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the municipal or Royal burgh of Dunfermline, and also within certain other areas not included within but which adjoin the boundaries of said burgh.

Lanchester.—The Guardians have referred to the Building Committee a statement compiled by the architects (Messrs. Newcombe and Sons, Newcastle) of the cost of lighting the workhouse, cottage homes, and other buildings with gas and electricity. The electric installation was put down at £1,725. The report was referred to the Building Committee for further consideration.

Stourbridge.—The District Council have passed a resolution instructing the Electric Powers Committee to lay before the Council a scheme for generating electric current for the town, and that the company which had obtained certain electric powers should be asked within seven days what favourable terms they were prepared to give the Council before other steps were taken.

Storage Batteries. — The Electrical Power Storage Co. inform us with regard to their increase of 5 per cent. in all their catalogue prices for complete cells, renewals, and plates, that this increase has been necessitated by the continued advance in the prices of raw materials, especially lead, during the past few months, and that it applies to all their outstanding estimates.

Oldham.—An inquiry has been held into the application of the Borough Council for a loan of £48,114 for the purpose of defraying expenses in connection with the electricity undertaking. Mr. Harold Cliff, on behalf of the Oldham Master Cotton Spinners' Association, and Mr. S. Wall, for the Ratepayers' Association, took exception to several items. We deal with this matter further in another column.

Southwark.—The Borough Council have adopted a report of the General Purposes Committee on the municipal supply of electricity in bulk, stating they could not recommend the Council to send delegates to a suggested conference in relation to the subject, and recommending that the Council express an opinion that any legislation for the supply of electricity in bulk should be initiated by the London County Council.

Finchley.—The Highways Committee have been considering for some time the question of lighting certain of the street gas lamps by the incandescent system, and have received an offer with reference thereto from the North Middlesex Gas Co. The matter has been referred to a joint committee of the Highways and Electricity Committees for consideration and report, so as to give the latter committee a chance to better the offer.

Pontnewydd.—The Redbrook Tinplate Co. have started new mills and new cold rolls. The mills and cold rolls, which were made by Messrs. Richards and Hopkins, engineers, Caerleon, are driven by electric power obtained from the South Wales Electrical Distribution Co.'s works at Cwmbran, and we understand are the first tinplate mills and cold rolls to be driven by electrical power. The directors propose, if the experiment proves a success, to drive the whole of their mills and cold rolls by electricity.

Stepney.—The Borough Council have approved an arrangement whereby Messrs. Cloke Bros. are to pay the Council the sum of 9d. for every ton of clinker and ashes drawn from the electricity works and passed into the clinker-crushing plant of the works department, and the Electric Lighting Committee are to pay the Works Committee at the rate of 7d. per ton in respect thereof. The Council have accepted the tender of Messrs. Cloke Bros. for the removal of rubbish and fine dust for the period of one year from Oct. 1, 1905.

Bettws-y-Coed.—The Bettws-y-Coed Council have accepted the invitation of a local syndicate to apply for a provisional order for the lighting of the district by electricity. The syndicate undertake to bear all legal and other expenses incurred on condition that they be given the first refusal to the carrying out of the scheme. Under the agreement the company undertake to have the scheme carried out within 18 months, failing which the order, with benefit of any existing right and contracts relating to the scheme, will revert to the Council free of expense.

Manchester.—At the inquiry noted in our last issue into the application of the City Council for powers to borrow a further sum of £60,000 for additional equipment at the distributing and balancing stations, etc., it was stated that the chief items were as follows: additional plant, £22,295; the railway in the Stuart-street station, £17,850; distributing and balancing stations, £14,285. These extensions were needed to enable the Corporation to deal with the increasing demand for supplies of electrical energy for lighting, power, and traction purposes both within the city area and the outlying districts.

Edinburgh.—The City Council on Tuesday adopted a report of the Electric Lighting Committee recommending the provision of condensing plant at Dewar-place station at a probable cost of £13,000 and at M'Donald-road station at a probable cost of £23 500, and that the engineers be instructed to prepare the necessary specifications and drawings; further recommending authority to make arrangements with the North British Railway Co. to take water from the Union Canal for condensing at Dewar-place station, and that provision be made in the forthcoming Bill to be promoted in Parliament for powers to take water from the Water of Leith for condensing at M'Donald-road station.

Ossett.—Minutes of a special meeting of the General Purposes Committee containing a letter from the Board of Trade revoking the Ossett electric lighting order were submitted at the last Council meeting. The committee asked the Board of Trade to reconsider the matter, and resolved that the scheme prepared by Mr. A. E. Mottram, gas manager, be adopted, and that application be made for power to borrow £3,500, the estimated cost of the scheme. Amendments that the minute alluding to the adoption of Mr Mottram's scheme be referred back to committee, and to ask the Yorkshire Electric Power Co. on what terms they would supply electricity in bulk were defeated, and the minutes were confirmed.

Mechanical Stokers.—A detailed account of the economies and other advantages resulting from machine firing was recently given in a paper read before the Keighley Association of Engineers, Keighley, by Mr. A. W. Bennis. We are informed that a free copy of the lecture may be obtained on application to Messrs. Ed. Bennis and Co., Little Hulton, Bolton. In this connection we note that the Hever Castle power station, Hever, Kent, is about to be fitted with an installation of four Bennis stokers and natural-draught furnaces for their Lancashire boilers. The same observation applies to the Midland Electric Corporation for Power Distribution, Wolverhampton, who have placed an order with the same makers for three stokers and compressed air furnaces for water-tube boilers.

St. Pancras.—The last report of the Electricity and Public Lighting Committee shows a large number of new applications for current. Application has been made to the London County Council for a loan of £1,464 for a period of 42 years and £410 for a period of 10 years, being the balance of expenditure on electricity capital account for the year ended March 31, 1905, to be repaid on the instalment system. A reply has been received stating that, subject, so far as the sum of £1,464 is concerned, to the Council agreeing by resolution to provide out of a sinking fund established for the purpose or from maintenance account for all renewals and replacement of any of the works, plant, and machinery provided, they are prepared to advance the sum of £1,874 applied for upon the terms that it is taken up at once and repaid by equal annual instalments, as noted above.

Islington.—With regard to the proposed conference convened for the purpose of considering the question of a municipal bulk supply of electricity, the Council have decided that the secretary of the conference be informed that though not prepared to introduce a Bill for Islington, the Council will support any action which is taken by the London County Council or by any other metropolitan borough council to enable municipalities to give a bulk supply of electricity on the lines indicated in his letter; and that a petition under the seal of the Council be presented to the Government, urging that the Supply of Electricity Bill may be passed into law in the next session of Parliament. A low-tension distributing main is to be extended at a cost of £95. In consequence of the prevalence of lack of employment, it is proposed that £5,000 of the profits realised by the electric lighting undertaking be used for the purpose of paying wages only for work that can be commenced forthwith.

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Award.—The Stirling Boiler Co., Motherwell, have been awarded a diploma and gold medal for their exhibit at the Naval, Shipping, and Fisheries Exhibition at Earl's Court. This exhibit included a marine Stirling boiler of 280 h.p. Part of the casing was removed to show the arrangement of the drums and tubes in the boiler. The boiler was lined with diatomite brick, which caused considerable interest, and it is claimed that it has a great advantage over ordinary firebrick, being a much more efficient non-conductor, and at the same time only one-seventh of the weight. The various tube cleaners used for cleaning the tubes of the boilers were also on exhibition. One of the tubes was split from end to end and a turbine cleaner inserted, thus showing how this efficient cleaner is worked. We are informed that similar boilers to that exhibited are at present in service in merchant vessels and shallow-draught steamers, etc.

Brighton.—The consulting engineer, Mr. Arthur Wright, has informed the Lighting Committee that the contractors had carried out quite satisfactorily the very difficult work of laying down the Southwick engine-room floors and turbine foundations, and that the basement floor had been proved to be perfectly watertight under the highest tides. The two completed turbines and the converters had been proved to run very satisfactorily, and he expected in less than a fortnight the Southwick plant would be in a position to continuously supply a very considerable portion of the electricity consumed in Brighton. There was no doubt that as soon as the coal-handling plant was installed, and the necessary reorganisation of the staff had been completed, very substantial economy would be effected in the cost of generating electricity for Brighton. A certificate has been issued for the payment of £60,221 on account of machinery supplied to the station by the British Westinghouse Co.

Hammersmith.—The last report of the Electricity and Lighting Committee shows that the premises of 20 additional consumers, representing a maximum of 350 8-c.p. lamps, have been connected to the mains, that five consumers have been disconnected, and that the present number of consumers taking current from the mains is 1,705. Extensions of mains are to be carried out at an estimated cost of £230. The committee estimate the annual revenue from these mains at £240, but this probably includes an expenditure of £371 previously sanctioned with regard to one of these extensions. The electrical engineer has reported that he is unable at the present time to vacate the rectifier house to enable it to be pulled down in accordance with the terms of the contract for the erection of additions to offices, etc., at the electricity works. In order to avoid a complete stoppage of the work, it has been arranged that the contractors shall proceed with the erection of the outer wall, and to postpone pulling down the rectifier house and laying the intermediate floor.

Hanley.—The last report of the Electric Lighting Committee shows that the total supply to private consumers for the six months ending June 30, 1904, was 311,939 units, compared with 321,200 in the first six months of this year. Taking the same months for public lighting, the supply was 86 397 last year and 89,247 for the first six months of this year. The total for the six months of last year was 398 336 units, compared with 410,447 this year. Mains are to be laid along Stoke-road from Newlands-street chamber, upon a guarantee of £150 per annum being received, along Franklyn-street from Leek-road, along Botteslow-street from Leek-road, and, if necessary, along Melville-street, to enable several applications to be complied with. The question of providing motors in a works close to Bucknall New-road has been deferred, but it has been agreed to lay the new high-tension feeder and spare conduit pipes along Waterloo-street into the Wellington-road Schools, thereby opening up a new district and utilising the Derby-street transformer chamber, when extended for the control of such main, instead of laying the same along existing route of cables in Bucknall New-road as first suggested.

Leek.—The Electricity Committee have decided that the local work for the committee be divided amongst the tradesmen of Leek each quarter. The committee had under consideration the following revision of prices for current to consumers who prefer to pay on a flat rate instead of maximum rate: suggested power rates for consumers whose installations do not exceed 20 b.h.p.—first 1,000 units consumed per quarter, 2d. per unit; second 1,000 ditto, 1½d.; all in excess of 2,000, 1½d. For consumers whose installations exceed 20 b.h.p. special terms can be arranged. Suggested flat rate charges for current as an alternative to the maximum demand system, based upon the prices obtained from the various classes of consumers during the past 12 months, are as under: offices, warehouses, and mills, 6d. per unit; shops, 5¾d. per unit; combined shops and private houses, 5d. per unit; private houses, 4½d. per unit; public houses, hotels, and clubs, 4d. per unit. These rates were approved at the last Council meeting, at which the engineer reported that the number of 8-c.p. lamps connected during the month was 785. The quotation of the National Telephone Co. for telephone connection of the generating station with the exchange at £6. 16s. per annum was accepted.

Fulham.—The Council have received a letter from the comptroller of the London County Council on the subject of the application of this Council for sanction to borrow the sum of £67,328 in connection with electric lighting extensions, stating that the Finance Committee have not yet arrived at any decision upon the application, and desire in the first instance to be informed whether the Borough Council have considered what would be the effect upon the Borough Council's electricity undertaking of the passing of any Bill for the supply of electricity in bulk in the Borough Council's area, such as the Administrative County of London and District Electric Power Company's Bill of last session. The borough treasurer has replied, intimating that the Borough Council has committed itself to carry out various necessary schemes of extension of the electric lighting undertaking to the full extent of the amount of the loan applied for, and, in fact, has already spent about £25,000 in connection therewith; therefore, the passage into law of any Electricity Bill such as referred to could not be considered in the direction indicated in respect of the present application. Subsequent to the above correspondence, we understand the Finance Committee of the London County Council has recommended that body to advance this Council the sum of £25,000 on account of the loan referred to, in accordance with the application.

Glasgow.—Last week the Electricity Committee of the Corporation visited the Port-Dundas station, the largest in the city, and inspected the two 4 500-h.p. turbines built by Messrs. Willans and Robinson, of Rugby, coupled to alternators built by Messrs. Dick, Kerr, and Co., of Preston. The length of the turbine and generator is about 38ft., the breadth about 10ft., and the height of the turbine alone, exclusive of condensing plant, is about 8½ft. The number of fixed blades in turbines is 45,730, and of rotating blades 45 730. It was stated that the turbines cost about one-half the price of the reciprocating slow-speed engines producing the same horse power, and occupy one-half the space. The equipment of this station now consists of nine reciprocating engines, varying in horse-power from 400 to 2,400, and representing collectively 10 050 h.p., and two turbines of 4,500 h.p. each, making a grand total in the works of practically 20,000 h.p. The reciprocating engines are coupled direct to low-pressure dynamos generating continuous current at 250 and 500 volts. The turbines are coupled to high-pressure alternators which generate three-phase current at a pressure of 6 500 volts. This current is transmitted to the sub-stations, where it is transformed to continuous current at 250 and 500 volts by means of motor generators. The low-pressure switchboard is in the engine-room. The switches for the high-pressure current are placed in a separate building for safety, but operated from the engine-room. A small battery-room is provided on each side of the entrance hall.

London Gazette.—The partnership between Thomas Rickard Bawden Nunn and Franks Herbert Watts, carrying on business as electrical engineers at 82, Mark-lane, London, has been dissolved by mutual consent. The partnership between Elizabeth Hahner and Max Wolff, carrying on business as telephone importers, dealers, and erectors, under the style of the Empire Telephone Co., has been dissolved by mutual consent. A receiving order has been made out on debtors' petition in the estate of Harry Jones and Gwilt Lloyd Cathrall, plumbers and electrical engineers, 19, Chester-street, Wrexham. Notice of substituted service appears in the estate of William G. Leather, trading as the Windus Electric Co., Sheffield, on the petition of the Union of London and Smith's Bank, 2, Princes street, London, E.C. The application is to be heard on Nov. 3 at 2 p.m. at County Court Hall, Sheffield. A first and final dividend of 6d. in the £ has been declared in the estate of Alexander Holland, electrical engineer, and trading as the Electrical and Mechanical Engineering Co., Bridgewater-street, Farnworth, Lancashire. The following applications have been made to the Light Railways Commissioners: (1) by the promoters of the Bath and Lansdown Light Railways Projects Limited, for power to make alterations in the line of the proposed railways and to widen High-street, Weston; (2) by the Barking Urban District Council to lease the line within the urban district from the boundary of the district at Loxford Bridge, adjoining the tramways of the Ilford Urban District Council, along Ilford-lane and Fanshawe-avenue to the junction of that avenue with Longbridge-road.

London County Council.—On Tuesday it was agreed to lend the Battersea Borough Council £9 792 for electric lighting, Islington Borough Council £4 308. 4s. 4d. for street-lighting purposes, St. Marylebone Borough Council £90 405, the Fulham Council £25 000, the Hampstead Council £6,000, and the Stepney Borough Council £10,000 for electric light installations. On Nov. 14 the Council will consider the following recommendations of the Highways Committee: "(*a*) That the operation of standing order No. A 161, relating to the time for the submission to the Council of schemes involving application to Parliament be suspended, in order that the following recommendations may be considered: (*b*) That authority be sought in the session of Parliament of 1906 (1) to enable the Council to supply electrical energy in London and certain surrounding districts on the lines indicated in the report of the Highways Committee dated Oct. 23, 1905; (2) to confer upon the Council power to carry out any necessary works, including the erection of buildings, the laying of mains, etc., necessary to give effect to such powers; (3) to empower the Council to make arrangements with local authorities and others having power to supply electrical energy, and to enter into agreements to give effect thereto; and (4) to confer upon the Council any general powers which may be necessary to enable it effectively to supply electrical energy. (*c*) That the costs and expenses of promoting the legislation referred to in the foregoing resolution be defrayed out of the county fund." The application of Mr. Highfield, on behalf of the Metropolitan Electric Supply Co., for the erection of a sub-station on the southern side of Randolph-mews, Portsdown-road, Paddington, was agreed to.

Bradford.—The report of the Electricity Committee upon the work of the department during the past year states that the committee are laying 16 additional lighting feeders for the purpose of augmenting the capacity of the consumers' networks in various parts of the city. Fuses are being put in for the purpose of dividing the distributing mains into sections corresponding approximately to the different feeders. The committee have given instructions for the augmentation of the supply to the tramways by the laying of four additional feeders on the present system of supply, and the erection of two sub-stations upon the extra high-tension system of transmission. In consequence, the tramways distribution system will be divided into 19, instead of eight, sections, as at present, and in the event of a feeder breaking down the inconvenience caused to the travelling public will be greatly reduced, and a more even pressure of distribution obtained as supplementary advantages to the primary object of the expenditure. It having been decided to supply the districts outside the present area of supply by means of extra high-tension feeders, sub-stations are arranged for at Thornbury and Odsal Top, and transformer chambers in Wakefield-road and Hoxton. These will be supplied with current at 6,500 volts derived from motor-generators at the works for stepping

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up the low-tension continuous current to extra high-tension three-phase current. It has also been decided to lay a number of extra high-tension feeders for general supply purposes on this system for both transmission and distribution to several of the outlying portions of the city. The Board of Trade consent to the adoption of this system has recently been received. The rates of charge have remained unaltered during the year, and the number of consumers has increased 6½ per cent., or from 1,925 to 2,049.

Exeter.—The City Council have adopted an interim report of the joint conference of the Lighting Committee and the Electricity Committee. The Council had previously decided to light the streets along the tramway route by electricity. The report states that the present annual cost of gas lighting is £4,210 and of electric lighting £850, and that to substitute electric light for gas throughout the whole area of the city would necessitate 1,214 lamps and the laying of cables in 27½ miles of streets, at a capital outlay of £10 381. The total annual cost would be £4,831. The recommendations were as follows: (1) that in the streets through which the tramlines are laid—excepting those already lighted by electricity—arc lamps should be suspended from the tramway poles and fixed to every alternate pole; (2) that in Queen-street and the main street from St. Anne's Chapel to the St. Thomas side of the bridge, the new golden-flame arc lamps be fixed to existing columns—28 lamps being substituted for the existing 37; and that the remaining length of streets be lighted by incandescent electric lamps, spaced about 55 yards apart. Another estimate gave the cost of converting the 300 or 400 gas lamps into incandescent electric lamps, and of providing 45 new arc lamps, including the 28 golden-flame lamps, at £2,000, and the annual maintenance at £3 264. The cost of the 13 miles in which cables are already laid would thus be increased by 43 per cent., and the candle-power by 235 per cent. The electrical engineer and the surveyor in the report remark that to obtain an equal effective candle-power with incandescent gas lamps would, on any system they were acquainted with, cost at least £4,000 per annum. A special committee has been appointed, with instructions to request the gas company to also submit a scheme for lighting the streets other than those through which the tramways run, with an estimate of the cost and the candle-power to be obtained.

Croydon.—At the last Council meeting a petition was read from residents in Penge-road, South Norwood, requesting that, in connection with the tramways extension through that road, electric arc lamps should be provided for street-lighting. The Council have already adopted this form of lighting for Penge-road at an estimated cost of £417. The committee will provide a main for this purpose in connection with the tramway feeder, and by reason of the cables for electric light being laid at the same time as the tramway cables, the estimated cost is reduced to £220. In connection with the construction of the tramway authorised by the Croydon and District Electric Tramways Acts, 1902-3, the committee have had before them a report from the borough electrical engineer for lighting the whole of the tramway track along Mitcham-road, from Pitlake to the borough boundary, by means of 32 magazine flame arc lamps, at an estimated cost of £882, a considerable saving in the cost being effected by this work being carried out simultaneously with the construction of the tramways. This extension would overcome a difficulty which has arisen and prevented the borough hospital being lighted by electricity, and would also make provision for a further supply in this neighbourhood, which will shortly be opened. The committee recommended that the tramway route be lighted by electric arc lamps as suggested, that the works be carried out simultaneously with the tramways construction, and that the cost be charged against the loan of £20,000 already sanctioned by the Local Government Board for the extension of electric mains. This was agreed to. The following resolution, which was discussed at two previous meetings—viz., "That the further consideration of the report on street-lighting be reconsidered at a future meeting of the Council, and that, in order that the matter may be fairly considered, the Lighting and Electricity Committee be requested to obtain from the Croydon Gas Co. and from the South Suburban Gas Co. respectively offers for the efficient lighting of the borough, and to submit such offers to the Council"—was negatived.

Newcastle.—The report of Mr. Ernest Hatton, manager of the Corporation tramways, upon the letter sent to the committee by the secretary of the Newcastle and Gateshead Gas Co., has been printed for circulation amongst the members of the Electric Lighting Committee. Mr. Hatton points out that the average number of hours each of the existing arc lamps now burns annually is 2 793, and the average number of hours each gas lamp burns is 3,776. The fact that gas lamps burn 983 hours longer than the electric arc lamps has always been a strong argument in favour of lighting streets by gas regardless of the extra amount of light given by each arc lamp during the hours such lighting is most required—namely, up to midnight. In the report submitted by the secretary of the gas company he had given a revised estimate of 2,793 hours per lamp per annum, or a reduction of 983 hours per lamp less than the hours specified in the report submitted by the superintendent of street-lighting, wherein it was stated that the rate per cent. of hours of burning for gas lamps over electric arc lamps was 35·18 per cent. The committee will have a large number of gas lamps burning 3,776 hours per lamp per annum, and 206 gas lamps burning 2,793 hours per lamp per annum. The secretary of the gas company pointed out that if it was decided to keep the whole of the 206 gas lamps burning all night or every alternate lamp burning all night, the additional cost to the city would be 14s. 2d. per lamp, increasing the cost per gas lamp from £3. 5s. 6d. to £3. 19s. 8d. per lamp per annum, or 2s. 1d. less than the amount provided in the report submitted by the superintendent of gas lighting—namely, £4. 1s. 9d. It is, therefore, somewhat difficult, Mr. Hatton says, to give a comparison between electric lighting and these altered circumstances of gas lighting, unless the committee previously decides how many hours per lamp per annum the proposed new lamps are to burn, but he endeavours to show the results on each basis. Assuming the extensions are carried out with 180 additional arc lamps, each burning 2,793 hours per annum, including the reduction that will be made to the committee in the existing arc lamps, he gets 360 arc lamps of 1,000 c.p. at £11 net per lamp per annum, costing in all £4,180; secondly, assuming the extensions are carried out with 206 new type gas lamps, each burning 2,793 hours per annum, he gets 200 1,000-c.p. arc lamps, for which the committee now pays £14. 18s. 6d. per lamp per annum, in all £2 980, and the cost of 206 new type gas lamps at £3. 5s. 6d. per lamp per annum, £674. 13s.—in all, £3,654. 13s., or with discount, £3,565. 11s. 9d. This is £614. 8s. 3d. less than lighting the same length of streets by arc lamps; but it must be noticed that the hours of burning for each gas lamp on this estimate has been reduced by 983 hours per lamp per annum. Assuming the extensions are carried out with 206 new type gas lamps, each burning 3,776 hours, he gets 200 1,000 c.p. arc lamps, for which the committee now pays £2,980; to which is to be added £820. 11s. 4d., the annual cost of 200 new type incandescent gas lamps, each burning 3,776 hours per annum, making in all £3 800. 11s. 4d., or with discount, £3,711. 10s. 1d. This is £468. 9s. 11d. less than lighting the same length of streets by electric arc lamps. Mr. Hatton refers the committee to what he has previously reported on the respective merits of electricity and gas for street-lighting, together with the benefit that would accrue to the ratepayers by utilising the existing plant in the power station for the purpose of generating the necessary units for the proposed 180 additional arc lamps. Mr. Hatton, in conclusion, gives a table of photometric measurements, showing that the candle-power of the arc lamps is fairly constant, while for incandescent gas lamps similar tests reveal an extremely varying candle-power, according to the condition of the mantles.

PROVISIONAL PATENTS, 1905.

OCT. 23.

21466. Carbon-holder for arc lamps. Herbert Edmund Moul, 18, Kensington Court-place, London.

21478. Improvements in electrical terminals and connections. Alan John Downes, Redvers Villas, Writtle-road, Chelmsford, Essex.

21480. Improvements in electrical ignition devices for internal-combustion engines. Henry Capel Lofft Holden, 2, St. John's-park, Blackheath, London.

21485 Improvements in electrical switches. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

21487. Improvements in letter-box plate for letter box and electric bell push combined. Daniel Timmins, 5, Clevedon-terrace, Ridgeway-road, Fishponds, Gloucestershire.

21519. Improvements in supports for electric incandescent lamps. Mabel Annie Cox, Hawthorn Cottage, Vale of Health, Hampstead, London.

21521. Improved coil trembler for electrical ignition apparatus of high-speed engines for motorcars and similar vehicles. Sidney James Williams, 149, Strand, London.

21523. Improved form of prepayment electricity meter. Harry Francis Jackson Thompson and John Horace Bowden, 10, Eastcombe-avenue, Charlton, London.

21533. Improvements in the manufacture of active iron mass for the electrodes of alkali accumulators. Ernst Waldemar Jungner, 31, Bedford-street, Strand, London.

21534. Improvements in the manufacture of electrodes for electrical accumulators by means of continuously operating machines and in the electrodes and accumulators thus manufactured. Ernst Waldemar Jungner, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, June 10, 1905, being date of application in Sweden.) (Complete specification).

21535. Improvements in or relating to insulation for accumulators with alkaline electrolyte. Adolf Emanuel Berglund, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, March 15, 1905, being date of application in Sweden.) (Complete specification.)

21585. Improvements in telephonic apparatus. Joseph Devonport Finney Andrews, 2, Park-avenue, East Sheen, London.

OCT. 24.

21581. Improvements relating to trolley poles of electric tramcars or the like. James Hunter Collie, 34, Castle-street, Liverpool.

21583. Automatic starting resistance for electrical motors. Ernest Bolton, 12, Beaconsfield-square, Hartlepool.

21615. Improvements in or in connection with the cells of electric accumulators, applicable also for other purposes. Alexander Battersby, 3, Brown-street, Market-street, Manchester.

21652. Improvements relating to electric motors. Henry Harris Lake, 7, Southampton-buildings, London. (International Holding Company, United States.) (Complete specification.)

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21648. Improvements in or connected with fuse boxes. W. T. Henley's Telegraph Works Company, Limited, and William Henry Nichols, 53, Chancery-lane, London.

21658. Improvements in or relating to electric motors, dynamos, electromagnets, and other machines or apparatus comprising an electrically produced magnetic field. Auguste Védrine and Count Raoul de Quélen, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 25, 1904, being date of application in France.) (Complete specification.)

21659. Improvements in electric road motor vehicles. Auguste Védrine and Count Raoul de Quélen, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 26, 1904, being date of application in France.) (Complete specification.)

21661. Improvements relating to sound boxes for phonographs, telephones, and the like. Piotr Lebiedzinski, 7, Southampton-buildings, London. (Complete specification.)

21672. Improvements in and relating to electric meters Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Oct. 28, 1904, being date of application in Germany.) (Complete specification.)

21675. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

21681. Improvements in electric shunts. Henry Stafford Hatfield and Frank Michael Lewis, Norfolk House, Norfolk-street, London.

Oct. 25.

21693. A new and improved mechanism in connection with prepayment electricity meters Francis Henry Merritt, Acrasto, Wells-street, Ryde, Isle of Wight.

21707. Protecting device for shunt field windings of electrical machines where shunt regulators are used. Thomas Edge, 34, Manchuria-road, Clapham, London. (Complete specification.)

21739. Improvements relating to electric heating or cooking apparatus. John Somerville Highfield, 322, High Holborn, London.

21752. Improvements in or relating to mechanism for making and breaking electric circuits in connection with alarm clocks, tell-tale clocks, and the like. Friedrich Kuhn, 31, Bedford-street, Strand, London.

21753. Improvements in and relating to electric resistances. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Oct. 26.

17402A. Improvements in electric switching apparatus. Heinrich Stern and Gustav Engisch, Thanet House, Temple Bar, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Aug. 28, 1905). (Complete specification.)

21761. Improvements in and relating to electric conductor rail insulators. William Vernon Bonsor, 36, Redcliffe-road, London.

21795. Improvements in or relating to electrically synchronised clocks. Frederick Augustus Chandler and Bahne Bonniksen, 18, Hertford-street, Coventry.

21798. Improved system of armoured insulated conduit for running uninsulated electrical conductors. Herbert Hugh Clements, 43, Cannon-street, London.

21804 A new or improved vacuum receptor or apparatus for the production of violet or ultra-violet rays, X-rays, or other rays, or combination of rays by induction on low-tension currents. John Hendry Phelps and John Cunningham Bowie, Birkbeck Bank-chambers, Chancery-lane, London.

21833. Improvements in electromagnetic apparatus. John McIntyre, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 29, 1904, being date of application in United States. (Complete specification.)

21834. Improvements in Ruhmkorff coils. John McIntyre, 53, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 8, 1904, being date of application in United States.) (Complete specification.)

21842. A new or improved method and means for neutralising deflecting forces acting on a magnet or system of magnets. Hermann Gereke, 31, Bedford-street, Strand, London. (Complete specification.)

21846. Improvements in and relating to electric telegraphy. Angelo Cipriano Boronio and Alexander Muirhead, 323, High Holborn, London.

21851. Improvements in or relating to alternating-current motors. William Allwood Dutton and the Brush Electrical Engineering Company, Limited, 46, Lincoln's-inn-fields, London.

21855. Improvements in electric power measuring and recording instruments for alternating currents. Vittorio Arcioni, Clun House, Surrey-street, London. (Date applied for under Patents Act, 1901, Oct. 27, 1904, being date of application in Italy.) (Complete specification.)

21859. Improvements in or relating to service apparatus for electric supply. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

21856. Improvements in electric clocks. George Bennett Bowell, 40, Chancery-lane, London.

Oct. 27.

21870. An improved method of securing or attaching a wire supplying electricity to a terminal. Alfred Austin Lines, 21, Harleck-avenue, Dewsbury-road, Leeds.

21882. Improvements in electrically-driven bicycles and like vehicles. Samuel Hopkinson Parry and Harry Barrett, 3, Brown street, Market-street, Manchester.

21931. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited. 83, Cannon-street, London. (General Electric Company, United States.)

21947. Improvements in and relating to dynamo-electric machines. Siegfried von Ammon, Oswaldestre House, Norfolk-street, Strand, London.

Oct. 28.

21949. Improvements relating to the manufacture of hypochlorite solution by electrolytic methods. William Pollard Digby, Trafalgar-buildings, Charing Cross, London.

22665. Improvements in insulated electric conductors. W. T. Henley's Telegraph Works Company, Limited, and Henry Savage, 53, Chancery-lane, London.

22011. Improvements relating to brushes or collectors for dynamos and motors. James Dickson, 8, Quality-court, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 16.

1904.

16258. Transforming the energy of electric currents. Weintraub. (Date applied for under International Convention, July 23, 1903.)

23253. Construction of section insulator for electric trolley wires or the like. Phillips.

24874. Alternating-current electric generators. British Thomson-Houston Company, Limited. (General Electric Company.)

25282. Electrode for apparatus producing radiant electrical energy. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, Nov. 24, 1903.)

25636. Electric power-transmitting mechanism. British Thomson-Houston Company, Limited, Meyer, and Hoppe.

26283. Electric meters. Imray. (Soc. pour l'Exploitation de Compteurs Electriques Rittener et Cie.)

26772. Electromagnetic apparatus such as is used in electric belts. Lake. (Schwarze and Kells.)

27082. Electrical counting apparatus, more especially applicable for use in connection with ships' logs. Crawford.

27083. Control of electric motors and apparatus therefor. British Thomson-Houston Company, Limited. (General Electric Company.)

27286. Emergency valves for fluid pressure systems. British Thomson-Houston Company, Limited. (General Electric Company.)

27317. Means of reflection in connection with electric and other lights. Jackson.

27399. Electricity meters. Hamilton and Ferranti, Limited.

27926. Electric demand or rebate indicators. Lewis and Reason Manufacturing Company, Limited.

28044 Electricity meters. Matthews.

28062. Treating carbon and methods of producing same. British Thomson-Houston Company, Limited. (General Electric Company.)

28129. Permeable diaphragms for use in electrolytic cells. Hirtz

28252. Electrical switches, plugs, and the like. Strode and White.

28278. Instruments for indicating the charged or uncharged condition of electric cables or other electric appliances. Thornton.

29343. Electrical gas igniting and extinguishing apparatus. Down and Wiseman.

29345. Electrical gas igniting and extinguishing apparatus. Down and Wiseman.

29346. Electrical gas igniting and extinguishing apparatus. Down and Wiseman.

1905

954. Vapour electric apparatus for current rectifying and other purposes. Churchward. (Date applied for under International Convention, Jan. 18, 1904.)

1926. Motor-driven air compressors. British Thomson-Houston Company, Limited. (General Electric Company.)

2115 Reciprocating fluid pressure engines. British Thomson-Houston Company, Limited. (General Electric Company.)

3918. Electric fans. British Thomson-Houston Company, Limited. (General Electric Company.)

4040. Electric motors. Burke.

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4321. Sparking plugs for electrically-fired internal-combustion engines. Lewis, Hill, and Whitfield.

4354. Electric time switch. Lübeck. (Rights under Patents, etc., Act, 1901, not granted.)

4383. Central station telephone systems working with a common battery. Birnbaum and Bell.

6987B. Fallers for electric stop-motion mechanism for looms and other textile machinery. Whitney. (Date applied for under Patents Rule 9, April 3, 1905.)

7682. Electrical alarm mat. Skinner.

8196. Multiple-unit control for electric motors. Perkins and Jackson. (Date applied for under International Convention, June 6, 1904.)

13384. Electric conductors and methods of insulating the same. British Thomson-Houston Company, Limited. (General Electric Company.)

13587. Starting switch for three-phase electric motors having a resistance in series with the rotor. Siemens Bros. and Co., Limited, Berry, and Toplis.

13954. Electrical testing devices. Harrison. (Electric Railway Improvement Company.)

14131. Construction of sound-proof telephone cabinets and other chambers. Haddan. (Akt.-Ges. Industrie für Holzverwertung.)

14208. Electrical switch apparatus for supplying current-consuming devices on several motorcars of electrically-propelled trains. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

17740. Apparatus for exploding mines by means of electrical waves. Schneider. (Date applied for under International Convention, Oct. 25, 1904.)

18013. Means of rectifying alternating electric currents. Povar and Livett.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £		Last week's price. £
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅜-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2⅞-2⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-¾
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100	..	93-97
—— 4½ per cent. 2nd Debenture Stock	100	..	78-81
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5⅛-5⅜
Crompton and Co.	3	..	1⅜-1⅝
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅜-1⅛ xd
—— "A" Shares, 01-017,139	5	..	2-2½ xd
—— 5 per cent. Debentures	100	..	92-97
—— 4 per cent. Deb. Stock, Red.	100	..	85-90
Electric Construction, Nos. 1 to 112,100	2	..	⅝-¾
—— 7 per cent. Cumulative Pref.	2	..	1⅝-1⅞
—— 4 per cent. Perp. 1st Mort Deb.	100	..	94-98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-100
W. T. Henley's Telegraph Works, Ordinary	5	..	12-13
—— 4½ per cent. Preference	5	..	5⅛-5⅜
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16⅛
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	33½-35½
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	12½-12⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-10½
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11½-12½
—— 4½ per cent. Debenture Stock, Red	100	..	107-109
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	104-107
Brompton and Kensington, Ordinary	5	..	9⅞-10¼
—— 7 per cent. Preference	5	..	9¼-9⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	8¼-9⅜
—— Nos. 60,001-80,000	5	..	8¼-9⅜
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	105-108
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	7⅛-8
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	6¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	..	4⅜-5
—— ditto (1903) 40,001-80,000	5	..	4⅜-5⅛
Chelsea Electricity Supply	5	..	5⅜-6⅛
—— 4½ per cent. Debentures	100	..	110-112
City of London, Ordinary	10	..	12½-13
—— 6 per cent. Cumulative Pref.	10	..	13½-14¼
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104-106
County of London Electric Supply, Ordinary	10	..	9⅞-10¼
—— 6 per cent. Cum. Pref.	10	..	12⅜-12⅞
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	104-106
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5⅜-6¼
—— 6 per cent. Cum. Pref.	5	—	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100	—	109-111
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5	—	2½-3
—— 5 per cent. Debenture Stock, Red.	100	—	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Havana Electricity, 1-15,000	10	..	9½-10½
Hove Electric Lighting, Ord., 1-13,000	5	..	8¼-8⅜ xd
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	101-104
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	31/32-1
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	12-12⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10¼
London Electric, Ordinary	3	..	2-2½
—— 6 per cent. Pref.	5	..	5¼-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 00,001-300,000	5	..	10 10½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅜ 5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98 100
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	102-104 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	..	8-8¼
—— do., 57,0 0-75,000	5	..	8-9⅛
—— 5 per cent. Pref., 1-57,000	5	..	6¼ 6⅜
—— do., 57,0 0-75,0 0	5	..	6¼-6⅜
Notting Hill Electric Lighting	10	..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98 100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6⅜ 6⅞
—— 4 per cent. Debenture Stock	100	..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ord 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3¼-4
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8¼-9¼
—— 3½ per cent. Deb.	100	..	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4⅜-4⅞
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5-5¼
Westminster, Ordinary	5	..	11⅜ 12¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	5¼-6⅜
Electric Tramways.—			
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5⅜-6¼
—— Ord.	5	..	8¼-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	104-106
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9 -10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	¼-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	98-98
British Columbia Electric Railway Co., Ord. Def.	100	..	126-129
—— Ord. Pref.	100	..	109-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	105-108
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	..	103-105 p.c. xd
—— 4½ per cent. Vancouver Power Deb.	100	..	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	..	9⅜-10⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	11-11½
—— 5 per cent. Perpetual Debenture Stock	100	..	121-123
—— 4½ per cent. 2nd Deb. Stock	100	..	99-101
Buenos Ayres and Belgrano Trams.	5	..	3 11/16-3 15/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	6⅜-5⅞ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5⅛ xd
—— 5 per cent. Deb. Stock, Red.	100	..	106-108
—— Prov. Cert., all paid	100	..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,258	5	..	9-9⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	1-1¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	3¼-4¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	103-105
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13½-14⅛
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	101-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14¼
—— 4 per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2⅛-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	9⅜-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	105-107
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9⅜-9¾
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8⅜-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100	..	102-105
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	91-93
—— 4 per cent. Pref.	100	..	101-103
—— " " deferred	100	..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	£100	..	110-112

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Name.	Amount paid.	Last week's price.
	£	£
City and South London, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	107-110
—— 5 per cent. Pref. Stock '91	100	118-121
—— ,, ,, ,, '93	100	117-120
—— ,, ,, ,, '01	100	113-116
Liverpool Overhead, 5 per cent Pref.	10	10-10⅛
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	-	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-100⅛
Waterloo and City, Ordinary	100	88-90

Name.	Amount paid.	Last week's price.
Telephones.—	£	£
National Telephone, Preferred	100	112-113
—— Deferred Stock	100	107-109
—— 6 per cent. Cum. First Pref	10	13-15
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅝
—— 3½ per cent. Deb Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1¼-1⅜
6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d
Aberdeen Corporation	Oct 28	1,208	1,187	+ 31	- 1,644	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 28	178	186	- 8	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	b·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 29	926	950	- 34	- 661	23 53	23½	March 31	55,025	11,145,531	1,309,803	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 28	367	325	+ 42	—	2	2	,, 31	17,133	4,709,728	265,525	·85	14·5	8,866	—
Blackburn Corporation	,, 29	918	911	+ 7	+ 978	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 26	404	435	- 31	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 28	241	338	- 97	- 927	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 29	1,788	1,682	+ 105	+ 2,141	40	38	March 31	95,765	20,235,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 25	1,237	954	+ 383	—	16 83	16 83	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 21	4 080	4,914	- 834	- 7,076	96	77	,, 31	230,085	47,108,000	5,053,393	1·172	10·927	2,396	—
Brighton Corporation	,, 29	767	833	- 66	+ 550	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 27	4,497	4,833	- 336	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 28	1,109	1,045	+ 64	—	10 60	10·60	March 3	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 29	292	304	- 22	- 1,255	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 2	1,776	1,964	- 187	+ 132	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	8·44
Carlisle Tramways Company	,, 28	161	170	- 9	- 141	8·5	8·5	Dec. 31	10,713	2,935,003	359,756	—	7·14	—	5·18
Central London Railway	,, 28	7,078	6,776	+ 232	- 1,270	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway	,, 29	8,741	8,618	+ 123	- 305	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 26	404	450	- 46	+ 718	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	Sept. 1	250	251	- 1	+ 242	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Oct. 2	2 5	198	+ 7	—	4½	4½	,, 31	11,250	2,853,800	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 27	95	100	- 5	+ 21	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 27	3,662	3,740	- 78	—	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dublin S. District, Electric	,, 27	803	838	- 35											
Dundee City Tramways	,, 25	830	820	+ 70	+ 1,032	23	23	May 15	44,695	11,611,525	933 006	·90	11·49	1,943	7 13
East Ham Corporation	,, 28	712	628	+ 84	+ 2,611	23	23	March 31	36,652	13,089,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 23	15,052	14,619	+ 443	+ 16,243A	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	Sept. 30	1,803	1,618	+ 185	+ 1,761	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	Oct. 28	1,535	1,412	+ 123	+ 1,212	35	35	,, 31	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 28	2,083	2,176	- 52	+ 521	27	26	,, 31	112,651	27,102,921	2,910,693	1	9 29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 25	138	164	- 26	- 787	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 18	185	208	- 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 28	5 618	5,420	+ 193	+ 3,719	89	89	March 25	238,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 21	1 976	1,813	+ 163	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 21	10 110	10,437	- 327	+ 8,617	103	103	,, 31	547,625	116,642,663	12.166,419	—	—	—	—
Liverpool Overhead Railway	,, 29	1,726	1,821	- 154	- 1,124A	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 21	14,278	13,398	+ 820	+64,391	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 28	151	160	- 9	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 26	91	126	- 35	-	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 23	12 285	12. 58	+ 727	+ 15,690	149	131½	March 31	631,956	126,900,875	14,123,124	1 19	10·73	4,299	6·99
Metropolitan District Railway	,, 23	7,401	6,996	+ 505	- 590	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 29	17,286	17,365	+ 21	+ 356	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 28	128	113	+ 14	+ 412	—	2¾	,, 31	6,159	1,972,647	206,358	·82	7·14	2,233	—
Newcastle-on-Tyne Corporation	,, 23	3,148	3 625	+ 523	+ 3,347	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 29	1 192	1 157	+ 435	+ 13,883	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 23	1,415	1,533	- 118	+ 1 103	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	,, 19	549	609	- 60	- 331	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 28	784	380	+ 404	+17,425	6½	4½	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 25	444	449	- 5	—	9½	7½	,, 31	23,563	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 30	4,076	4,024	+ 52	+ 6,618	70½	—	,, 31	214,111	39,213,560	4,884,580	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 29	4,779	4,559	+ 220	+ 6 896	65½	52½	,, 25	240,565	63,952 283	6,049 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 25	847	905	- 57	- 451	—	18	,, 31	49,365	9,294,771	1,108,329	1·27	11 02	—	7 85
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 27	755	527	+ 228	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 29	1,227	1,125	+ 102	+ 1,083	20	20	,, 31	64,858	15,364,463	1,495,685	1 004	10·36	—	6·37
Swindon Corporation	,, 18	171	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 28	677	669	+ 8	+ 648	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 26	1,810	1 080	+ 730	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 25	764	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. A Half-year's figures.

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NOTES.

Birthday Honour.—We are pleased to see from the list of birthday honours that Prof. G. H. Darwin, F.R.S. (president of the British Association), has been appointed a K.C.B.

Metric System.—According to the *Age* of last month, the Prime Minister of the Commonwealth of Australia has stated that a Bill is now being drafted on the subject of the weights and measures, and that probably power will be asked to introduce the metric system.

Motor Show.—The fourth international motor exhibition held by the Society of Motor Manufacturers and Traders will be opened at Olympia, Kensington, on Friday, Nov. 17, and will remain open till Saturday, Nov. 25, inclusive. The exhibition will embrace all sections of the motor industry, and a large number of manufacturers will exhibit. Electric ignition devices and electric automobiles will be well represented.

Wireless Telegraphy.—It is proposed to conduct extensive experiments with wireless telegraphy at the mouth of the Tyne. The public bodies in the locality are being invited to confer with a view to facilitating the arrangements for carrying out the experiments. At the last meeting of the Newcastle Chamber of Commerce a letter from Lord Armstrong on the subject was read, and a sub-committee appointed to confer with his lordship.

Tube Combine.—It is reported in the daily Press that negotiations on the part of Scotch and English tubemakers to form an Anglo-Scotch tube combine have not proved successful, the big Scotch companies having withheld their support. It is stated that had the proposal been made months ago, when orders were scarce and competition ruinously keen, the Scotch houses might have fallen in with the proposal, but at present they are booked heavily, and at substantial prices.

Books Received.—The "'Practical Engineer' Pocket-Book" and the "'Practical Engineer' Electrical Pocket-Book" (price 1s. each net, leather 1s. 6d.) have reached us from the Technical Publishing Company, of Manchester. These books are convenient in size, and contain much valuable data. The editors, as usual, have kept them up-to-date by revision and inclusion of new matter, and in the "electrical" book several suggestions put forward during the year have been embodied in the new issue.

Technical Education.—Mr. Wilson Worsdell, chief mechanical engineer of the North-Eastern Railway, speaking at a prize distribution in connection with the classes at the North-Eastern Literary Institute, Gateshead, last week, emphasised the importance of our youths improving themselves technically and scientifically. Sir Walter Plummer, M.P., in presenting the prizes, commented on the fact that more students had entered for electrical than for steam study. He stated that, whether steam or electricity was the motive power of the future, the North-Eastern Company would not be behind-hand, and that the works in that locality would not suffer by the consequent change.

Royal Institution.—A general monthly meeting of the members was held on the 6th inst., Sir James Crichton-Browne, M.D., F.R.S., in the chair. Lady Alford, Mr. W. Friedlaender, Dr. A. Muirhead, and Mr. D. A. Thomson were elected members. The special thanks of the members were returned to Mr. Robert Hannah, M.R.I., for his gift of the picture, painted by him, of "Master Isaac Newton in his Garden at Woolsthorpe in the Autumn of 1665." A Christmas course of lectures, adapted to a juvenile auditory, will be delivered at the institution by Prof. Herbert Hall Turner, D.Sc., F.R.S., on "Astronomy." The dates of the lectures are Dec. 28 and 30, 1905, and Jan. 2, 4, 6, and 9, 1906, at 3 o'clock.

Overhead and Underground Wires.—The dispute between the General Post Office and the Cardiff City Council respecting the laying of trunk telephone wires along the North-road was investigated by the deputy stipendiary of Cardiff, Mr. E. Milne Jones, who sat as arbitrator. It was explained that the Post Office authorities desired to remove certain telegraph wires now on the poles and place them underground, and carry overhead additional trunk telephone wires between Cardiff and Pontypridd. Mr. W. Harpur, the city engineer, said the Council would not object to all the wires being laid underground, but they were averse to there being a number of wires above ground and others underground. The deputy stipendiary reserved his decision.

Institution of Civil Engineers.—At the inaugural meeting of the eighty-seventh session of the institution, held on Tuesday, the 7th inst., Sir Guilford Molesworth, K.C.I.E., the retiring president, alluded to the loss which the institution and the engineering profession generally had sustained during the recess by the deaths of Mr. James Mansergh, F.R.S., and Mr. George Robert Stephenson (past presidents), and of Sir William Shelford, K.C.M.G. (member of council). He then formally introduced to the members his successor to the chair, Sir Alexander Binnie. Sir Alexander Binnie then delivered an address to the members, in which he traced the influence of scientific thought and investigation upon the development of engineering practice. The president subsequently presented the medals and premiums awarded by the council for papers dealt with at the institution in the course of the past session, and afterwards received the members in the library.

Photography by Telegraph. — Prof. Korn, who has devoted close study to the problem of the transmission of photographs over telegraph wires, recently communicated in a lecture to the members of the Electro-Technical Association at Munich the results of experiments which he had made with a view to perfecting the apparatus employed in the process. These were carried out on the telegraph line from Munich to Nuremberg, a distance of about 100 miles, and had satisfied him that it was possible to transmit a photograph or sketch 6in. or 7in. square in a period varying from 10 to 20 minutes, though he claimed that after improvements had been introduced in the apparatus the feat would be accomplished within five seconds. The subject has now occupied the attention of inventors for ages, and the results of Prof. Korn's investigations do not mark any considerable advance towards perfection, nor do they add to the stock of knowledge already extant on the subject.

Incandescent Lamps and Fires.—The extended use of electricity in mines gives rise to the belief that the dangers thereof are increased owing to the possibility of explosions caused by the heat from the lamp igniting the coal dust. This was demonstrated by a fire which took place at one of the collieries in the North of England some time ago. It was suspected that the heat from an electric lamp was the cause, so experiments were made by placing an incandescent lamp on the top of a pail of coal dust, in a similar position to that at the scene of the fire. Thermometers recorded a very quick rise of temperature in the coal dust, followed by combustion if the lamp was allowed to remain. Investigations were then carried on by Mr. Hall, H.M. inspector of mines, who in a report states that in one case where a 16-c.p. lamp was slightly covered with

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coal dust the temperature rose to 370deg. F. in 10 minutes, and that in another case the lamp exploded at 450deg. F. in four minutes, while a temperature as high as 650deg. was registered in a third case. Mr. Hall remarks that after the coal dust has been raised to a certain temperature, spontaneous combustion commences.

Institute of Bankers.—The session was inaugurated last week, when Mr. J. Spencer-Phillips delivered his presidential address. He was able to announce that the past year had been an exceedingly prosperous one, and that the clearing-house returns, which had advanced 18 per cent. during the year, indicated a real improvement in trade conditions. The president regarded the commercial outlook distinctly encouraging, and in discussing future prospects adopted a tone of cheery optimism. He sounded a note of timely warning, however, against the dangers resulting to bankers from the competition for the deposits of the public by municipalities and other bodies, who were freed from the responsibility of keeping a large reserve of idle money, or money earning very slight interest, and could therefore offer terms which bankers could not afford to do. Bankers do not suffer alone in the limitation of their business by the growing encroachment of municipalities upon their preserves, and the time is now opportune for the whole question of municipal and private rights to form the basis of a Government inquiry.

Assessment.—We note that the appeal of the Merthyr Electric Traction and Lighting Company, which was recently heard by the Merthyr Assessment Committee, against excessive assessments has been successful. The dispute resolved into the question whether the company should be assessed on their property and rolling-stock or upon their income and expenditure. The company claimed to be assessed on the latter basis, as is done in the case of gasworks and other undertakings. At present the tramways and appurtenances were put at £2,400 gross and £1,200 rateable, and the depôt, yards, etc., at Penydarren at £600 gross and £480 rateable. They urged that 6 per cent. on the gross receipts of lighting and traction would be fair, for there was the special circumstance of an abnormally stiff gradient for the Dowlais traffic. It was stated that the expert consulted by the Assessment Committee had advised a reduction of £530, but it was eventually decided that the assessment of the entire undertaking be reduced to £864 rateable, arrived at by taking 6 per cent. on the gross receipts of the whole concern, and that relief be granted in the four half-yearly rates extending from April, 1905, to April, 1906.

Cape-to-Cairo.—The November number of the *Pall Mall Magazine* contains an interesting article on the erection of a telegraph wire from Cape Town to Cairo, and gives an historical account of the undertaking, which is now rapidly approaching completion. The author states that the experiment of adopting the Marconi system of wireless telegraphy over a portion of the route northwards from Udjidji to Rosares, where the Egyptian telegraph system has its termination, is contemplated. The country between these two places is in parts very swampy, and about 100 miles of it quite unsuited for the erection of an ordinary land telegraph. It is proposed, therefore, to carry the line as far as possible north and south of this region, and then to bridge over the intervening space with a Marconi installation. The volume of traffic over the line opened out is already considerable, and in 1903, which is the latest year for which complete returns are available, 16,470 messages, containing in all 370,214 words, were forwarded along the line, and in the same period 16,289 messages, containing 390,354 words, were received, and 15,389 messages were transmitted. It is anticipated that the completion of the telegraph will not be delayed beyond the year 1907.

German Industry.—In his report for the first half-year 1905 on the trade and industry of Germany, Mr. Consul Schwabach deals with the combines in the electrical industry. Following the two powerful combines of 1904 between the Allgemeine Elektrizitäts-Gesellschaft-Union-Elektrizitätsgesellschaft and the Siemens-Schuckert-Werke, there took place in April of this year an amalgamation of the manufacturing departments of the Lahmeyer Electrical Works, of Frankfort-on-Main, with the Felten und Guilleaume Karlswerk A.G., of Cologne, under the name of "Vereinigte Felten-Guilleaume-Lahmeyer-Werke A.G." This new concern disposes of a share capital of £2,750,000. A purchase office for electrical works has been established by 28 members of the Union of Electrical Works, which is composed of over 200 German and foreign works. The principal object of the new office is to buy for joint account materials required by electrical works, but it also collects manufacturers offers, and settles buying and delivery condition with them. Members are obliged to meet exclusively through the office their ordinary requirements for carbon-filament incandescent lamps, excepting candle lamps and abnormal globes, also of such other materials as may be decided upon at a general meeting. In this way, the consul points out, members will be provided with incandescent lamps of the best quality only, every single lamp bought through the office being previously tested.

Vaporisation of Metals by High-Frequency Discharges.—When an electric discharge from a battery of Leyden jars is sent through a wire placed between two glass plates, an excessive amount of heat may be generated in the wire in an extremely short time (a few hundred thousandths of a second), and this heat is often sufficient to vaporise the wire. The consequent increase in pressure blows the vapour out in all directions, and as it cools it is deposited in the form of finely divided metal with vacant spaces in between. The deposit near the path of the wire is so close that light is reflected from it as from a uniform surface, but a little further from the wire the deposit lies in lines at right angles to the direction of the wire with metal-free spaces between. Some tests made under these conditions and recorded photographically are described by F. Braun in the *Annalen der Physik*, p. 359, 1905. A battery of 20 Leyden jars giving a 6mm. to 8mm. spark was employed, and wires of tantalum, zinc, carbon, brass, platinum, silver, etc., were dealt with. In the case of carbon (an incandescent lamp filament) actual vaporisation did not take place, but globules of melted carbon were readily distinguishable under the microscope. In the case of alloys, by suitably adjusting the strength of discharge the several component metals could be separated—the metal of lower melting point being deposited nearest to the path of the wire.

Electro-Deposited Copper.—Prof. A. K. Huntington, in a paper read before the Faraday Society, explained that the direction of the lines of crystallisation of an electro-deposited metal are the same as in a casting made on surfaces having the same inclination—*i.e.*, the crystals form at right angles to the surface on which the deposit or the casting is made. From this he concluded that when the crystals which form on surfaces more or less at an angle to one another meet, there is a want of continuity in the two sets of crystals and a line of more or less weakness is developed. In exemplification of this, he took a casting composed of 50 per cent. copper and 50 per cent. zinc, from which it was observed that crystals from the opposite long sides, which must be approximately parallel, did not merge one into the other, but, on the other hand, showed a break.

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The importance of avoiding sharp angles in castings and deposits, when strength and not rupture is aimed at, was pointed out by various examples. Prof. Huntington exhibited a number of photo-micrographs showing that when electro-deposited copper is annealed, the long crystals of the deposit are completely broken up and become largely twinned. He then compared this with a rolled copper rod which had been annealed, from which he concluded that brittleness due to the direction in which crystals form in castings and electro-deposits may be modified and probably completely removed by suitable annealing. This, however, would be the case only when there was a line of weakness and the continuity was not entirely broken, otherwise the unequal expansion caused by the heat would make matters worse rather than better.

Military Engineering.—Lieut.-Colonel Heath, R.E., discoursed on "Field Engineering in Modern War" at the Royal United Service Institute last week, and in an interesting address, insisted that the illumination at night of obstacles placed in position to impede an enemy's attack was a matter of great importance. In this connection Colonel Heath stated that a searchlight company at Aldershot had lately been experimenting, and, as electric light was not always available, they were trying acetylene lamps and acetylene flares. It had been found that these gave a fairly effective light. The lighting apparatus was placed on the obstacle and connected with the trenches by a cord, and in case of attack the flare was turned on to light up the attackers. Speaking of the difficulty of cutting wire entanglements, Colonel Heath said it was a question whether some form of steel shield could not be devised to protect the men engaged in this hazardous operation from the fire of the enemy. Bullet-proof steel weighed 8lb. to the square foot, however, and an effective shield would be very heavy. Smoke screens had been used with great success in baffling the use of the searchlight by an enemy. Bundles of straw threw out dense volumes of smoke, and, provided there was not much breeze, a searchlight was of very little effect. In advancing by entrenchments upon a position, it would be a great help to have tools which would enable men to entrench themselves while lying in the open and exposed to an enemy's fire. Experiments were being tried with a tool resembling an adze. Recently some men entrenched themselves in half an hour, while lying down, by the use of it, but still it was not a very satisfactory trial.

Obituary.—We regret to record the death of Mr. C. G. Mott, a director of the Great Western Railway Company and chairman of the City and South London Railway, which took place at Stanmore on Wednesday. Mr. Mott was 72 years of age, and during his active commercial life was regarded as one of the most notable figures in the railway world. He has not inaptly been termed the "father" of tube railways, for, with the assistance of the late Mr. Greathead, he introduced the City and South London Railway, which was the first tube railway in London. The *Evening Standard* states that in the early eighties he was invited to take an interest as a director in a company which was then being formed in the City and Southwark Subway Company, to construct a short tube line from King William-street in the City to the Elephant and Castle, to be worked on the cable system. He accepted, and became chairman. On looking into the scheme, however, he came to the conclusion that the cable system was not one which would prove workable on lines of this description, and he accordingly insisted on electricity being experimented with. There was opposition from the people already interested in the scheme, but ultimately they agreed and approved. Firms of electrical engineers were consulted, and after considerable experiments the contract was given out. At the time there were no electric railways in the world, and it was entirely owing to his enterprise and his insistence on electricity that the first electric tube railway was constructed. He found the funds, and subsequently, under his control and advice, the line was extended to Stockwell and Clapham Common to the south, and again on the north from Moorgate-street to the Angel, and is now being extended farther to Euston.

Institution of Electrical Engineers.—The Council have entered upon the agreeable task of formulating plans for the reception and entertainment next year of the kindred institutions in Europe and America. Invitations to visit Great Britain as guests of the Institution have been issued to the American Institute of Electrical Engineers, the Canadian Electrical Association, the Associazione Elettrotecnica Italiana, the Electrotechnischer Verein, the Verband Deutcher Elektrotechniker, the Schweizerischer Electrotechnischer Verein, and the Société Internationale des Electriciens. On many occasions we have associated with the above-mentioned societies abroad, and have reaped advantages which inevitably follows from such intercourse. The hospitality which has been extended to the English delegates both in Europe and America has always been on a most lavish scale, and the welcome accorded has never lacked sincere cordiality. The forthcoming visit, which will take place in June, 1906, will be the first that has been made by foreign societies to our shores, and we are convinced that as far as arrangements for the hospitality of our guests are concerned these will be well looked after by the capable secretary of the Institution of Electrical Engineers, Mr. G. C. Lloyd. It is impossible to over-rate the benefits which result from such gatherings, and the meeting in this country of representative societies from Europe and America cannot fail to stimulate the electrical industry. It remains for manufacturers and others engaged in electrical engineering to support the Institution by granting full facilities to the delegates for observing the electrical developments in this country. Now that our turn has come to extend a welcome to the kindred institutions abroad, it behoves all concerned to see that it is not lacking in that welcome and cordiality which made our visits so enjoyable and successful.

The Royal Society.—We are informed that the following gentlemen have been recommended by the president and council for election into the council for the year 1906 at the anniversary meeting on Nov. 30: President—Lord Rayleigh, M.A., D.C.L., O.M. Treasurer—Mr. Alfred Bray Kempe, M.A. Secretaries—Prof. Joseph Larmor, D.Sc., D.C.L., LL.D.; and Sir Archibald Geikie, D.C.L., Sc.D., LL.D. Foreign secretary—Mr. Francis Darwin, M.A., M.B. Other members of the council—Dr. Shelford Bidwell; Sir T. Lauder Brunton, M.D.; Prof. J. Norman Collie, Ph.D.; Prof. Wyndham R. Dunstan, M.A.; Prof. John Bretland Farmer, M.A.; Prof. Francis Gotch, D.Sc.; Dr. Sidney Frederic Harmer; Sir William Huggins, K.C.B., O.M.; Prof. Edwin Ray Lankester, M.A.; Dr. John Edward Marr; Mr. George Ballard Mathews, M.A.; Mr. Hugh Frank Newall, M.A.; Sir William Davidson Niven, K.C.B.; Prof. John Perry, D.Sc.; Prof. Ernest Henry Starling, M.D.; Prof. William Augustus Tilden, D.Sc. The following is a list of those to whom the society has this year awarded medals. The awards of the Royal medals have received the King's gracious approval: the Copley medal to Prof. Dmitri Ivanovitch Mendeléef, of St. Petersburg, for his contributions to chemical and physical science; a Royal medal to Prof. John Henry Poynting, F.R.S., for his researches in physical science,

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especially in connection with the constant of gravitation and the theories of electrodynamics and radiation; a Royal medal to Prof. Charles Scott Sherrington, F.R.S., for his researches on the central nervous system, especially in relation to reflex action; the Davy medal to Prof. Albert Ladenburg, of Breslau, for his researches in organic chemistry, especially in connection with the synthesis of natural alkaloids; the Hughes medal to Prof. Augusto Righi, of Bologna, on the ground of his experimental researches in electrical science.

Milan Exhibition.—In addition to the awards which we previously announced in connection with this exhibition, we are now officially informed that the executive committee have allotted £200 of the sum given by his Majesty the King of Italy as an international prize for the purpose of encouraging the study and practical testing of a simple appliance of small cost which shall serve to detect the existence of currents of high potential in electrical cables which have to be handled by workmen charged with the laying or repair of such cables. Applications for admission to the competition must reach the executive committee of the exhibition before Dec. 31, 1905, and must be accompanied by a registration fee of 16s, together with a description (in no less than two copies) of the invention, either in Italian or French. The chief technical conditions which the appliance has to satisfy are the following: (*a*) Must be easy to handle, conveniently portable, and not exceeding 7lb. (3 kg.) in weight. (*b*) Must reliably reveal clearly and safely differences of potential of not less than 300 volts. (*c*) Must not require special conditions of application, and must give indications easily readable and of a nature to avoid all uncertainty. (*d*) The cost of the appliance must be low, wherefore, other things being equal, the most economical will be preferred; it must be easy of repair, and so constructed that the breakdowns in working to which it may be subject as a whole or in any part shall be easily detected and noticed, and such as not to give rise to any dangerous uncertainty. (*e*) Shall not be liable to easily get out of order or out of repair, even when subjected to very great differences of potential, or through atmospheric influences, shocks, abnormal position, etc. (*f*) The method of mounting the parts subjected to wear and tear and exchange shall be such as to disclose in some clear fashion any getting out of order which may be dangerous. The prize will be assigned by a jury composed of five members, who can also award one or more honourable mentions, without monetary prize, to those among the other competitors whom they shall deem worthy. This offer should do much to stimulate the study of that special subject.

Manchester Local Section.—The opening meeting of the Manchester Section of the Institution of Electrical Engineers will be held at the Grand Hotel, Manchester, on Friday, Nov. 17, at 7.30 p.m., when the chairman, Mr. S. L. Pearce, will give his address. The following programme of meetings has been arranged for the session: Nov. 28, Dr. W. G. Rhodes, M.I.E.E., "Theoretical Considerations of Feeder Systems"; S. J. Watson, M.I.E.E., "Street Cable Systems"; Dec. 12, Haydn Harrison, M.I.E.E, "Street-Lighting"; Jan. 16, W. C Mountain, M.I.E.E., "Electric Winding as applied to Main Shafts, considered Practically and Commercially"; Jan. 30, James Atkinson, M.I.M.E., "Gas-Engines applied to Electric Driving"; Feb. 13, M. B Field, M I E E, "Idle Currents"; Feb. 27, T. H. Schoepf, M I.E E, "Single-Phase Railway Working"; March 2, annual dinner; March 12, J. R. Salter, M.I.E.E, "Economic Considerations in the Employment of Storage Batteries"; March 27, L. J. Hunt, A.M.I.E.E., "Alternating-Current Motors"; April 10, general meeting, H. C. Crews, M.I.E.E, "Lifts and Hoists." In connection with the students' section meetings and visits have been arranged as under: Nov. 24, address by James Swinburne, M.I.E.E.; Dec. 8, W. H. M. Parr, "The Electrification of Existing Steam Railways"; Dec. 22, J. C. Ward, "The Electrical Equipment of Automobiles'; Jan. 12, W. T. Massey, "The Manufacture of Electric Cables"; Jan. 26, F. Shaw, "Electric Lamps"; Feb. 9, H. A. Carney, "Electrical Instruments"; Feb 23, annual dinner; March 9, E. Müller and J. Davies, "Modern Primary Batteries"; March 23, R. C C. Yates, "Lubrication and Lubricants"; March 23, W. Browning, "Notes on Electrical Conductivity"; April 6, general meeting at 7 p.m., D. L. Sands, "The Selenium Photometer. Visits—By the kind permission of the undermentioned firms visits have been arranged as follows: Dec 2, the works of Messrs. Dick, Kerr, and Co, Limited, Preston; Dec. 16, the Stuart-street generating station of the Manchester Corporation; Jan. 6, the works of the Chloride Electrical Storage Company, Limited, Clifton Junction; Jan. 20, the works of the British Insulated and Helsby Cables, Limited, Helsby, near Warrington; Feb. 3, the works of the National Gas-Engine Company, Ashton-under-Lyne; Feb. 17, the works of Messrs. Hick, Hargreaves, and Co., Limited, Bolton; Feb. 17, the works of Messrs. John Musgrave and Sons, Limited, Bolton; March 3, the works of Messrs. Ferranti, Limited, Hollinwood; March 17, the Liverpool and Southport Electric Railway.

Ventilation of the Law Courts.—The problem which faces the engineer in his endeavour to equip large public buildings with a perfect scheme of ventilation is not a simple one, and in the case of the Law Courts, where each chamber is presided over by a judge whose views as to temperature and ventilation are sometimes distinct from those of his brother in the adjoining chamber, the problem is by no means simplified. It is not surprising, therefore, to read the strictures recently made by one of his Majesty's judges on the imperfect ventilation of his court. The *Lancet* also comments upon the matter from the hygienic standpoint, and gives a few facts as to the provision for ventilation made in the Royal Courts of Justice. In the crypt beneath the corridors of the courts are located the steam engines and boilers which work the dynamos for generating the electric power to drive the 21 fans used for extracting the vitiated air, and for forcing the fresh air to the several courts. The supply of air can either be heated or cooled before delivery. For the former purpose there are two calorifiers, in which the circulating coils are heated by the exhaust steam from the engines; the hot water in the coils then circulates through the various radiators throughout the buildings. In addition to the circulation of the water by gravity, there are two powerful steam-driven force pumps connected to this hot-water circulating system that accelerate the flow of water through the radiators. The mechanism by means of which the fresh air is heated in its passage to the Tobin's ventilators fixed in the court consists of a separate vacuum engine for extracting the moisture from the steam as it leaves the exhaust in its passage to the calorifiers. The air before delivery into the Tobin's tubes is washed in a spray and filtered or cooled. For the purpose of cooling the air in very hot weather, there is a complete freezing plant which keeps the water at a temperature of 40deg. F. The dynamos that drive the fans yield a pressure of 110 volts 650 amperes, the current required when all the fans are in operation being 350 amperes There is also working in connection with the dynamos a booster for charging the 60 accumulators stored in a separate building, each of which weigh 15cwt. These accumulators also form a reserve for supplying the

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electric light in the event of any failure of current from the mains. Two chambers are devoted to the control of the electrical apparatus, one for lighting and the other for regulating the current to the several fans and machinery in connection with them. The switchboards are of white marble, and are also fixed in these chambers.

Junior Institution of Engineers.—The annual general meeting of this institution, which took place last week, the retiring chairman, Mr. S Cutler, jun., M.I.Mech.E., presiding, was also the first general meeting of the society after its constitution as an incorporated body, and was held under the requirements of the articles of association. The annual report of the council showed an increase in membership of 888. There were 32 visits to works during the year, and 11 meetings had been held to the celebration of the "coming of age" of the institution. The election of officers resulted as follows: chairman—Mr. Adam Hunter, A.M.I.C.E; vice-chairmen—Messrs. Lewis H Rugg, A.M.I.C.E, and F. S. Pilling, M.I.M.E.; members of council—Messrs. G. T. Bullock, F. R Durham, A.M.I.C.E., G H. Hughes, M.I.M.E., and A. G. Young; provincial members of council—North of England, A. E. Rasey, A.M.I.M.E; Midlands, E. King, A.M.I.M.E; Eastern Counties, J. Julian; Southern Counties, F. S. Miller; West of England, E. W. Porter, A.M.I.C.E; Scottish District, G. E. Jackson; Irish, W. E. Lilly, M.I.M.E.; Welsh, H. F. Hunt, B.Sc. On Nov. 3 the inaugural meeting of the twenty-fifth session took place. The chair was taken by Sir William H. White, K.C.B., F.R.S, past-president, in the absence of Mr. W. H. Lindley (the president). The institution medal for the most meritorious paper of the previous session was presented to Mr. George H Hughes for his contribution entitled "Practical Notes on Waterworks Construction." A very cordial vote of thanks having been passed to Mr. Lindley for his services to the institution during the past year, Sir William White then inducted to the chair the new president, Mr. Dugald Clerk, M.I.C.E., investing him with the badge. Mr. Clerk took as the subject of his presidential address "The Problem of the Gas-Turbine," an account of which appears elsewhere in our issue. The address was followed with the closest interest throughout, and at its conclusion a hearty vote of thanks was accorded the president. Sir William White was also thanked for undertaking the duties of acting president. It was announced that a visit would be paid to Messrs. Barclay, Perkins, and Co.'s brewery at Southwark on Saturday afternoon, Nov. 18, and a meeting would be held on Dec. 8, when a paper on "Electric Mains for Power Transmission Work" would be read by Prof John T. Morris, M.I.E.E (member). The other meetings, etc., of the new session have been arranged as follows, and visits to various works will take place, of which due notice will be given: Jan. 26, "Some Notes on Boiler Trials," by Prof. J. D. Cormack, B.Sc. (hon. member); Feb. 2, "Some Recent Electrical Engineering Measuring Instruments," by Mr. Kenelm Edgcumbe, M.I.M.E. (member); Feb. 10, anniversary dinner in the Victoria Hall of the Hotel Cecil, the president in the chair; Feb. 15, "Architectural Design and Expression," by Mr. H. Heathcote Statham; March 2, "Gas-Engine Indicators," by Mr. L. F. de Peyrecave, Stud.I.C.E (member); March 10, conversazione—a lecturette on "The Evolution of the Man-of-War," illustrated by lantern slides kindly lent by the Navy League, will be given during the evening by Mr. C. Alfred Smith, B.Sc. (member); April 11, joint meeting with the discussion section of the Architectural Association at 18, Tufton-street, Westminster (near the Church House and Westminster Abbey), commencing at 7.30 p.m., paper on "Ferro-Concrete," by S. M. Bylander, M.J.I.E; April 20, "The Internal-Combustion Engine as applied to Marine Purposes," by Mr. Francis J. Maddox, Stud.Inst.C.E. (member); May 11, "The Structural Design of Factories," by Mr. Adam Hunter, A.M.I.C.E. (chairman).

Signal Wires.—The committee appointed to inquire into the question of rubber-covered wire for railway signal installation presented their report to the recent convention of the Railway Signal Association, Niagara Falls, N.Y. The object of the inquiry was to obtain a proper insulated signal wire, and data were gathered principally from the results of researches and experiments carried on by the Government and some of the telegraph and telephone companies. No definite specifications were put forward by the committee for adoption, and the investigations are in a sense yet incomplete. However, some of the requirements and tests which are contained in the report may be of interest. Conductors must be soft-drawn, annealed copper wire having a conductivity of not less than 98 per cent. of that of pure copper. Each wire forming a conductor must be continuous, without splice, must be uniform in cross-sections, free from flaws, scales, or other imperfections, and provided with a heavy uniform coating of tin. Each solid conductor must stand an elongation of 25 per cent. of its length in 10in. before breaking. In torsion it must stand before breaking 30 twists in 6in. Samples of the wire must be thoroughly cleaned with alcohol and immersed in hydrochloric acid of specific gravity 1·088 for one minute. They must then be rinsed in clear water and immersed in a sodium sulphide solution of specific gravity 1·142 for 30 seconds and again washed. This operation must be gone through four times before the wire becomes clearly blackened. The vulcanised rubber compound must consist of not less than 30 per cent. of the best grade of fine Para gum mixed with sulphur and dry inorganic mineral matter only. The insulation must be tough, elastic, adhering strongly to the wire, homogeneous in character, and must be placed concentrically about the conductor. The rubber insulation must be subjected for one hour to a temperature of 260deg. F., using dry heat, and at the expiration of that time must be tested for elasticity, elongation, and permanent set. The circular mils cross-section, the thickness of the rubber insulation (measured at the thinnest point), the minimum resistance in megohms per mile, and the dielectric strength for the various sizes of wire shall conform to the following table:

Size. B. & S. gauge.	Area in circular mils.	Thickness of insulation.	Insulation resistance. Megohms per mile.	Test voltage. Alternating current.
0	105,592	$\frac{1}{8}$in. wall or $\frac{1}{32}$ O.D.	800	8,000
1	83 694	$\frac{1}{4}$in. ,, $\frac{1}{32}$,,	800	8,000
2	66.373	$\frac{1}{4}$in. ,, $\frac{1}{32}$,,	800	8 000
4	41.742	$\frac{3}{32}$in. ,, $\frac{1}{32}$,,	800	5 000
6	26,250	$\frac{3}{32}$in. ,, $\frac{1}{32}$,,	900	5 000
8	16,509	$\frac{3}{32}$in. ,, $\frac{1}{32}$,,	900	5 000
9	13,090	$\frac{5}{64}$in. ,, $\frac{5}{32}$,,	900	4 000
10	10.380	$\frac{5}{64}$in. ,, $\frac{5}{32}$,,	900	4 000
12	6.530	$\frac{5}{64}$in. ,, $\frac{5}{32}$,,	1,200	4,000
14	4 107	$\frac{5}{64}$in. ,, $\frac{5}{32}$,,	1,500	4 000
16	2 583	$\frac{1}{16}$in. ,, $\frac{5}{32}$,,	1.500	3,000
18	1,624	$\frac{1}{16}$in. ,, $\frac{5}{32}$,,	1,500	3,000

The test for insulation must be made upon all wire without braiding, and after 48 hours' immersion in water at a temperature of from 65deg. to 75deg. F. Tests must be made with well-insulated battery and galvanometer with not less than 150 volts, and reading must be taken after one minute's electrification. The test voltage must be applied to the completed length of wire after the insulation test for a period of five minutes, using alternating current from a generator and transformer of ample capacity. The committee hope that at some future date complete specifications will be presented.

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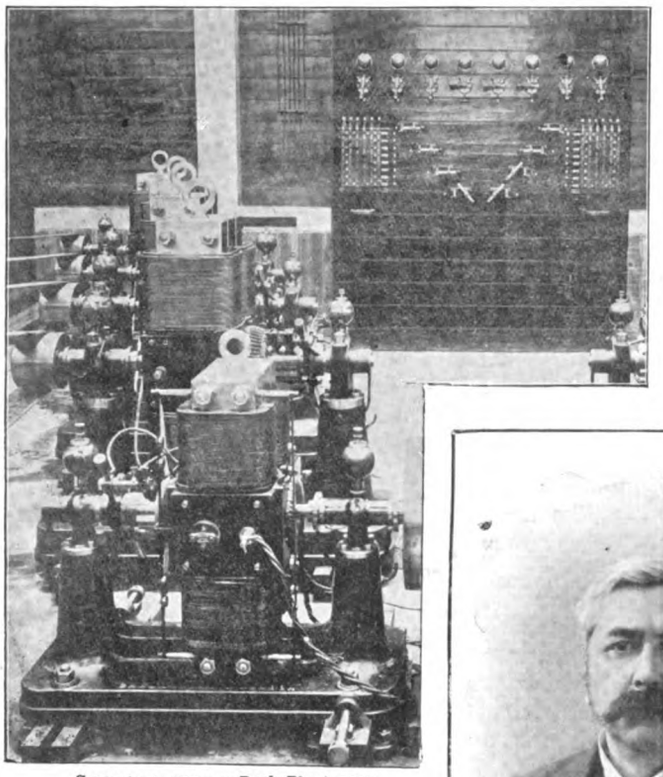
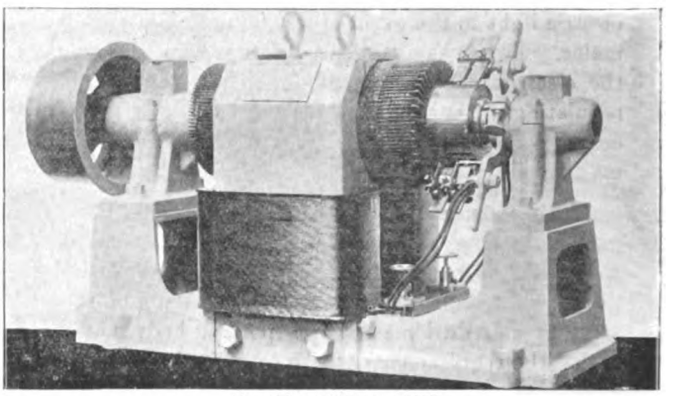
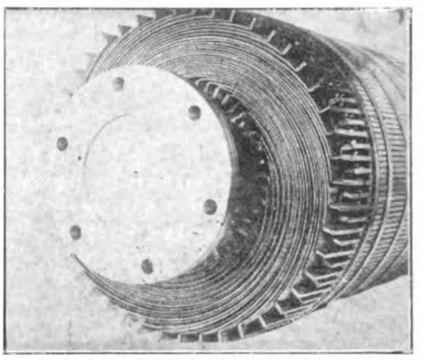


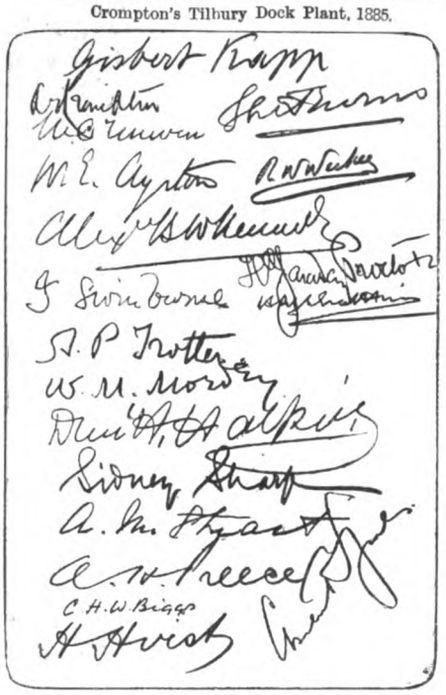
Crompton's Tilbury Dock Plant, 1885.

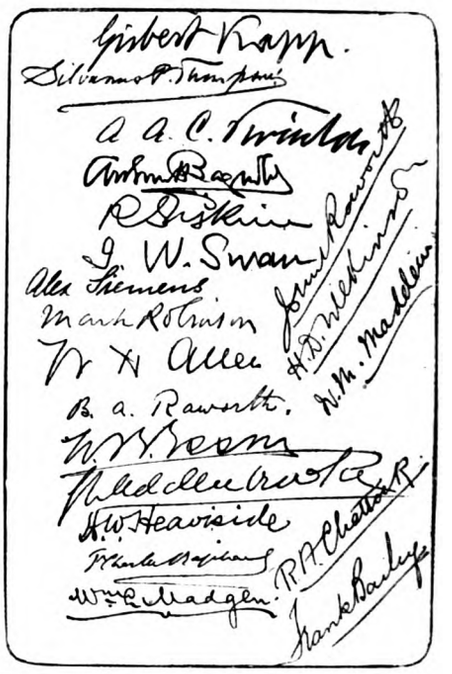


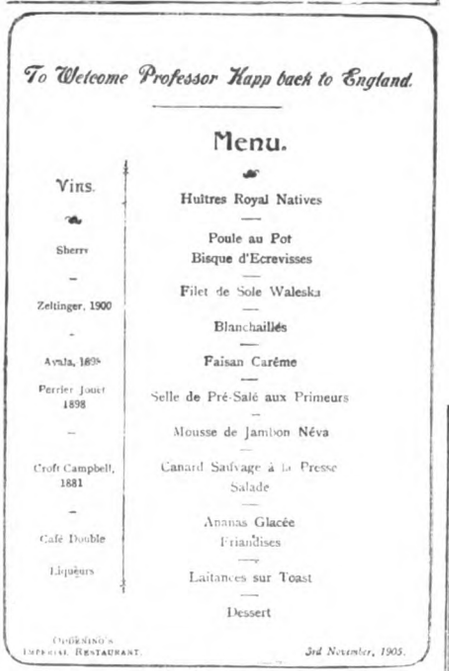
Allen-Kapp Dynamo, 1887.

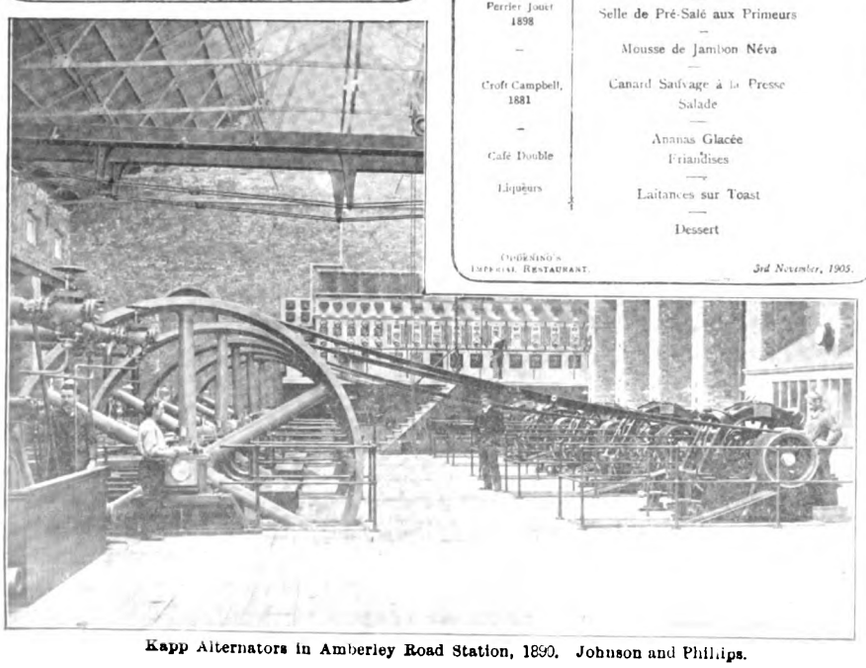


Crompton-Kapp Drum Armature.

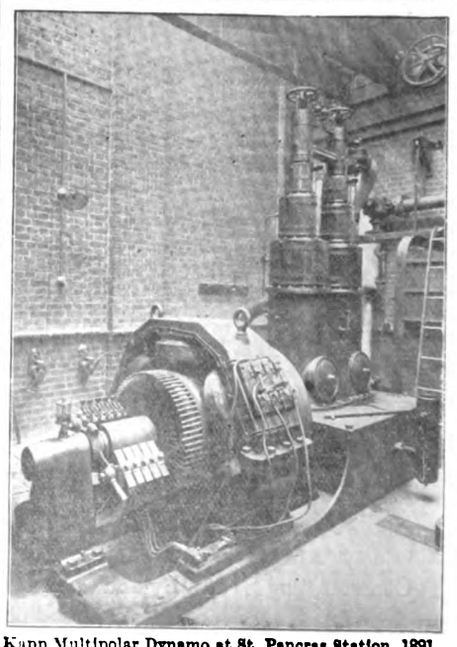








Kapp Alternators in Amberley Road Station, 1890. Johnson and Phillips.



Kapp Multipolar Dynamo at St. Pancras Station, 1891. Johnson and Phillips.

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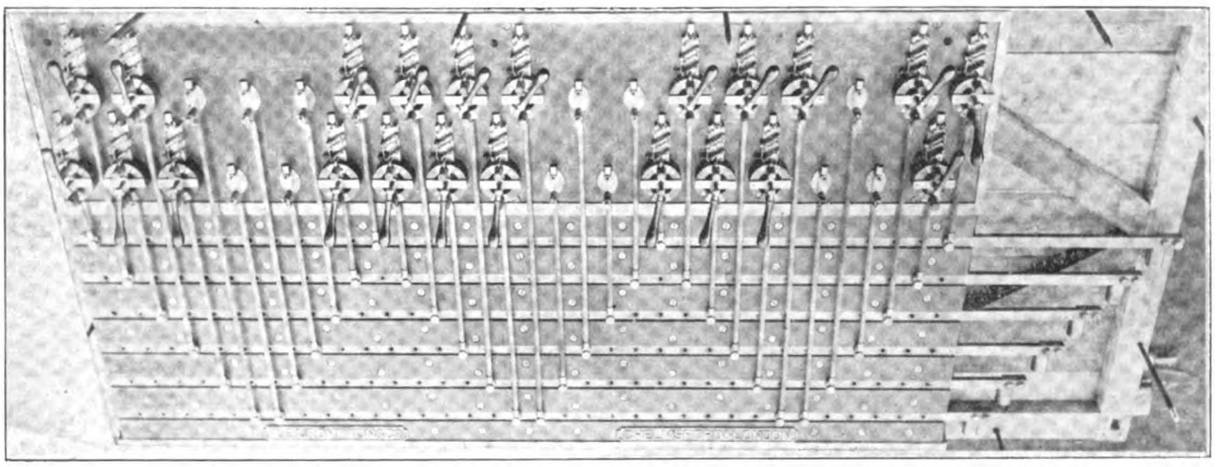
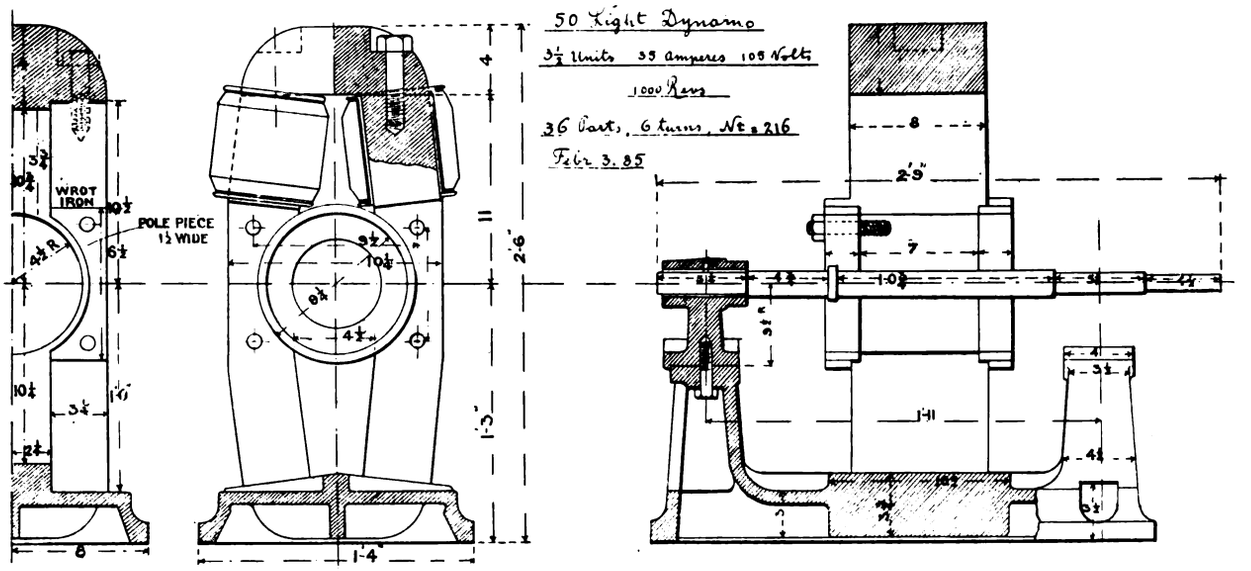
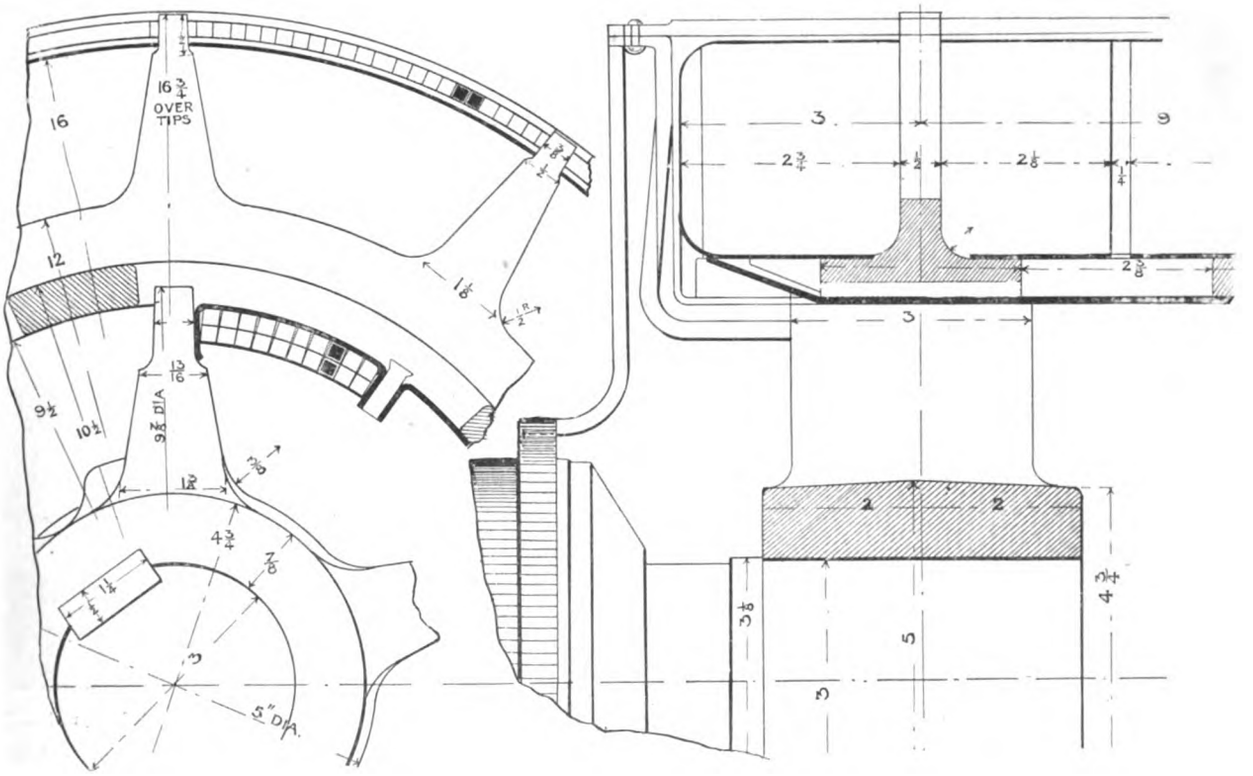
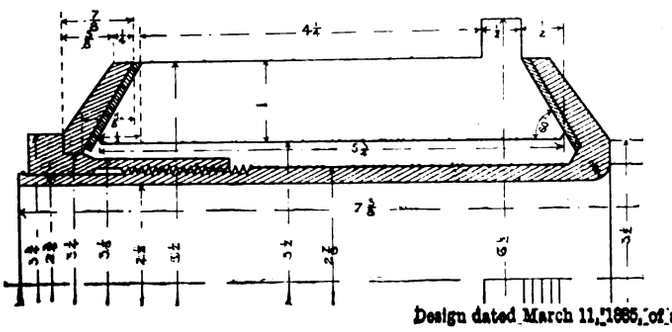


A Crompton Distribution Switchboard for the Vienna Central Station, March, 1835.







Armature for Slow Speed 50 Light Dynamo
105 Volts 350 Revs 20 turns of 185 square mils per wire
36 part Commutator 4 turns per section
Mch 11. 85

Total length of Armature wire required 340 yds 185 square
Order 350 yds double cotton covered 185 square wire
242 ft wire was wrong at one time 1.8

Design dated March 11, 1885, of an Allen-Kapp Dynamo.

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PROF. GISBERT KAPP.

Welcome Back to England.

On Friday last a number of prominent engineers entertained Prof. Gisbert Kapp in order to welcome him back to this country. The dinner, which was held in London, was presided over by Colonel Crompton, and amongst those present were Sir J. W. Swan, Sir Alexander B. W. Kennedy, Mr. Alexander Siemens, Profs. Unwin, Ayrton, and Silvanus P. Thompson, Mr. W. M. Mordey, Mr. J. Swinburne, and a number of other leading engineers.

Colonel CROMPTON proposed the only toast of the evening, welcoming Prof. Kapp back, and wishing him every success at the Birmingham University.

Prof. S. P. THOMPSON seconded, and congratulated Birmingham on its new professor. The university were to be commended for their procedure when filling the chair of electrical engineering. Instead of advertising the post at the lowest possible remuneration, they had looked round for the best man available and intimated to him that they would like him to apply. They could not have secured a man of wider experience, as Prof. Kapp added a full knowledge of German and Continental practice to his previous experience in England. He hoped that the work at Birmingham would further the electrical engineering industry, and that Prof. Kapp would remain for a long time with us.

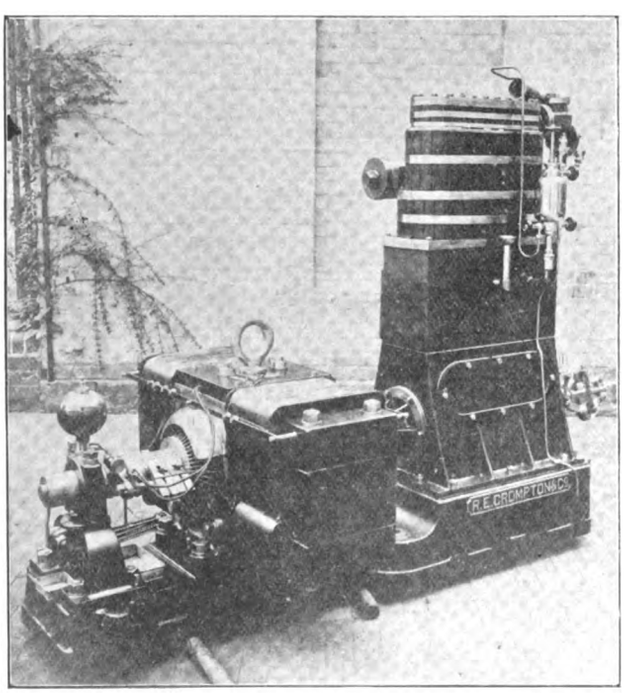
Other speeches were made giving reminiscences of the pioneering work in which Prof. Kapp had taken part. Mr. JAMES SWINBURNE gave amusing anecdotes of what he found at the Crompton works at Chelmsford when he succeeded Prof. Kapp as designer. One dynamo designed first by Mr. Crompton with no iron in the armature, and afterwards by Prof. Kapp with a cast-iron core, was now serving the useful function of an earth-plate for earthing the middle wire of the lighting system. Mr. RAWORTH recalled an unsuccessful application made to the Edison Swan Company, or its predecessor, for a position. Prof. Kapp, who was then just leaving college, offered to take any position without salary. Disappointed here, he found employment with Messrs. Gwynne and Co., designing centrifugal pumps, and Mr. W. H. ALLEN, who was then the manager of Gwynne's, recalled these facts.

Prof. KAPP, in thanking all present for their good wishes, described the difficulty he had in obtaining a start in electrical work. When the company-promoting boom was on in 1882, millions of capital were subscribed for electrical undertakings. None of the companies, however, were prepared to pay salaries to men with brains. At last he met Colonel Crompton, who offered him a position of works manager. To his statement that he had not sufficient knowledge of electrical design, Colonel Crompton replied that he would teach him. The time spent at Chelmsford had been most pleasant, and he appreciated having his old employer in the chair that night. He wished to teach at Birmingham the best English practice, and he trusted that all present would assist him by freely giving any information he might require for his students. What success he had had as an instructor in Germany was due to the freely given information which German manufacturers had placed at his disposal.

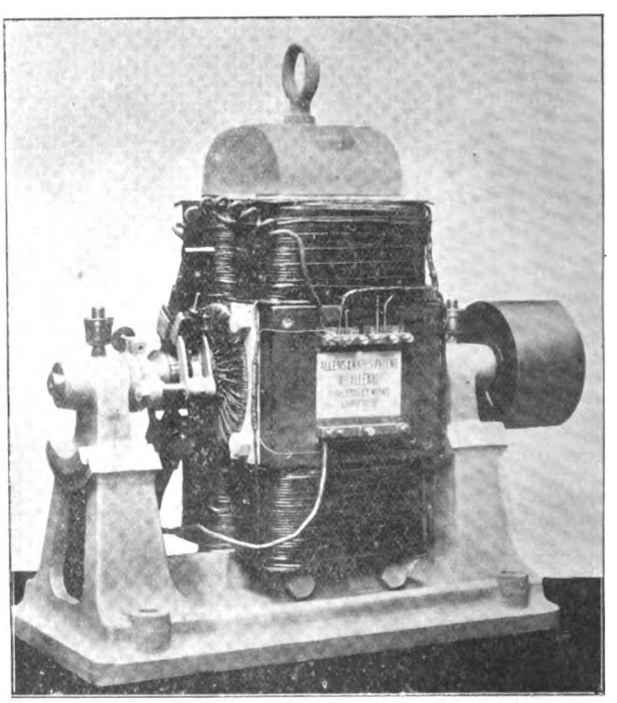
A few more informal speeches terminated a most enjoyable evening.

As a memento of the dinner, the signatures of all Prof. Kapp's hosts were obtained on the back of the menu cards, which were handed to him. These cards and signatures we reproduce herewith, together with a portrait of Prof. Kapp. Through the courtesy of Messrs. Crompton and Co., Messrs. W. H. Allen and Co., and Messrs. Johnson and Phillips, we have been able to surround these with illustrations of historic work carried out under the supervision of Prof. Kapp in the early pioneering day of electric lighting. It was with Crompton's that he had his first experience in the design and manufacture of electrical machinery. With Colonel Crompton he did a great deal of original investigations into dynamo design, which were freely placed by him at the disposal of electrical engineers. The result was that in the eighties practically every designer of dynamo machines relied for their data on his books or on papers communicated by him to various engineering societies. We do not wish in any way to depreciate the work done by other pioneers, but Prof. Kapp's lucid descriptions of his methods of design made his work more valuable to the general engineer.

The illustrations surrounding his photograph on p. 654 of this issue show progressive steps in the design of direct-current dynamos. The Tilbury Dock plant, installed in 1885, consisted of a large number of small units, the machines being of the vertical two-pole double magnetic circuit type. The switchboard used to control these machines, which were, we believe, used solely for arc lighting, would not pass the requirements of a fire insurance company now, but it successfully served its object for many years. The Allen-Kapp dynamo of 1887 shows an inverted Hopkinson type which for many years held the favour of most manufacturers in this country. It was a drum machine, and had the Kapp patent end connections. The end view of an early Crompton-Kapp drum armature is shown



A Crompton-Willans Searchlight Set supplied April, 1885, to H.M.S. Curlew.



The Allen-Kapp Dynamo made from the designs illustrated on previous page.

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below. At the bottom of the page we reproduce a view of the Amberley-road station, in which Kapp's alternators were employed driven by Hornsby engines. These machines had a ring core armature and two sets of field-magnets, one on either side of the same. Although installed

The Birmingham University.

in 1890, they are still used by the Metropolitan Electric Supply Company. One of the resident engineers in charge of the station, which has become renowned for the multiplicity of types of plant it contains, told us that the Kapp alternators never failed him on emergencies. The remaining block is of a Kapp multipolar dynamo, one of a large number installed in 1891 in the St. Pancras station by Messrs. Johnson and Phillips. These machines may be looked upon as the pioneers of the multipolar type in this country. That they had faults, no one will deny, but they were the first of a type which now holds the market in every country, even for small sizes, where the two-pole machine was supposed to be invincible. Some of the St. Pancras machines have now been displaced by larger units occupying less floor space for a given output. The others are still at work, and have for the last 13 years supplied electricity to the St. Pancras mains. Thus both the alternating and direct current central-station plants supplied by Messrs. Johnson and Phillips in 1890 to Prof. Kapp's designs have withstood all demands upon them. On p. 655 we reproduce, through the courtesy of Messrs. W. H. Allen and Co., an original drawing, with Prof. Kapp's own handwriting on it, dated 1885. It will be seen from this that he was introducing then mechanical means for directly driving the armature bars, which on smooth-cored armatures was absolutely necessary. On the same page will be found a distributing switchboard supplied by Messrs. Crompton and Co. in 1885 to the Vienna Gas Company for their electric lighting undertaking. Our concluding block is of the Birmingham University, where Prof. Kapp's new work is to be undertaken. His past experience practically assures one that he will make his department a thorough success, as he will secure the co-operation of all the prominent electrical engineers of the country. His tact and business capacity will also induce the active support of both the university senate and of his staff.

ELECTRIC LIGHTING LOANS AND LOCAL GOVERNMENT BOARD INQUIRIES RESPECTING THE SAME.

In our last week's issue we dealt in our leading article with the connection between the Local Government Board and electrical undertakings. Elsewhere in the same issue there appeared a considerable portion of the evidence given at the inquiry at Torquay respecting a proposed loan of £9,500 for more plant and for the reorganisation of the existing generating station. We propose this week to go more fully into the subject with reference to the action of the Board in Torquay and other places. The following is a *résumé* of the powers which Parliament has vested in the Local Government Board, also of some instances in which we think these powers are being exceeded. This last portion of the subject is divided under two heads, showing respectively what we think to be essential errors in the general policy of the Board and errors as to technical details on the part of their inspectors.

With respect to the power of local authorities to borrow money, the Electric Lighting Act of 1882 provides, under Clause 8, that:

(8) A local authority authorised to supply electricity by any license, order, or special Act may from time to time borrow money on such security, with such consent and subject to such provisions and restrictions with respect to borrowing and the repayment of loans as are in the schedule to this Act in that behalf mentioned, and the money so borrowed shall be deemed to be borrowed under the enactments subject to the provisions and restrictions of which it is borrowed, and the accounts of all receipts and expenditure by the local authority in pursuance of this Act, or any license, order, or special Act, shall be subject to such audit as is in the said schedule in that behalf mentioned: provided always, that any moneys borrowed under this section by the local authority of any district to which the Local Loans Act, 1875, extends, may, if it is thought fit, be borrowed in manner provided by that Act; and in the construction of the said Act for the purposes of this Act the expression "prescribed" means prescribed by any conditions imposed by the authority whose consent is required to borrowing under this section. Where any local authority is authorised by any Act to raise any money which they may be empowered to borrow for certain purposes by the issue of corporation or other stock any money which a local authority may be authorised to borrow under this section may, if it is thought fit, be raised by them by the issue of such stock as aforesaid. This section shall not apply to the mayor, commonalty, and citizens of the city of London or to the Metropolitan Board of Works, except in so far as the Metropolitan Board of Works may be concerned in the borrowing of any money by any vestry or district board.

Under the schedule at the end of this Act the local authorities controlling urban sanitary districts or rural sanitary districts can only raise money upon the security of the local rates with the consent of the Local Government Board, and subject to the provisions and restrictions as to the borrowing and repayment of loans contained in Sections 233, 234, and 236 to 239 (both inclusive) of the Public Health Act of 1875. The first of these clauses requires the sanction of the Local Government Board for all loans. The second (No. 234) provides that money shall not be borrowed except for permanent works, and that the whole sum raised for all purposes in any one district shall not at any time exceed "the assessable value for two years of the premises assessable within the district in respect of which such money may be borrowed." Sub-clause 3 of this section reads:

Where the sum proposed to be borrowed with such balances (if any) would exceed the assessable value for one year of such premises, the Local Government Board shall not give their sanction to such loan until one of their inspectors has held a local inquiry and reported to the said Board.

The rest of the clauses of the section deal with the repayment of loans. Clauses 236 to 239 deal with mortgages authorised under the Act, and with the appointment of a receiver should the interest and sinking fund not be paid within six months of the date due. Under Part 9 of the Act there are four clauses as to Local Government Board inquiries, which read as follows:

293. *Power of Board to Direct Inquiries.*—The Local Government Board may from time to time cause to be made such inquiries as are directed by this Act, and such inquiries as they

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see fit in relation to any matters concerning the public health in any place, or any matters with respect to which their sanction, approval, or consent is required by this Act.

294. *Orders as to Costs of Inquiries.*—The Local Government Board may make orders as to the costs of inquiries or proceedings instituted by, or of appeals to the said Board under this Act, and as to the parties by whom or the rates out of which such costs shall be borne; and every such order may be made a rule of one of the superior courts of law on the application of any person named therein.

295. *Orders of Board under this Act.*—All orders made by the Local Government Board in pursuance of this Act shall be binding and conclusive in respect of the matters to which they refer, and shall be published in such manner as that Board may direct.

296. *Powers of Inspector of Local Government Board.*—Inspectors of the Local Government Board shall, for the purposes of any inquiry directed by the Board, have in relation to witnesses and their examination, the production of papers and accounts, and the inspection of places and matters required to be inspected, similar powers to those which poor-law inspectors have under the Acts relating to the relief of the poor for the purposes of those Acts.

It should be borne in mind when considering these clauses, that the major portion of the Public Health Act of 1875 deals with sanitary work and local improvements which have to be carried out by local authorities, and which are not directly remunerative. The Board of Trade are responsible for the granting of electric lighting provisional orders, and the fact that such orders are granted may be taken to be evidence that a supply is needed in the district in question, which supply the Board of Trade think the local authority should provide. The system of supply has also to be approved by the Board of Trade, and the accounts, methods of charging, etc., come under the regulations of the same authority. It would seem, therefore, that the field of the Local Government Board was limited to the granting of loans, subject to proof that capital and revenue charges are properly separated, and that the loans in question do not exhaust the borrowing powers of the local authority, or take money which may be required for sanitary or other more necessary work which cannot be carried out by private enterprise.

GENERAL POLICY AS TO ELECTRIC LIGHTING LOANS.

The Local Government Board do not issue a statement as to their general policy for refusing or granting loans, but the same can be fairly well gauged from the statement of inspectors at local inquiries and from the reports issued as a result of these inquiries. From these it is evident that the present policy of the Board is to check municipal expenditure, which, without doubt, has been rashly undertaken in certain instances. The effort is a good one, but the method adopted is sometimes disastrous, and may defeat the express wishes of a local authority to carry out its parliamentary obligations. The policy has also led the Board to make suggestions as to alternative courses to the granting of loans, which, if adopted, would be wrong both technically and from a commercial standpoint. A third effect of the attempt to decrease expenditure is that, when holding inquiries as to the reasons for granting or withholding a certain loan, the inspectors have gone outside the scope of the inquiry to consider the financial success or otherwise of departments of the local authorities which have nothing to do with the loan in question.

The following brief *résumé* of special cases may serve to bear out at least a considerable portion of the general charges made above. Where small-type extracts are given they are taken from reports from the local papers of the proceedings at the inquiry, as to the exact accuracy of which we are not responsible.

Torquay.—On pp. 634 and 635 of our last issue will be found a fairly full report of the second Local Government Board inquiry respecting extensions of the Torquay electric lighting station. We are now able to give the charges which the Dolter Company will pay for the energy the Corporation have agreed to supply to them. For the first 100,000 units 2d. per unit will be charged, for the next 50,000 units 1¾d., and all in excess of this the price would be 1½d. per unit. It will be remembered that the inspector expressed a strong opinion that these terms were not favourable to the Corporation. Few supply engineers will agree with this. We would also especially refer our readers to the report in our last issue, in which the inspector practically censured the Corporation for not fully considering "the other proposals of the Dolter Company, as to taking over the whole of the electricity undertaking and working it on a profit-sharing basis." Surely the final conclusion from this suggestion is that the Dolter Company would only make such an offer if they were assured that the whole undertaking would be profitable to them when duly extended.

Rochdale.—In January this year an inquiry was held at Rochdale to consider the application of the Corporation to borrow £42,405 for the purpose of extending the electricity works to meet the growing demand for current for lighting and for the supply of the tramways. There was no opposition to the application from the ratepayers, but the inquiry lasted 3¾ hours. The details of the loan asked for were as follows:

Extension of building	£4,500
Two 412-kw. steam dynamos for direct-current supply	5,200
Three 200-kw. steam alternators for three-phase high-tension supply	4,500
One 200-kw. motor-alternator	800
Three Lancashire boilers	3,150
Five superheaters, with fittings, pipe connections, etc.	2,750
Two jet condensers, surface condenser, etc.	2,650
Additional feed pump, feed piping, tanks, valves, and accessories	500
High-tension switchboards' extensions and alterations to low-tension switchboards for new sets, cable connections, etc.	2,950
Motor-generators, transformers, switchgear, etc., for sub-station	1,550
Meters, services, cables, conduits, etc., for distribution	10,000
	38,350
Fees and contingencies 10 per cent.	3,855
Total	£42,405

The Town Clerk explained that:

The additional expenditure now proposed was rendered necessary by reason of the extension of the tramways and the increased private supplies. It was anticipated that during the year 1905-6 there would be required for tramway purposes 600 kw. capacity and for lighting 500 kw. capacity. At the end of December last there were 214 private consumers of current. For the 12 months ended March, 1904, the private light consumed was 193,751 units, 255,350 units were sold for private power, and 392,237 units went out for electric tram traction, making a total of 841,338 units sold, against 423,389 in the previous year. At present 29 tramcars were running, and 21 more were expected shortly, so that the current required for tramway traction would be increased considerably. Up to August of last year only about 4½ miles of tramway was being operated; now the length of route on which cars were running was over 13 miles, and when the Littleborough and Heywood sections were completed there would be about 19 miles of route being worked. For the year ended March 31 last the receipts at the electricity works amounted to £7,542. 2s. 10d., and the expenditure £6,919. 9s. 3d. (of which £3,847 was interest and sinking fund payments), leaving a balance to the good of £622. 13s. 7d., against a loss of £1,492. 1s. 10d. in the year before.

The following dispute then took place between the inspector and the borough treasurer, Mr. F. Boothman:

The Inspector remarked that the department was not making a profit on the current used for lighting. Really there was a loss on the working of the department.

Mr. Boothman: Excluding, of course, the income from tramways.

The Inspector: If the trams are not making a profit, you cannot put the revenue they pay to the profit of another department.

Mr. Boothman: It is not printed as profit. It is a sale just as it would be to any private company.

The Inspector: Quite so, but taking the two together the result is a direct loss. You cannot take the work of one department and charge it to another and say, "I am making a profit." You are not.

Mr. Boothman was not able to follow that argument. The works showed a surplus of £622.

The Inspector said one undertaking could not make a profit at the expense of the other.

Mr. Boothman agreed that taking the departments as one undertaking there was a deficit.

The Inspector: They must be taken as one undertaking.

Mr. Boothman: We are bound to take them separately as a trading undertaking.

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The Inspector: That is merely a question of keeping accounts. The £622 which you say is profit is dependent on the revenue from the tramway account, which shows a very large deficit.

The Town Clerk pointed out that the deficit on the tramways was due to the period being one of reconstruction, when there were no receipts to set against the capital expenditure.

The engineer, Mr. Atchison, gave similar evidence that they sold electricity to the tramway department, and, of course, charged a reasonable and profitable price for the same, but the inspector replied that he was charging this to an insolvent department. With respect to deficits made in previous years, the town clerk explained that these had been met out of the rates. Thus:

In the accounts for the year ending March, 1901 (not a complete year's working), there was a loss on the year's operations of £1,666; the next year to March, 1902, the loss was £2,385, the third year it was £1,492, and last year there was a surplus of £622.

The Inspector: You have practically lost £5,000 on the undertaking.

The Town Clerk: We suggest that the repayment of capital is not a loss. I don't want you to lose sight of the fact that the sale of current for lighting has increased from 141,735 units to 193,000, and for private power consumption from 65,000 units to 255,000.

In reply to a question as to how long the proposed new plant would meet the demand, Mr. Atchison replied about two or three years. A good portion of the remaining time at the inquiry was spent in an investigation of the accounts of the tramway department, which it was shown were in the transition stage from horse to electric traction.

It is our contention that this inquiry into the tramway undertaking and its profits or losses was *ultra vires*. The question as to whether the electric lighting department were or were not supplying the tramway department at a loss would be a legitimate issue. Under the powers and obligations conferred on the Rochdale Corporation by its provisional order it was bound to supply the tramway undertaking with current. At this inquiry the question was also raised as to why the Corporation had not entered into negotiations with the Lancashire Power Company for the supply of the tramways with electrical energy. We believe we are correct in stating that, although the loan with certain reductions was ultimately granted, the matter was in suspense for some nine or ten months. We are indebted to the *Rochdale Observer* for the above report.

Wood Green.—The case of Wood Green was dealt with more or less fully in our issue for Sept. 16, 1904. In this issue we published the full text of the Local Government Board's decision in refusing a loan for electric lighting purposes. For the sake of easy reference we reproduce this decision here:

"I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the inquiry held by him with reference to the application of the Urban District Council of Wood Green for sanction to borrow £43,200, since increased to £43,570. The Board have very carefully considered all information placed before them by the District Council, and it appears to them upon that information to be extremely doubtful whether the scheme, if carried out, would be likely to prove a financial success. The evidence given as to the probable demand for current was of an unsatisfactory character, for it was first stated that the demand was estimated to be equivalent to 330 consumers at 60 8-c.p. lamps per house, but when it was pointed out and admitted by the engineer that the number of lamps estimated for was far too high considering the class of property to be supplied, the estimate of the demand was altered to 660 consumers at 30 8-c.p. lamps per house. It does not clearly appear in what manner either estimate has been arrived at. The Board consider that the District Council before undertaking a scheme of the magnitude proposed should obtain more reliable information as to the extent to which the electric light is likely to be taken up. Moreover, the Board are by no means convinced by the evidence submitted to them that the District Council are acting prudently and in the best interests of their district in proposing to erect a generating station for the supply of electricity, and they think that the whole question, including the methods of supply, should be reconsidered by the District Council."

The net result of this decision is that there is no electric light or power to be obtained in Wood Green. The local Council have so far refused to be driven into the hands of the North Metropolitan Electric Power Distribution Company, and they have not again approached the Local Government Board for a loan to enable them to do what Parliament has approved their doing in a way which the Board of Trade have sanctioned.

Technical Details.

We now propose to refer to two instances where the Local Government Board inspectors have adversely criticised the technical details of proposed schemes, and in which the expert opinions of the inspector are either directly in opposition to approved practice, or at least open to that doubt which frequently exists between expert opinions by different gentlemen. This point we have dealt with more fully in our leader, but the question of an economic supply from a power company for lighting purposes only is very questionable. The power factor of the lighting load is extremely low, and this results in the capital charges for the high-tension transmission system averaging out to a high figure per unit. It is yet to be proved that for lighting only the bulk supply is profitable unless the transmission mains can be also utilised for power distribution, which may then bear the bulk of the capital charges. As an example of this, the North Metropolitan Electric Power Distribution Company entered into an agreement with the St. Albans Corporation some years ago for the taking over of the electric lighting order. The company never proposed to supply St. Albans from its large power station at Willesden, but would have put down a separate plant for St. Albans in the same way that the town would have done. As a matter of fact, we believe that neither the town nor the company have done anything but make agreements and consider reports as to the supply of St. Albans with electricity.

In the first inquiry held at Torquay, when a completely new station was proposed, the following evidence was given as reported in the *Torquay Directory*:

The Inspector asked why it was proposed to instal two different sets of boilers—cylindrical and water-tube?

Councillor Ball stated that the object was to effect a saving in the coal bill.

The Inspector did not think that the saving would be appreciable in practice when regard was paid to other considerations. For instance, the boilers would require to be stoked differently, "and you know," said he, "that much money is frequently wasted in stoking." Uniform boilers, which could be stoked without men undergoing special instruction, would be desirable.

We think it a great pity that Councillor Ball answered this query instead of Mr. P. Storey, the electrical engineer of the town. The query shows a curious lack of knowledge on the part of the inspector of the requirements from an electric lighting boiler-house. We think the bulk of engineers working such stations are now unanimously of opinion that it is most economical to have Lancashire boilers to meet the general demand for steam during, say, 20 hours per day. The quick-steaming properties of the water-tube boilers make them most suitable for supplying the extra steam needed during the lighting peaks. The large water capacity of the Lancashire boilers makes them most valuable for dealing with a sudden fog until such time as the water-tube boilers can have their steam raised. As regards the inspector's fear as to inefficient stoking due to having two types of boilers, Mr. Storey and most other station engineers would deal with the inefficient stoker quite as summarily as the Local Government Board did with the first Torquay application.

We have other reports before us as to the inquiries at Oldham, Norwich, Salford, and elsewhere, from which extracts of interest could be given, but they would only duplicate the general sense of the above.

THE DISTRIBUTION OF ELECTRICITY IN MINES.

BY B. C. H. J.

(Concluded from page 625.)

Gas barrel and other descriptions of metallic piping are used in the workings, principally in connection with lighting cables, as these are smaller than those used for power. In a mine which has permanent wallings these pipes act very well in giving a solid, mechanical protection

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to the cables. Where falls are usual, however, such piping gets strained, bent, and twisted so badly that the cables inside are spoilt, and, moreover, there is extreme difficulty in extracting them. This is the case with screwed pipes; but where split barrel and open joint piping is used and the length is not so mechanically solid, danger arises from the free ends of each length and the split longitudinal edges cutting into the cable when distorted by mechanical shocks.

A class of cable that is largely coming into use for coal-cutter trailing leads is one insulated by rubber, and protected by leather either in a form of strip braiding or as a tube with stitched sides. This is taking the place of the simple rubber-insulated, hemp-braided, or the bitumen-insulated and braided conductor, neither of which last long under the trying conditions to which they are subjected.

The question of joints in the workings is not so momentous as that of joints in the shafts, as the conditions of working are, on the whole, less hazardous. Nevertheless, the fewer there are of them the better, and special consideration should be given to each one, so that it may properly suit the local conditions. There are not the same facilities for making joints in mines as there are in electricity supply work. In many collieries fire cannot be used on account of the firedamp, and this means that the conductor joints may not be sweated solid, that ordinary joint-box compound cannot be used, and to this is added the difficulty of adequate supervision under the conditions of mining transit. The great thing is to employ a jointer who is a bit of an archangel as to conscientiousness, and is, further, expert and likewise used to mining conditions governing jointing. Such a treasure is not easily found in this world outside cable works.

As regards straight-through joints, rubber cables should have vulcanised joints made in the usual manner wherever possible. This method comprises wrapping the conductor with a pure rubber tape, then with vulcanising tapes, binding this solid with cotton tapes, and then immersing the joint in a compound of paraffin wax and sulphur (heated to an even temperature of 300deg. F.) for about an hour. There are three ways of applying the heat, as follows: (1) the old-fashioned colza oil lamp heated cure; (2) a fire-heated cast-iron cure; (3) an electrically-heated cure. The latter is most to be commended if it is possible to arrange for the supply current. It is safe, simple, and easily adjustable as to temperature, and therefore likely to give the best results in awkward situations. Where vulcanising is impossible, the joint should be thickly bound with the best rubber tape, over which is tightly lapped a strong weather-resisting tape, the whole completed joint being well varnished. It may be as well to mention that a slight strain put on pure rubber tape when binding it on is more satisfactory than the use of solution.

Joints in bitumen-insulated cables should be made with bitumen or guttaroid tape, evenly lapped around without strain, each layer being firmly smoothed and compressed by the jointer's hand, which must be dry and of natural heat the better to mould the layers together into one solid sleeve. This mould is covered by impregnated cotton tapes and varnished. If possible, the joint should be vulcanised similarly to a rubber joint (the time of immersion in the compound being only a minute or so) before finally taping up and varnishing for the better welding together of the bituminous taping.

In some cases iron joint-boxes are preferred, and these are generally used for paper-insulated, lead-covered cables. Whatever the class of cable, however, if it is composed of more than one conductor, such as a concentric or three core, boxes are usually the best method of connecting together the factory lengths, as the insulating material is then run into the box in a fluid state. This more effectively insulates one conductor from another, and seals the whole joint than taping ever can, the box acting as a mould and mechanical protection. The question then arises as to the kind of filling material. There are two: one is an insulating oil, and the other a bituminous compound. The requirements are high insulation, waterproofedness, adhesiveness, and solidity. Care should be taken that the compound used is not merely pitch or bitumen, as these are deficient in most of the qualities mentioned; the best compounds have a mixture of suitable oils to attain the qualities before mentioned. Further, the use of compound is a snare if it is poured in a half-baked state through the plug-hole of a joint-box, as it will not then fill the box properly, and the spaces left will attract moisture to the utter undoing of the cable. For this reason oil is sometimes used to fill the box with, but there is always a good chance, especially on a slope, that the oil will run down the interstices of the cable or out of the glands or faced surfaces of the box itself, leaving the interior of the box with a moisture attracting vacuum. With some box compounds, however, such as diatrine, the special mixture and low melting point prevents it cooling too much for the purpose, up to a period of two hours after heating; so that there would be ample time for conveying it from a safe part of the mine to the job in the special covered buckets supplied by the makers. The use of a petroleum residue for filling the boxes under such conditions has been considered, but there would appear to be nothing gained in the majority of cases, and the permanently semi-solid nature of the material might combine the faults of the oil and the compound respectively, merely to secure convenience in the jointing process.

To make quite sure that joint-boxes are properly filled up, it is recommended that the top is removable, as with disconnecting joint-boxes, instead of being merely fitted with plug holes for pouring purposes. All boxes should have the cable gripped under pressure, or the fittings positively anchored, so that there may be no chance of the box sliding along the joint and touching the terminals through rough usage or negligence. This possibility is to a great extent guarded against if the box glands are made to grip the cable tightly without using a loose bush, also if the box is filled solid with compound, the adhesiveness and solidity of which should prevent movement.

The conductor fittings, if not of the sweated type usual with public supply cable boxes, should have specially ample contact surfaces, while screw contacts on the inner conductor should be many and strong. At least four ¼in. grub screws per cable end should be allowed, and this means eight per straight joint. Here is where the archangel conscience comes in at an awkwardly situated, back-bending place, if supervision is absent, and the jointer can only count up to five. Lead sleeve joints are sometimes used with single or multicore cables, and these when properly made and protected are quite satisfactory. The unreliability of plumbing in awkward situations and the general lack of the conscience mentioned is, however, against the extensive use of this class of joint in mines.

Just a paragraph here to mention that, as in most mechanical work, joints are the weakest point of a cable network, and it is therefore necessary to pay special attention to this detail. Interested persons sometimes provide cable-jointing accessories which may be standard practice on electricity supply work above ground, but which are absolutely useless for the special conditions of mining work; and it is to save trouble on this point that the matter is now dealt with, in perhaps superfluous detail to many engineers.

Disconnecting boxes are sometimes used in place of switches for interrupting the supply of current at a branch, and these act equally as well if properly designed. An ideal pattern for such a box is one (1) in which the terminals are mechanically fixed thereto on solid insulating bases; (2) where the cable is gripped so as to be immobile to strains put upon it; (3) where the live parts are separated from one another by solid insulation that is fireproof and non-hygroscopic; (4) where the links or fuses are provided with insulating handles to prevent chance of shock when these are being operated upon; and (5) where the lid is so arranged that access is easy to an authorised person, and water cannot get inside when it is shut.

The switch and plug boxes used in connection with coal-cutters should be very simple, solid, and insulated to the verge of exagerated absurdness. The main item of design should be safety for the coal-cutter attendant, and strength. The switches fitted inside should only be capable of switching on current after the coal-cutter connection plug is affixed to the box. This prevents the chance of the machine

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being started up when the attendant is away fixing the plug into the box. The mining regulations decree that metallic joint-boxes shall be earthed, and this is best done by screwing a brass set screw clamp on to the body of the box, to which is attached the earthing wire. On leadless or unarmoured cables the wire should be taken to the nearest earth, but on lead-covered cable it may be used to connect the box to the strand of wire that is used to connect the cable sheathings together, the lead or metallic covering being earthed itself at proper intervals.

As regards the official measurement of leakage, which affects cables as well as the underground machinery, it is generally conceded that Clauses 6 and 7 of the regulations cannot be literally fulfilled in practice, but apparatus is in use that at present sufficiently carries out the requirements of the situation. The clauses read as follows (the italics are the writer's): "(6) The insulation of every complete circuit, other than telephone or signal wires, used for the supply of energy, including all machinery, apparatus, or devices forming part of or in connection with such circuit, shall be so maintained that the leakage current, so far as is reasonably practicable, shall *not exceed one-thousandth of the maximum supply current, and suitable means shall be provided for the immediate localisation of leakage* (7) In every completely insulated circuit earth or fault detectors shall be kept connected up in every generating or transforming station, *to show immediately any defect in the insulation of the system.* The readings of these instruments shall be recorded daily in a book kept at the generating or transforming station or switch-house."

The fault detectors specified to show immediately any defect in the insulation is met by the use of a meter connected to the mains and to an earth-plate, no reading being shown when no leak exists. A leak upon either main will deflect the pointer in a distinctive direction, and by concentrating the instrument, as it were, upon that main by means of a switch the amount of leakage current is shown. This is not exact as to the comparative number number of amperes (as the amount of leakage from the other main or mains requires to be taken into account), but it is near enough for most purposes. Further, a fault of equal seriousness occurring on both mains would not be shown on the instrument when in its normal state of connection, but such a happening is hardly likely. As to the immediate localisation of leakage, this condition is best met by the provision of a portable testing set and plenty of disconnecting points in the circuit. Some engineers are under the impression that the instruments are required to write in chalk on a blackboard the exact locality of the fault to a yard within a few seconds of its happening, and this point of view is somewhat encouraged by the wording of the clause in question. The words "so far as is reasonably practicable" should not, however, be lost sight of in reference to this and many other of the regulations that may appear impracticable to the casual reader.

It should be noted that although this article has dealt with conditions obtaining under continuous-current practice in many of the items discussed, the same very frequently obtains for three-phase current work, except where it has been pointed out otherwise.

In conclusion, the writer would draw attention to a vital part of the subject by quoting another of the aptly-put truisms with which the 1904 report of the Home Office Committee abounds: "On one point, however, we observed that all witnesses were agreed—namely, that the apparatus should always be thoroughly well made and erected, and all the parts well protected from accident, and the dangerous parts from coming into contact with the workmen. Bad work, even in the first instance, does not save 20 per cent. of prime cost, and always ends in occasioning far more loss than the initial saving. In the record of accidents which have occurred the cause can almost always be traced to bad plant or arrangements. The reason of the unsatisfactory condition of the plant in many mines is, we think, to be found in the fact that electricity was introduced by instalments, and upon a small scale. This timidity has led in too many instances to insufficient power being supplied, and to the work being done in a temporary manner. But when once it has been introduced it has almost invariably proved so successful that its auxiliary and temporary character has passed away and it has become not only a permanent necessity, but a prime factor, with the consequence that the capacity of the plant as first introduced has been strained to the utmost, and has not infrequently broken down under these adverse conditions, and ultimately had to be replaced entirely by larger and more perfect appliances." *Verb sat. sap.*

THE PROBLEM OF THE GAS-TURBINE.*

BY DUGALD CLERK, M.I.C.E., PRESIDENT.

The wonderful success obtained by your distinguished past-president (the Hon. C. A. Parsons) and his many able followers with the steam-turbine in its various forms, has naturally attracted the attention of engineers to the apparently analogous problem of the internal-combustion turbine. Accordingly, much mathematical and engineering ability has been recently devoted to the subject—so far, I am sorry to say, without concrete result. In this subject, as yet, the dreams of the theorist obstinately decline to realise themselves in tangible iron and steel. I have not been able to find any gas-turbine in a state of effective rotation doing useful work, although I have noted many statements in the Press to the effect that some wonderful German, French, or Italian gas-turbine had worked, or was about to work, in such a manner as to relegate the ordinary cylinder and piston gas-engine to the museum with which many engineers used to threaten the steam-engine. One gas-turbine only has really rotated within my own direct knowledge. It was designed by Mr. F. W. Lanchester, of Birmingham, to operate with the exhaust gases from one of the petrol engines used in his well-known motorcars. He assured me a few days ago that it really rotated at a high speed, and made a loud shrieking noise, but only gave, he said, a total brake horse-power equal to that capable of being evolved by two blue-bottle flies. This power he did not consider to be satisfactory.

Speaking seriously, it does seem remarkable that so much interest should be taken by so many able men without any sort of result in practice. Why is this? I propose to-night to answer the question in so far as I can. It appears to me that most of those who have written on gas-turbines, and have even designed and patented them, have given too little weight to certain differences between the steam and internal-combustion engine problems. Many, indeed, have assumed that the solution of the gas-turbine problem is the easier of the two, and that few difficulties exist which have not already been met and conquered by Mr. Parsons in the steam-turbine. Many distinguished men have been of this opinion, and even Mr. Parsons himself, so early as his first turbine patent (No. 6,735 of 1884), appears to have been of opinion that the hot gas or internal-combustion turbine presented practically the same problem as the steam-turbine. In that specification he makes the following statement: "Motors according to my invention are applicable to a variety of purposes, and if such an apparatus be driven it becomes a pump, and can be used for actuating a fluid column, or producing pressure in a fluid. Such a fluid pressure producer can be combined with a multiple motor according to my invention, so that the necessary motive power to drive the motor for any required purpose may be obtained from fuel or combustible gases of any kind. For this purpose I employ the pressure producer to force air or combustible gases into a close furnace of any suitable kind, such as are used for caloric engines, into which furnace there may or may not be introduced other fuel (liquid or solid). From the furnace the products of combustion can be led, in a heated state, to the multiple motor, which they will actuate. Conveniently, the pressure producer and multiple motor can be mounted on the same shaft, the former to be driven by the latter; but I do not confine myself to this arrangement of parts." Clearly here Mr. Parsons intended to apply his invention to the gas-turbine as well as to the steam-turbine, and in this paragraph he outlined the fundamental idea of nearly all subsequent proposals of gas-turbines. Many other inventors

* Address to the Junior Institution of Engineers delivered Nov. 3, 1905.

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have followed him, but I may only mention two well-known names—those of Ferranti and Stodola. Both have proposed turbines similar to this, with more or less elaboration, as well as other modifications intended to overcome certain difficulties.

In a very able paper read before the Institution of Mechanical Engineers last year, Mr R. M. Neilson discusses various cycles of operation which can conceivably be applied to gas-turbines, and he calculates the efficiencies of these cycles in various combinations. More recently, too, the subject has excited great interest in America, and very interesting articles are to be found in the *Engineering Magazine* by Dr. Charles E Lucke and Prof. Sidney A. Reeve. These gentlemen take somewhat opposing views of the position of the problem. In most of the recent discussions upon gas-turbine problems, it has been recognised that the temperatures possible in the cylinder gas-engine are impossible for the gas-turbine. It has been fully proved by many investigators, including myself, that the temperatures quite common in ordinary gas-engine practice range as high as 2,000deg. C., although in the best practice, for most economical results, 1.500deg. C. or 1,600deg. C. appears to be an upper limit. With the temperatures of 1,500deg. C. or 1,600deg. C a first-class modern gas-engine of about 50 h.p. will give an indicated efficiency of 35 por cent. At the same time the negative work of the cycle is so low that the mechanical efficiency of the engine may be as high as 86 per cent., or even over. If one realises what the temperature 2,00deg. C. means, it becomes very evident that no turbine constructed either on the lines of Parsons or Laval could possibly be made to work with continuous supply of such gases; 2,000deg. C. is considerably over the melting point of platinum. It is much higher than the temperature at which cast iron flows from the crucible, or, indeed, the temperature of the interior of the blast furnace itself. Any blades of iron, steel, or, in fact, any other material—even firebrick itself—becomes fluid or semi-fluid at this temperature. It is obviously hopeless, therefore, to attempt in the gas-turbine temperatures which are quite feasible in the cylinder engine. This fact, as I have said, is generally recognised. It is accordingly said by those who take a favourable view of the gas-turbine, that it is necessary to supply the turbine with gases at a much lower temperature. Mr. Neilson fixes the temperature of 700deg. C as one which steel turbine blades would probably stand without too rapid deterioration. I fear that on this point I must differ from him, because, in my experience, oxidation of steel and even iron is a fairly rapid process at this temperature. Nothing new has been proposed as to the thermodynamic cycle of the gas-turbine, so that all reasoning upon efficiencies depends upon the deductions already made from internal-combustion engine practice.

Seeing the impossibility of constructing a turbine with materials to stand a high temperature, many have proposed to convert bigh temperature into kinetic energy, so that, instead of having work stored up in the gas in the form of heat, the heat shall disappear, and the energy of the heat be transformed into motion of the gaseous particles at a high velocity. Such proposals, then, include the compressing of a gaseous mixture to, say, 50lb. or 60lb. above atmosphere, the igniting of that mixture within a combustion chamber at constant pressure, and the expansion of the mixture through an expanding jet of the Laval type, so as to drop the temperature and obtain its equivalent in kinetic energy or velocity of the gaseous particles. The rapidly moving particles at the relatively low pressure and temperature are then allowed to impinge upon rapidly rotating blades of sickle configuration, and they are supposed to give up their energy of motion to those blades, and so expend work upon the turbine. This appears to be the most feasible of all the gas-turbine proposals, so I will proceed to examine it a little more minutely. Success by this cycle of operations requires (1) a rotary or turbine compressor of high relative efficiency; (2) an expanding nozzle which shall ensure that free expansion is quantitatively equivalent to adiabatic expansion behind a piston; (3) a rotating turbine of such construction as to secure very high efficiency of transformation of kinetic energy of the moving gas into effective work available at the turbine shaft.

Assuming air to the working fluid and specific heat to be constant through the temperature range, it is easy to calculate the efficiency of the Joule or Brayton cycle, which these operations in effect represent. It would be useless to attempt to work a turbine at a pressure so low as to be relatively inefficient compared with the gas-engine, so I have chosen a Joule cycle of, say, 48 per cent. ideal efficiency, which in a cylinder gas-engine would probably give in practice about 30 per cent. indicated efficiency. For this ideal efficiency the pressure of compression would require to be 141lb. per square inch absolute. To give power with a reasonably small pump, I shall assume a maximum temperature of 1,700deg. C. That is, assuming a perfect compressor and a perfect nozzle expander, the temperature would only fall from 1,700deg. to 750deg. C. Plainly this temperature would be too high for a Laval disc with blades. In order to get a reasonable temperature on expansion, it would be necessary to assume a maximum temperature in the combustion chamber no higher than 1,000deg, and this would bring down the temperature after complete expansion to about 500deg., which, no doubt, steel turbine blades can be expected to stand for some considerable time. With these assumptions, however. the gas-turbine would not be very economical as compared with cylinder engines, even assuming all difficulties overcome. The theoretical and practical difficulties, however, are very serious indeed. To begin with the question of an efficient air compressor. I am not aware of any turbine compressor capable of compressing up to 140lb. absolute from atmosphere with anything like 60 per cent. efficiency. Before success could be attained, this efficiency of compression, so far as diagram is concerned, should be at least 90 per cent., in order to allow for unavoidable mechanical and other losses in the subsequent processes. It has, it is true, been proposed to substitute cylinder compressors operated from the turbine, instead of turbine compressors; but this, it appears to me, would be equivalent to abandoning at once all the advantages of the turbine principle. If reciprocating cylinders are to be used for compressing, there is no objection to using them also for expanding. No gas-turbine with cylinder compressors could, in my view, succeed.

Assuming, however, even 90 per cent. efficiency from a turbine compressor, and assuming that we have a compressed gaseous mixture burning freely in the combustion chamber at the desired pressure and temperature, we have yet to face the problem of the expanding nozzle. It is always assumed that with the use of an expanding nozzle, temperature drop can be as certainly attained as with an expanding piston in a cylinder. This, it seems to me, has been by no means proved. You will all recollect Dr. Joule's famous experiment with two vessels immersed in water and connected together by a pipe having a stop-cock upon it. Air was compressed into one of those vessels, the water round the vessels stirred, and equilibrium obtained, while the other vessel was rendered as vacuous as possible. The stop-cock between the two vessels was opened, and it was then found that when the water was stirred again no disturbance of the equilibrium ensued. This, of course, meant that although heat was lost in the one vessel, giving velocity to the gases, it was gained in the other vessel by the impact of the gases against the walls. Joule modified this experiment by placing the two air vessels in separate water containers. He then found that the temperature of the one vessel dropped, due to expansion, but the temperature of the other vessel rose as much as the first dropped. Now apply this experiment to reasoning on the behaviour of the flame in an expanding nozzle. Assuming the two vessels to be connected together by a Laval nozzle, and assume that while in the nozzle the gases experienced the full temperature fall due to adiabatic expansion. Immediately, however, on contact with the walls of the second vessel the velocity of the particles would be stopped, and the temperature would be restored to a point somewhat above the original temperature—that is, the mass of expanding flame in the pressure vessel would gain heat by the amount the first vessel lost. That is the result of the final process. It will be easily recognised that to obtain a sufficient tem-

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perature drop in an expanding nozzle necessitates the practical absence of turbulent motion of every kind—that is, to expand adiabatically the jet must be so constructed that there is an absolutely smooth flow from high pressure to low, and no impact or loss of velocity from any cause whatever. So far as I understand expanding jets, no adiabatic expansion so perfect as this has ever been obtained.

Assume, however, that the efficiency of expansion in such a jet is, say, 90 per cent. We now come to the question of the efficiency of conversion by the turbine blades. In many calculations from diagrams it is assumed that the efficiency of conversion of motion into work is practically perfect. This, however, is by no means the case in present turbines. Even the steam-turbine, high as its efficiency is compared with the reciprocating engine, has no very high efficiency of conversion in any of the forms of turbine at present on the market. That is, if we assume a mass of gas to exist in a compressed state in a reservoir, and we choose to expand this mass of gas in two ways, for the sake of comparison (1) behind a piston and (2) by means of a Laval jet and turbine, we shall find that the efficiency of conversion of the turbine, once high velocity is attained, does not exceed 80 per cent. In this respect the efficiency of conversion of rotating turbine blades is inferior to that of a moving piston in a cylinder. The reason of this is obvious. It is impossible to so arrange the impact of a rapidly moving gas with a turbine blade or blades in such manner as to entirely avoid turbulent motion. The impact, for example, of swiftly-moving gases on a fixed surface results ultimately entirely in turbulent motion, which restores to the gas or to the blade struck all the heat which has disappeared in temperature fall due to adiabatic expansion. What is true of a fixed blade is to some extent also true of the moving turbine blades. A certain proportion of the energy existing in the gas in the form of motion is inevitably lost whenever this gas comes into contact with any solid surfaces. So much is this the fact that in designing steam-turbine blades for any type of turbine, the shape of the blades, the shape of the space between the blades, both moving and fixed blades, or fixed jet and moving blades, is of the first importance, and it has only been found by experiment that certain shapes of blades and passages have a much higher efficiency of conversion than other shapes. In this respect, too, the turbine principle is inferior to the cylinder and piston. In a cylinder, gases expanding behind the piston, the efficiency of expansion may be considered to be 100 per cent., and even an efficiency of compression in many gas-engines is also the same order. I do not here refer, of course, to heat losses due to conduction, or anything of that kind, but to efficiency of adiabatic compression or expansion.

Although the efficiency of expansion is relatively low for gases in steam-turbines, yet the turbine offers a great advantage in total work obtained from steam. This is due to the fact that the turbine avoids initial condensation; and, further, it permits of the utilisation of a very long range of expansion at the low-pressure end, which is not available in the case of steam-engines. By saving, therefore, in minimising initial condensation, and in obtaining added work from pressures wasted in the ordinary steam-engine, the Parsons steam-turbine more than compensates for any inefficiency of expansion as compared with the cylinder engine. It is well known, however, in turbines of practically all constructions, including Mr. Parsons, that the efficiency of the steam-turbine at the high-pressure end is not so great as that at the low-pressure end. This is partly due to difficulty of adjusting the velocity of blades to suit the necessarily varying velocities at different points of the flow of the steam. This, however, is a small difficulty with the steam-turbine, but it is a very great difficulty with the gas-turbine. Compared with cylinder expansion, I cannot see how it is possible with present knowledge to obtain an efficiency of conversion in a gas-turbine greater than 80 per cent. This, of course, is partly due to the high velocity of the issuing hot gases. To produce an efficient gas-turbine, therefore, on the favourite cycle so much discussed recently, it is necessary first to have, as I have said, a very efficient compressor, a very efficient expanding nozzle, and a very efficient conversion when the moving gases strike the turbine blades. Using the numbers I have suggested, of 90 per cent. efficiency of compression, 90 per cent. efficiency of nozzle expansion, and 80 per cent. efficiency of conversion in turbine, we have, with a cycle having negative work equal to 0·4, the following efficiencies: to get 0 4 of work in compression, we shall require 0·445 of work put into the compression. On expanding in the nozzle we shall obtain 0·9 only of the total energy of the flame gases in the shape of kinetic energy, and of that 0·9 we shall only get 0·8 returned in the shape of available work by the turbine part. That is, we shall get a total work from the turbine of 0·72, and deducting the negative work, 0·72 – 0·445 = 0·275—that is, from a cycle which should give us 0·6 in work we shall only get 0·275, or about 22 per cent. The practical efficiency of an engine of this kind will only be 22 per cent., even assuming the high efficiencies of compression and jet expansion which I have mentioned. In my view, no such efficiencies of compression or jet expansion are at present known, and accordingly there appears no likelihood of the production of any gas-turbine which can rival the reciprocating gas-engine in efficiency and in economy. To produce such a turbine requires the solution of three problems: (1) an efficient turbine compressor, comparable in efficiency with cylinder compression; (2) an efficient nozzle expander with a higher efficiency than 90 per cent.; (3) an efficiency of conversion of kinetic energy of the moving gases into work delivered at the turbine spindle of greater than 80 per cent. Either these problems must be satisfactorily solved, or else new materials discovered which will stand temperatures which at present melt firebrick. The outlook, I fear, is not hopeful.

This thermal efficiency of 22 per cent. assumes no losses in the combustion chamber due to heat conduction, no losses in the expanding jet due to heat conduction, and no losses in the turbine itself from the same cause. Considering the losses in gas-engine cylinders of small size, it would not be too much to allow in a turbine a heat flow loss of at least 25 per cent. This, of course, reduces the efficiency from 22 per cent. to 16·5. In arriving at this figure, I have assumed that no greater loss would be incurred from heat flow in the turbine than in the cylinder engine; but even with reduced temperatures when striking the turbine, the very fact of requiring a reservoir for combustion to operate, and the forcing of the whole of the hot products through a relatively small nozzle, necessarily means greater loss than I have assumed. Assuming, however, no more loss than I have given, an engine with an efficiency of only 16½ per cent. of the total heat given to it could not compete with internal-combustion motors of existing construction. It may be said that the advantage of continuous rotation is so great that even at this low efficiency the gas-turbine would be successful. Personally, I doubt it very much, because the mechanical difficulties with gas-turbines would be much greater than the mechanical difficulties of the steam-turbine. In all steam-turbines, as you, I am sure, know, it is necessary to work with relatively small clearances between the tips of the blades or shrouding and the enclosing casing. This is also true as to endwise clearance between fixed and moving blades. Comparatively small clearances are necessary for economy. The use of even temperatures so high as 400deg. C. or 500deg. C., by introducing unequal expansions, greatly increase the difficulty of obtaining economy. No doubt if a plentiful supply of relatively tow-temperature gases under considerable pressures could be obtained, these gases might with advantage be expanded in a nozzle, and used to operate a turbine. To carry this idea into effect has already been attempted, as I have said, by Mr. Lanchester, and there is some hope of operating in this way. I fear, however, that the temperature of the gases in the exhaust in the gas-engine are too high as they stand to be so used. Gases, however, from an exhaust or air supercompression engine, such as I have lately been working with, could no doubt give considerable efficiencies in turbines. I do not see, however, any solution of the gas-turbine problem here, because the amount of energy available for the turbine after the gases leave the gas-engine is too small for consideration in connection with any really high-power machines.

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Some of the difficulties I have discussed with you have been mentioned by Dr. Lucke. He adopts the view that jet expansion is not as efficient as piston expansion, and here I agree with him. No doubt the type of jet expansion has to be carefully considered, and the efficiency of a jet as a means of converting the expansion from a high pressure to a low into kinetic energy depends entirely upon its configuration, and the design of the proper areas and relative lengths for the nozzle. All this, however, is as yet a relatively new field, and much study will be required before any certainty can be attained in the design of expanding jets. Prof. Reeves, in another able article which I have already mentioned, differs from Dr. Lucke, and considers that he has overstated the difficulties of the expanding jet. He accordingly takes a more favourable view of the turbine problem. There is a great deal of truth, however, in what Dr. Lucke has said. Even the best expanding jets yet known appear to have a low efficiency, and nothing is known of the efficiency of expansion starting from flame temperatures. Apart from the mechanical efficiency of the expansion, as I have already pointed out, the heat loss due to conductivity will be great in such nozzles.

I quite agree with Prof. Reeve, however, that the more hopeful line for the gas-turbine lies in the use of steam to provide the working fluid under compression without a compressor, and in the heating of this steam when produced by a very small quantity of combustible mixture of gas and air under pressure. Such a turbine would be a compromise between what I may call the flame-turbine and the steam-turbine, and it presents more possibilities; but its efficiency would not be high, although no doubt such a machine could be got to operate mechanically with fair success. This line of work depends upon the fact that negative work may be greatly reduced by using steam as working fluid, when steam is heated highly by internal combustion of a relatively small amount of inflammable gas and air. This proposal is more hopeful, but for success, even, it requires temperatures, in my view, too great for existing turbines to stand with economy. This proposal may be considered to be analogous to that of an excessive superheat, as used in an existing steam-turbine. Many methods have been discussed which depend upon the use of regenerators. I have a great distrust of regenerators, so far as engine work is concerned. Many able men have proposed regenerative contrivances from the time of Stirling, in 1817, down to the present day, but I am not aware of any actual working engine which has ever succeeded in practice using a regenerator.

From what I have said, you will see that my view of the future of the gas-turbine is not favourable; but, notwithstanding, the subject is so fascinating that many inventors and scientific men will doubtless continue to investigate the problem, and possibly new solutions may be discovered which are not dreamt of to-day. I am the last man in the world to deprecate daring in any practical and scientific work, but I would advise the junior engineers—members of our institution—to avoid the subject except as a scientific study. I fear there is little hope for a young man to make a position and a business success of any internal-combustion turbine, so far as our present knowledge carries us.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.*

BY JOHN GAVEY, C.B., PRESIDENT.

In tendering my thanks for the high honour you have conferred on me, may I say that I fully recognise that I have been selected as a representative of the great body of telegraph engineers, the original founders of this Institution, as well, perhaps, as a representative for the time being of the new and growing telephone industry, rather than because of any merits of my own? Under the circumstances, and in view of the fact that these industries have not been reviewed recently, I propose with your permission to attempt that task in my address.

One of the penalties attached to advancing age, whether of individuals or of institutions, is the periodical loss of old friends or co-workers in the field in which we are labourers. Last year the President had to announce the loss by death of Major-General Webber. This year it is with deep regret that I have to refer to the death of Mr. W. E Langdon, one of our earliest members, for some time secretary and late president of the Institution. It was my good fortune to be closely associated with him from the early sixties, and I need scarcely say to those so well acquainted with his work as the members of this Institution are, that in his death we have lost one of the very able, energetic, and upright of our colleagues. Another well-known figure in the telegraphic world has also passed away in the person of the late Mr. Gerhardi, a gentleman closely associated with cable enterprise, he having formed one of the group of pioneers connected with the 1856 Atlantic cable, and later having been for a long period the general manager of the Direct Spanish Cable Company.

Before I commence the main subject of my address I may, perhaps, refer to one of two questions in which the Institution is largely interested, and in which its members are taking an active part. Dealing first with the Engineering Standards Committee, and more especially with the important work entrusted to the committee on electrical plant, the latter has appointed sub-committees to consider the following subjects: (1) generators and motors; (2) transformers; (3) prime movers for electrical purposes; (4) physical standards; (5) telegraphs and telephones; (6) cables; (7) electrical tramways; (8) electrical nomenclature: (9) electric automobiles; (10) electrical plant accessories; (11) publications and calculations. Some of these committees have reported, and all the work is well in hand, but it necessarily in many cases can only progress slowly if it is to be of a permanent character. It is difficult to overestimate the advantages, both to the profession and to the public, that will ultimately result from the labours of these committees. Again, in reference to the proposals made at the electrical congress held in St. Louis last year, to the effect that the revision of the existing electrical standards should be undertaken, and that an endeavour should be made to arrive at an international agreement on the subject of the standardisation of electrical nomenclature and rating of machinery, you will be glad to hear that the preliminary steps have been taken to carry out the views of the congress, and it is to be hoped that satisfactory conclusions will ultimately be arrived at.

The art of telegraphy considered in its broadest sense as a means of conveying intelligence over distances beyond the reach of the human voice may be classed under three different heads: (1) the communication of a limited number of definite orders or items of information by certain prearranged arbitrary signals. Under this heading may be included railway signalling, lighthouse signals, fire-alarms, and other kindred uses. (2) Communication of all classes of information by means of alphabets, either arbitrary or those in common use, including semaphore and flag signalling, Morse and other signals, printing and writing telegraphs. (3) Communication by actual exchange of speech, the telephone.

Telegraphs for Special Requirements.

Under this heading, one of the most important of the applications of telegraphy is that of directing and controlling the movements of trains on railways. For this purpose a modification of the old semaphore telegraph was introduced in the early railway days, mainly for the protection of traffic at stations and crossings. The range over which a mechanical semaphore can be worked is about 1,000 yards as a maximum, and the introduction of electricity for the working of telegraphs was soon followed by the invention of electrical miniature signals or indicators, placed in railway cabins, from which the outdoor manual signals were worked in accord with the indications recorded electrically. By this means the range of the signals was extended so as to cover the whole length of a section, and this led to the practical introduction of the block system of working traffic. Successive improvements in the electrical apparatus have been introduced—for example, on single lines this apparatus is now associated with the train staff

* Delivered at the meeting of the Institution last night.

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or tablet, without which no driver is allowed to enter a section of line, and as a second staff or tablet can only be withdrawn at the far end when the first train has arrived, the possibility of two trains meeting on a section is obviated. Repeaters of various types which show the position of points, the indication of signals, the presence or absence of trains in defined localities, and other information, keep the signalman advised of all the facts with which he should be acquainted, and it is not too much to say that the safety and regularity with which the heavy railway traffic in this country is conducted is largely due to the work of the electrical engineer. Lately definite advances have been made in two directions in this field of applied electricity. In the first, complete electrical systems of actuating points and signals have been introduced, the apparatus providing interlocking gear and indicators which give the signalman positive information as to the position of every point and signal; the working being easy, rapid, and apparently reliable in so far that every eventuality and cause of trouble appears to have been foreseen and provided against. This method admits of working points and signals at distances far in excess of the manual system, such distances, in fact, only being limited by considerations of safety and convenience, and the heavy and cumbersome lines of levers that under old methods could in many cases only be worked by the full exertions of the signalman's strength can now be replaced by miniature levers, which only need intelligence to work them.

In another direction automatic methods have been designed for working outdoor signals directly by the action of the train itself, its entry, continuance in, and exit from a section being faithfully followed by the appropriate movements of the semaphores. In one system sets of batteries consisting of a few cells are connected across the running rails in each section, and in all sections that are clear the corresponding batteries actuate relays which, either through the agency of compressed air or by means of electromotors, move and retain the semaphores at "line clear." The entry of a train into a section short-circuits the local battery, the relay tongue is withdrawn by its retractile spring, and the signals are automatically placed at danger.

In a recent journey across the American continent, where hundreds of miles of desert are traversed by single lines of railway, with numerous sidings for the crossings of trains, I watched with great interest the perfect and regular working of the signals without the direct intervention of human agency. Each section was, of course, guarded by two signals, one for the up and one for the down traffic. As the train left one section for another, the signal guarding the former moved from danger to clear, whilst that guarding the latter moved from clear to danger. This method, of course, involves the necessity for bonding the rails throughout, although others have been designed which are actuated through special conductors. Automatic signals appear to meet a definite want on certain classes of railway, although, no doubt, the day is far distant when the trained signalman will be dispensed with at complicated junctions and stations. It is not too much, however, to say that without the various methods of electrical control that have been devised and which are in general use, it would be utterly impossible for the great railways of the world to carry one-half the traffic they are now dealing with daily with safety and dispatch. In this branch of electrical work steady progress is being made, and, apart from the question of haulage, the extension of the methods of electrical control will probably be considerable in the immediate future.

Fire-alarm signals have within the last few years assumed a position of considerable importance, owing to the growth of great cities, the increasing height of commercial buildings, and the large quantities of combustible material necessarily stored in the great centres of population. Starting from a simple alarum which was merely the old fire-bell worked electrically, complete systems of fire alarms and indicators have been devised, which, when actuated from any given point, give the appropriate signals at all the fire stations concerned, and admit of a rapid concentration of the necessary fire plant at any given spot in an incredibly short space of time. America has been in the past, and probably still is, in the forefront in the matter of fire-alarm appliances, and in my recent visit to that country I witnessed one example of the alacrity with which fire-engines can be called to any given spot. We had been visiting a number of telephone exchanges in New York and neighbourhood, and were motoring down on the long avenues on Manhattan Island. As we passed one shop, I noticed that some children leaning out of a first-floor window had just set fire to the canvas sun blind, which was burning over an area of half a square yard, so that it had only just been set alight. Before we had got out of sight of the burning blind we were passed by a steam fire-engine, a fire-escape, and a hose reel.

For the purpose of transmitting defined but limited items of information for special instructions or for making demands, innumerable electrical appliances have been designed, but there is a general tendency to replace such apparatus by telephones which simply extend the range of speed the natural method of intercommunication to any distance, and which render these subsidiary aids unnecessary.

(To be continued.)

HULL TELEPHONES.

Political papers always assert that little notice should be given to isolated by-elections, but when a succession of by-elections result in a given direction attention has to be and is given to the trend. Something similar goes on with regard to municipal telephones. An interested reader taking up a particular paper, or, for the matter of that, almost any paper at random, will be sure to find, if the plain figures of a balance-sheet show a profit, that profit attributed to bad book-keeping, bad finance, too lenient a looking at or writing down depreciation, or too little put aside as a stand-by—every reason, in fact, to demonstrate the dishonesty of municipal finance. It does not matter whether the figures deal with Glasgow, Guernsey, Brighton, Portsmouth, or any other town, they are all wrong. Now the half-year's figures *re* Hull are available, and, as in every other case, these figures to the ordinary mind spell success, and we maintain prove success. We are interested to hear what particular sins are laid on the Hull Corporation and their consulting engineer in this case. Here are the figures:

Revenue Account for Half-Year ended Sept. 30, 1905.

Dr. Expenditure.	£	s	d.
To exchange repairs and maintenance	2	0	9
Overhead ditto	51	7	10
Instruments ditto	114	18	10
Roof repairs	18	16	7
Charges	194	16	4
Salaries and wages of office and operators	748	10	10
Wayleaves	7	5	0
Printing and stationery	63	7	3
Rent, rates, and taxes	213	18	11
Petty expenses	25	0	0
Royalty	306	19	0
	1,747	1	4
Balance	1,422	11	7
	3,169	12	11
Interest on loan, less B/E	568	12	7
Sinking fund instalment (proportion for half-year)	554	11	8
	1,123	4	3
Net balance	299	7	4
	£1,422	11	7

Cr. Income.	£	s.	d.
Exchange rentals	2,920	17	1
Private line rental	101	17	6
Terminal fees	0	4	0
Public telephones	44	13	6
Local tolls	76	16	11
Trunk fees, etc.	25	3	11
	3,169	12	11
Surplus	£1,422	11	7
	£1,422	11	7

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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LOCAL GOVERNMENT BOARD LOANS.

Last week we dealt somewhat briefly with the methods of the Local Government Board in granting or refusing loans for electric lighting. This week we have carried the matter farther, and given a series of facts which justify, we think, the opinions expressed below. As these opinions reflect somewhat seriously on the Local Government Board procedure, we wish to express at once our high appreciation of the good work the Board has done through its inspectors in preventing municipalities from juggling with their accounts. The firmly enforced rule that new loans must not be used to replace defective machinery on which there is still capital outstanding is to be highly commended. We also wish it to be clearly understood that while we in this article and elsewhere in this issue comment strongly on the methods of Mr. Ross Hooper, we do so in no personal spirit, looking upon him as the mouthpiece of the Local Government Board. Coming to our subject, under the Electric Lighting Acts Parliament reserves the right to grant or refuse electric lighting orders. Having granted powers to a local authority, it rests with the elected representatives of the ratepayers to decide how much money shall be expended for electric light and power distribution purposes. The ratepayers back their representatives' actions by being responsible for any deficits which may arise. The November elections then become the effective means of checking extravagant expenditure and defective management. So far all is clear, but lately the Local Government Board, which sanctions the loans, have conducted their inquiries in such a way as to show a disregard both of the parliamentary obligations of the undertakers and of the expressed wishes of the ratepayers. The case of Rochdale emphasises this point. In the first few years the undertaking was not able to meet all its capital charges, and from time to time the ratepayers have been called upon to pay in all five thousand pounds to clear off annual deficits. The Corporation, composed of business men, were convinced that the undertaking was a sound one, and asked for some forty-two thousand pounds for extensions. The ratepayers, in spite of the deficits they had had to bear, so far agreed that not one of them opposed the loan. It remained for the Local Government Board inspector only to throw doubt on the soundness of the undertaking. He delayed the granting of the loan in consequence for a considerable and inconvenient period of time. In other places he has lectured local authorities on extravagant expenditure. A *résumé* of the early days of municipal lighting should convince him that then the great fault was in the opposite direction. The councillors of the various towns were so timid that the consulting engineers were forced to lay down small plants, which in a few years became quite useless when dealing with the load. We could give the names of a dozen towns offhand where practically every item of generating plant first installed is now either displaced or not used, due to its small size. When replacing such plant a considerable loss has had to be borne by the ratepayers. Councillors have gradually been convinced that electric supply undertakings are sound, and that extensions must be made on a reasonably large scale. The action of the Local Government Board in this respect is well illustrated at Torquay. The case is an exceptional one, and the result of the last inquiry is not yet to hand. If the loan is granted, we shall be much interested to see for what period. Thus the Board have refused a loan which would enable the Corporation to build an economical station to replace the existing one. They are now considering a proposed loan of nine thousand five hundred pounds for tinkering with a station

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which we condemned on the day it was opened seven years ago. Mr. E. Manville, in his evidence at the last inquiry, said that when the work was completed the station might serve to supply the lighting, power, and tramway load for three years. If the Corporation extended their mains as they should do (not one-half of the streets have now mains in them), we are sure that it would not serve so long. Still, assuming that for nine thousand five hundred pounds the present station can be made to serve for three years more, what will happen then? The new station on a site where water and coal can be easily obtained must then be constructed. Having done this, it would be obviously absurd to work both stations, and we are sure that the good plant in the old works will be removed to the new. In so doing, the whole cost of the proposed structural alterations, the foundations, the induced-draught plant, the pipe and other connections, and the general erection charges become valueless. We believe that the loss incurred by the removal will be more than a third of the proposed expenditure. The special depreciation, therefore, due to the cheeseparing policy of the Local Government Board will involve the Corporation in a loss of at least one thousand pounds a year for the next three years. We are amazed at the proposal being even considered by an engineer of Mr. Hooper's standing. One more point, and then we are finished. A regular query has been put to municipal authorities at these inquiries recently: "Why have you not considered the taking of a supply in bulk from the local power company?" We would ask the Local Government Board, "Why have you not considered the most unsatisfactory position of these power companies?" Only one—*i.e.*, that at Newcastle—has paid a dividend, and while the others are, many of them, only starting, it must be remembered that so far they have been financed by manufacturing firms who look to their profit from the supply of machinery. Power distribution over large areas for power purposes will, we think, be eventually successful in the manufacturing districts of this country in spite of these methods of promotion and, what is more important, in spite of the cheapness of coal in this country. Power distribution in districts where lighting only is needed will never be successful in our opinion, due to the low power factor of the demand and the high cost of the underground mains to meet the maximum demand. In concluding, we would remind the Local Government Board of a fact which company advocates always slur over—*i.e.*, that cheapness of municipal supply needs to be considered as well as the balance-sheets. It is the correct policy for a municipality to so reduce its charges that it does not make that profit the absence of which the Local Government Board deplores.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL ELECTRICITY.

SIR,—Referring to the report under the above heading of the action of Mulholland *ats.* the Hammersmith Borough Council in your issue of the 27th ult., may I, as solicitor for the defendant, point out that the necessity for reduction "by mutual agreement" arose from the fact that there had been a deliberate overcharge by the Corporation, in that they undertook to supply continuous current and alternating current at a uniform rate, and then, notwithstanding this, charged, not for the continuous current that the motor-generator or transformer supplied, but for the alternating current that worked it, and this they endeavoured to continue even after the fact was brought to their knowledge. The result of the county court proceedings was to vindicate to the full my client's contentions, and to expose the systematic overcharge deliberately made, the amount claimed being reduced by the further amount my client had throughout stated he was entitled to have taken off—viz, £16. 3s. 8d. This left a judgment in the plaintiffs' favour of an admitted amount of £36. 13s. 7d., with costs. After setting up against the ratepayer every defence that the ingenuity of counsel could invent, the plaintiffs withdrew their judgment, the costs of claim and counterclaim being set off the one against the other.—Yours, etc.,

J. MOVERLEY SHARP.

London, W., Nov. 4, 1905.

ENTERTAINMENT OF KINDRED INSTITUTIONS BY THE INSTITUTION OF ELECTRICAL ENGINEERS.

SIR,—I shall be deeply indebted to you if you can find space for a short notice of the plans of the Council of the Institution of Electrical Engineers for 1906 in the next issue of your valuable journal, and I send you the following notes for you to deal with in any way you think fit.

Arrangements have been set on foot by the Council of the Institution of Electrical Engineers to entertain next year the kindred institutions in Europe and America, who, as it will always be remembered, have shown such lavish hospitality to the members during their visits abroad. Official invitations to visit Great Britain as guests of the Institution have been sent to the American Institute of Electrical Engineers, the Canadian Electrical Association, the Associazione Elettrotecnica Italiana, the Elektrotechnischer Verein, the Verband Deutscher Elektrotechniker, the Schweizerischer Elektrotechnischer Verein, and the Société Internationale des Electriciens.

The date for the arrival of the foreign guests has been fixed for the last week in June, 1906, and the visit will probably extend over about a fortnight. The programme exists, of course, in outline only as yet, but the present idea is to spend about one week in London, which will give an opportunity to the guests to see the new electrical developments and to make excursions in the neighbourhood. It is then proposed to make a tour through some of the principal industrial centres in the United Kingdom to visit works and provide local entertainments for the visitors.—Yours, etc.,

G. C. LLOYD, Secretary.

ELECTRIC LIGHTING ACTS, 1882 AND 1888.

SIR,—I am directed by the Board of Trade to state that their attention has been called to the large number of instances in which they have in recent years found it necessary to revoke provisional orders which have been obtained by local authorities under the Electric Lighting Acts, or in which local authorities having obtained provisional orders have entered into agreements with companies for carrying the order into effect, these agreements being in many cases *ultra vires*, or, at least, of doubtful validity.

It appears to the Board that it is undesirable that a local authority should apply for a provisional order without having a definite intention of exercising the powers under the order when obtained, and in future the Board will not be prepared to grant an order to a local authority unless they are satisfied that the powers will be exercised either by the local authority themselves or in exceptional cases by a company (to be named in the order) where special power is taken to transfer to the company with a limited period.

I am at the same time to state that the Board have observed that there is a growing practice for individuals or unregistered companies or firms to apply for provisional orders under the Electric Lighting Acts. In such cases the Board, having in view the undesirability of individuals or unregistered bodies exercising statutory powers involving the breaking up of streets, have inserted in the order, as granted, a provision that the powers under the order shall not be exercised unless within a fixed period they are transferred to a registered company approved by the Board. In the majority of cases the company is named in the order.

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This procedure has proved to be unsatisfactory and inconvenient. In some cases the orders have lapsed by reason of the grantees being unable to form a company with a capital sufficient for the purposes of the undertaking, and in others the submission to the Board of the proposal to transfer has been postponed to so late a date as to leave insufficient time for the due consideration of the matter.

In these circumstances the Board have decided that in regard to any future application of this nature, they will require that the proposal to transfer shall be submitted to the Board not less than three months before the expiration of the period fixed by the order for the completion of the transfer.—Yours, etc, T. H. W. PELHAM.

MILAN INTERNATIONAL EXHIBITION, 1906.

SIR,—I have been asked, as chairman of the electrical section, to invite attention to the special opportunities offered to all those interested in electrical matters in this country by the above exhibition, and hope that you will personally interest yourself therein with a view to ensuring that a representative show of the varied products of British electrical industries worthy of their growing manufacturing importance and international standing may be made thereat.

The British Government has shown a practical interest in the exhibition by a grant of £10,000 towards the cost of the formation of a British section, and have approved the appointment of a British Commission.

The participation of leading firms in all the general lines of British manufacture is assured, and it is hoped that the electrical industries will be adequately represented. The King of Italy has given £4,000 in prizes, to be awarded by the international jury in the various sections of the exhibition, of which a prize of £200 is to be given for the best method of detecting high-voltage currents without danger to the operator.

The comprehensive character of the electrical divisions of the exhibition will be gathered from the enclosed details relating to the section for land transportation (electric traction, telegraphs, and telegraphs), and that of manufacturing and decorative arts (lighting and heating). The inducements to exhibit are evidently as great as the Italian authorities are able to make them, and, in addition, the greatest of all inducements will be the fact that the present is the first international exhibition ever held in Italy.—Yours, etc, (Signed) CHARLES P. SPARKS,

Chairman of the Electrical Trade Section.

P.S.—Detailed information regarding the exhibition may be obtained on application at the offices of the British Commission at Oxford-court, Cannon-street, E C.

IMPERIAL NOTES.

NEW ZEALAND.

In the course of a previous note under the above heading we referred to the legislation whereby the New Zealand Government reserved unto themselves all water power in the country, thus causing many private schemes to be dropped. From information now to hand, it appears the Government are at last making a start to utilise this water power for electrical transmission. It is not intended, then, to pursue a dog-in-the manger policy. In the public works statement of Sept. 8 last provision is made for a vote of £53,000 for the purpose in question. The total amount of water power available in New Zealand may be put down at 550,000 h.p. in the North Island and 3,450,000 h p. in the South Island, or, in round figures, 4,000,000 h.p.—estimated as brake horse-power at the turbine shaft—for the whole country, but these figures are by no means exhaustive or final. It will be gathered from the accompanying table that the £53,000 in question represents but an insignificant proportion of the total contemplated expenditure, which is £3 640,000, and provides for the utilisation of 150,000 b.h p. There are several schemes projected, varying considerably in magnitude, but the proposed initial outlay is evenly distributed between them except in the case of Opiki, the smallest of all, which would seem to be neglected for the moment.

Scheme.	Brake horse-power.	Estimated cost.	Proposed vote.
Huka	30,000	£1,000,000	£10,000
Hutt	12,000	340,000	10 000
Clarence	25 000	600,000	10,000
Opiki	10 000	250,000	—
Heviott	25,000	600,000	10,000
Hauroko	40,000	850,000	10,000
General	—	—	3,000
Total	150,000	£3 640,000	£53,000

Speaking generally, the greatest obstacle against water-power schemes in New Zealand is that the transmission lines will need to be very long, the water in most cases being a great distance from the large towns. In spite of this, it is the opinion of prominent engineers on the spot that several of the projected schemes will be profitable investments. The possibilities involved should certainly not be lost sight of by manufacturers at home, as the fruition of these schemes would mean placing some good initial orders for plant, and the supply of cheap energy which it is the object to render available for manufacturing and other purposes, would certainly stimulate developments not only in the existing large towns, but also along the transmission lines, thus bringing in train a large amount of new work.

TRANSVAAL.

Johannesburg—The Municipality's electricity supply and tramways undertaking is making steady progress towards completion we learn. It cannot be said, however, that a normal state of working has been reached yet. The present supply of electricity for lighting purposes is obtained partly from the Council's own station and partly in bulk from outside companies—viz., the Rand Central Electric Company and the Robinson Deep Gold Mining Company—the demand amounting to about 1,500 kw. The new station now under construction will be equipped with Oechelhauser engines worked by producer gas, and coupled to generators of 9,000 kw. aggregate output, the former being supplied by Messrs. W. Beardmore and Co., and the latter by Messrs. Siemens Bros. and Co. The inner area of the town will have a supply on the three-wire, direct-current system, with 460 volts between the outers, while the outlying suburbs will be supplied with alternating current from a two-phase system. The voltage on the primary side will be 3,000 per phase and the frequency 50. The secondary voltage will be 400 between the two outers of a three-wire system, and in most places only one phase will be available. Power will be supplied from the same station for working the tramways, which comprise 52 miles of track. The first instalment of this system is expected to be ready at the end of the present year. Provision is made for 100 cars, and the whole scheme represents a total capital expenditure of about £1,500,000. Mr. J. F. I. Thomas is the general manager of the Johannesburg electricity supply and tramways undertaking, Messrs. Mordey and Dawbarn being the consulting engineers. It may be added that the town has a population (white and coloured) of 160,000 and a municipal area of about 80 square miles.

CANADA.

Algoma—The Algoma Power Company, Limited, are utilising a water power on the Michipicoten River in the district of Algoma, Ontario, being situated seven miles from the mouth of that river, where it enters Lake Superior, on the north shore. The development is under a head of 128ft., and the first installation of plant will consist of two units of 2,100 i.h p. each. It is not expected that this installation will be completed before about next spring, when a resident engineer will have to be appointed. As further developments of the undertaking are probable, the lot of the successful applicant for this post should be a happy one. The headquarters of the company are at Berlin, Ontario.

Wiarton.—A project is on foot to supplement the supply of electricity at Wiarton, Ontario, Canada, from a source of water power some eight miles distant. The existing electricity works contain alternating-current generating plant of 100-kw. capacity and 25 kw. in direct-current arc-

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lighting machinery. Instead of extending this plant, it is proposed to develop the outlying source in question, where some 500 h.p. is available for utilisation. This is another example, if but a minor one, of the attention which is now being given in Canada to the development of the water power in which the country is so rich. Three-phase transmission seems to be the ruling practice in connection with all these schemes. It may be added that Mr. Robert Millar is the resident engineer at Wiarton.

THREE-PHASE INDUCTION MOTORS ON SINGLE-PHASE MAINS.

It has long been known that three-phase induction motors can be run off single-phase mains under more or less normal three-phase conditions by means of split phase arrangements involving the use of condensers and choking coils. Tests taken under such conditions have seldom been published, owing to the comparative uselessness of the arrangement so long as reliable cheap condensers were unobtainable. Of recent years, however, the manufacture of condensers has improved considerably, and a certain amount of interest, therefore, attaches to some tests recently made in the above direction by J. Dalemont (*Elektrotechnische Zeitschrift*, Nov. 2, 1905).

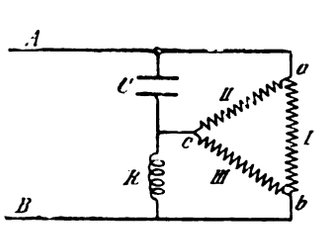

FIG. 1.

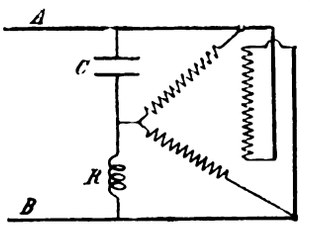

FIG. 2.

The motor tested was a standard three-phase 1-h.p. one running at 1,500 r.p.m., and arranged for either 120 volts star-coupled or 69·5 volts mesh coupled, the latter arrangement being used during the tests. Three sets of tests were made: (1) as an ordinary three-phase motor with three-phase supply; (2) as a single-phase motor in combination with a condenser, C, and a choking coil, R, as shown in Fig. 1; and (3) as a single-phase motor in combination with a condenser, C, and a choking coil, R, and with one phase of the stator winding reversed, as shown in Fig. 2.

With the arrangement shown in Fig. 1 the voltages in the different stator phases bear a 60deg. phase relation to

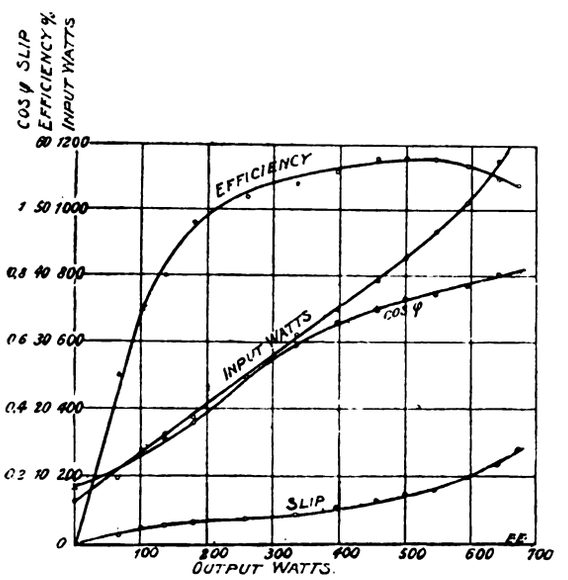

FIG. 3.

one another, whilst with the Fig. 2 connection the proper three-phase relation of 120deg. is obtained, and correspondingly better results. The results obtained on the three tests are shown by the curves of Figs. 3, 4, and 5 respectively. A complete table of results is given with each curve, and from these the following particulars for a load equal to about half normal load (the highest reached in the case of arrangement 2, Fig. 1) are abstracted.

The only condensers and choking coils available for the above tests were high-voltage ones, and so were connected through transformers instead of direct.

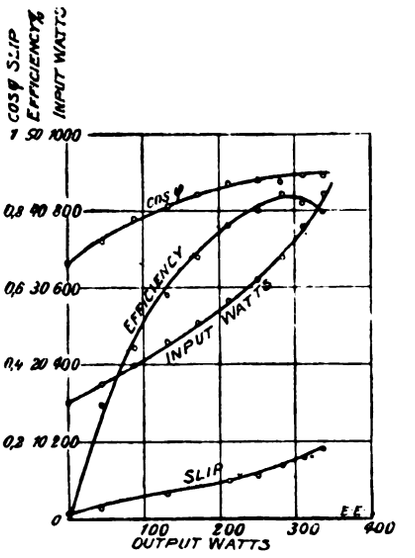

FIG. 4.

	Test as three-phase motor.	Test as single-phase motor connected as in Fig. 1.	Test as single-phase motor connected as in Fig. 2.
Output watts	336·6	339 5	326·5
Input watts	622	842	610
Speed (revolutions per minute)	1.4208	1,265	1 390
Efficiency	54 2%	40 3%	53·6%
Power factor	·59	·896	·87
Slip	·085	·189	·1
Current per phase	7 8	—	—
Total line current	13 5	11 75	9·95
Current in Phase I.	7 8	20·2	—
,, Phase II.	7 8	10 35	—
,, Phase III.	7 8	4 55	—
,, condenser	—	3 87	2·2
,, choking coil	—	·24	·1
Terminal volts	70	80	70
Volts over Phase I.	70	80	70
,, Phase II.	70	62	67·8
,, Phase III.	70	69·2	66·7

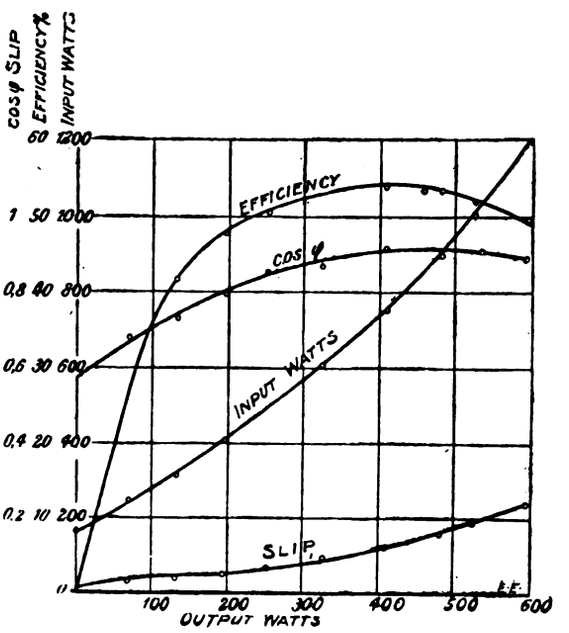

FIG. 5.

From the last series of curves (Fig. 5) it will be seen that very satisfactory results, especially as regards power factor, can be obtained when running a three-phase motor off a single-phase supply in this way. By varying the condenser capacity and the inductance of the choking coil, the torque

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at a given speed can be controlled as well as the starting torque of the motor, as has been pointed out by Steinmetz.

ELECTRIC FURNACES.*

BY J. H. STANSBIE, B.SC., F.I.C.

The main object of this paper is to introduce to you some simple forms of electric furnaces which can be readily fitted up for experimental purposes. The literature of the subject is rapidly becoming voluminous, especially that which refers to the specifications of patents. Every known principle seems to have been appropriated in the hope that something useful may be covered, but in spite of its many successes the application of the electric furnace for industrial purposes is still in its infancy, and there is much hope for its future.

Electric energy may be converted into heat in a variety of ways, and the chief of these have been utilised for electric furnace work. Electric furnaces may be divided into two main classes: (*a*) Electro-thermic, in which the heat equivalent only of the electric energy passing into the furnace is utilised for producing physical, chemical, and metallurgical changes; and (*b*) electrolytic, in which part of the energy of the current is used up directly in effecting chemical changes, and the remainder for heating effects. The first class only will be dealt with in this paper.

There is only one direct way of converting electric energy into heat, and that is by putting material resistance into the path of the current which is carrying it. This resistance may be furnished by either a solid, a liquid, or a gas. If the resistance is offered by solid or liquid matter the apparatus is known as a resistance furnace, but if by gaseous matter it is an arc furnace. A large number of furnaces, both experimental and industrial, arrange themselves under these heads, and there are several sub-divisions according to the particular way in which the principles are applied. In the majority of these furnaces the resistance is in the path of the primary current. There is, however, a resistance furnace in use which does not appear to have passed through the laboratory stage, but to have been developed at once for industrial purposes. It is based upon the transformer principle, and consists of a cored coil for carrying light alternating currents of high potential surrounded by an annular space or hearth lined with refractory material in which a continuous circuit of the metal under treatment carries the heavy induced currents of low potential, and offers the resistance necessary to develop sufficient heat for its fusion. Its best known form is the Kjellin furnace, although others claim to have introduced important modifications. Kjellin uses currents of 80 to 90 amperes at a pressure of 3,000 volts in the primary, and 30,000 amperes at seven volts in the ring of metal in the hearth, which has a capacity of 35cwt. of steel. Furnaces of this type having a capacity of a few pounds should prove very valuable for the preparation of pure metals.

In resistance furnaces generally the resistance is either in or out of contact with the material to be heated, or the material itself offers the resistance. Also, either direct or alternating currents may be used, the most economical being heavy currents of low pressure. Hence it is necessary to use transformers with alternating currents brought from a distant power station. The terminals by which the current is led into and out of the furnace are almost invariably carbon rods or blocks, although water-cooled metal electrodes have been used. In some furnaces a combination of arc and liquid or solid resistance is found most useful, and in this case the pressure must not be too low.

At present the ideal source of the mechanical energy for dynamos and alternators is water power, and where this can be obtained the electric furnace flourishes. The enormous loss of energy taking place between the stoker's shovel and the flywheel of an engine puts the direct combustion of solid fuel out of court, but the use of gaseous fuel direct, especially of the waste gas from blast furnaces, will much improve the chances of electro-thermic processes being made successful generally. It is estimated that about 500,000 h.p. developed from falling water is being used in electric furnaces for the production of aluminium, carborundum, calcium carbide, graphite, iron, steel, ferro-alloys, etc. The Acheson furnace for carborundum, the Heroult furnace for steelmaking, the Stassan furnace for ore reduction, and the Keller furnaces may be mentioned as being in use in

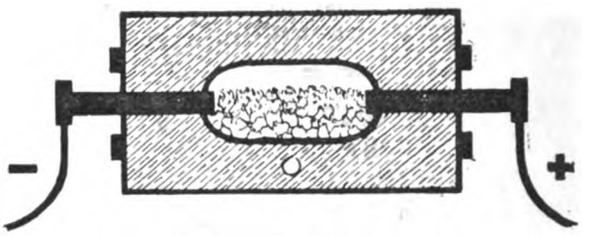

FIG. 1.

successful industrial processes, while the number of furnaces being used for the manufacture of calcium carbide is very large.

Experimental Furnaces.—A small resistance furnace for demonstrating the melting of metals is readily made by chipping the large face of a firebrick so as to form the cavity and two semicircular channels running from it to

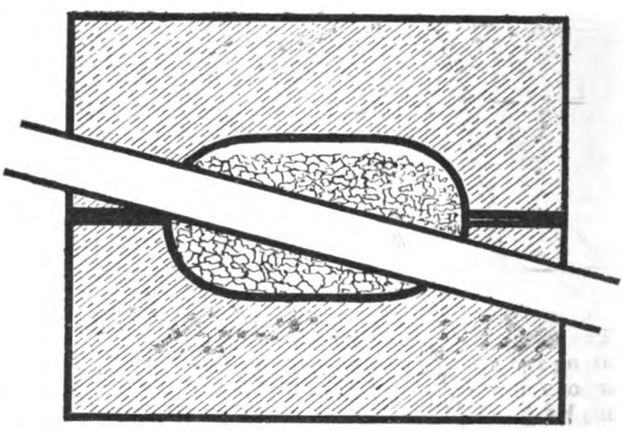

FIG. 2.

the ends of the brick. A second brick with a shallower cavity and similar channels serves for the top. The cavity forms the hearth of the furnace, and the channels allow of the introduction of two carbon rods which are fixed with their ends just projecting into the cavity. The metal is placed in the cavity, and covered with a layer of small pieces of carbon so arranged as to fill up the space between

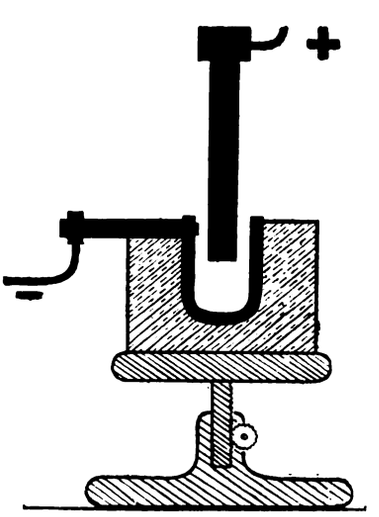

FIG. 3.

the carbon rods. (Arc carbons broken up serve the purpose very well.) The top is placed in position and the current switched on. The temperature rises rapidly, and a charge of cast iron is soon melted. This can be run from an inclined tap hole passing through the bottom of the cavity by plugging the upper end with a piece of the metal before

* Abstract of paper read before the Birmingham Electric Club on Nov. 4, 1905.

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charging. The metal plug melts last, and the whole charge runs from the furnace in a continuous stream. A vertical section of the furnace is shown in Fig. 1. A slight modification of this furnace enables it to be used with a carbon tube. For this purpose an inclined channel is made in the walls of the hearth at right angles to the length of the bricks to hold the tube, the ends of which project from the sides of the furnace. The cavity is filled with carbon fragments to surround the tube and connect the rods. On passing the current into furnace a rapid increase in temperature takes place, and substances to be experimented with can be readily introduced into the tube. Reductions and fusions are rapidly effected. The tubes are easily made by drilling pieces of arc carbon of requisite length. See Fig. 2, which shows the furnace in vertical transverse section.

A small arc furnace of the Siemens type is easily fitted up. A hole is drilled in the side of a carbon crucible, and a carbon rod fitted tightly into it. The crucible is placed in a cavity in a fireclay block, which also supports the carbon rod along part of its length. The block is placed on a small iron table having a vertical rack motion, and a carbon rod to act as the positive electrode is fixed vertically over the crucible. When the charge has been introduced and the current switched on, the arc is readily struck by raising and lowering the table. The operation can be regulated by the same means. Fig. 3 shows the furnace in vertical section.

A more durable form of the Moissan lime furnace can be made with strongly compressed magnesite bricks. Two of the bricks are chipped out on corresponding faces, so as to form the crucible cavity and the channels for the carbon

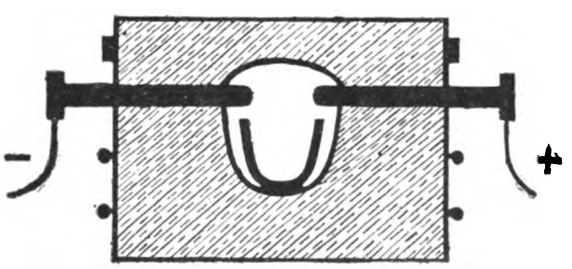

FIG. 4.

rods. They are then braced firmly together, and the top formed by a third brick, hollowed out a little to correspond to the cavity below. The electrodes are carbon rods, 1in diameter and 15in. long, having copper electro-deposited on part of their length to ensure good contact. The reactions are carried out in a shallow carbon crucible, and the majority of the fusion and reduction experiments requiring very high temperatures can be made in it. Chromium and molybdenum are readily reduced from their oxides. The current used in these furnaces varies from 100 to 200 amperes at a pressure of 110 volts in the mains.

A good idea of the interest taken in electric smelting by those who are in position to deal with the subject practically can be obtained from a review by M. Minet in the *Electro-Chemist and Metallurgist* for December, 1904. No less than 260 references, extending from Davy's work with the alkalies in 1808 to the present day, are given, and some 40 of these refer to calcium carbide alone. This shows that much attention is being given to reactions which take place at exceptionally high temperatures, and for the elucidation of which M. Moissan has done so much. One of the latest developments is that dealing with tantalum, the cheap production of which bids fair to mark an epoch in the history of incandescent lighting.

Electricity in Cotton Mills.—A Lancashire correspondent states that, following upon the starting of the electrically-driven Acme spinning mill at Pendlebury, near Manchester, and the announcement that the Kearsley Spinning Company's new mill at Prestolee, Farnworth, is to have electricity as the motive power, it is understood that another mill at Farnworth is arranging for a supply of electricity, and a mill to be built at Swinton is to be electrically worked.

EXPERIENCE ON THE ROAD: AN INCIDENT WITH WATER-COOLED TRANSFORMERS.*

BY G B ROSENBLATT.

Preconceived opinions in trouble work are a great hindrance in discovering true causes of difficulty. A case of rather unusual interest came to the writer's notice some while since. Three fair-sized water-cooled units connected in delta on a three-phase 14,000-volt system and supplying a lighting and small motor load were running hot. Their temperature had been steadily rising ever since their installation, until at the end of a year they showed a temperature rise of about 55deg. C. in the oil, even with an abundant supply of cold water flowing through the cooling coils. The maximum load possible could not tax the transformers more than 60 per cent. of their rated capacity, and there was no reason to believe that there were any cross currents between the transformers. Evidently the trouble lay inside the transformers.

Much has been said and written of late concerning deposits in transformer oil, and in some cases these deposits have caused considerable annoyance to transformer operators. Inasmuch as the transformers in question showed measured losses no larger than they were designed for, the conclusion was immediately reached that the cooling coils were not working properly. This conclusion was corroborated by the fact that the temperature of the water leaving the cooling coils was but little higher than that of the entering water. It was a fair presumption that the only thing which could affect the action of the cooling coils was a coating that would impair their conductivity. A deposit from the oil? Yes, of course. An inspection of the cooling coils showed them to be covered with a thin vaseline-like layer of about $\frac{1}{8}$in. in thickness—the sort of a deposit that may occur in any oil-insulated transformer without materially affecting its operation or temperature. However, it was decided that this was evidence that there was a deposit from the oil, and that while the coating on the cooling coils could not account entirely for the high temperature of the transformers, it undoubtedly helped and surely indicated a deposit in the ventilating ducts between the windings.

Accordingly, the feasibility of cleaning out the transformers was discussed, and an engineer was sent from the works to make an inspection and to superintend the cleaning operation. So imbued with the oil-deposit idea was everyone connected with the plant that the engineer from the works never doubted the cause of the trouble as stated, and that all there remained for him to do was to remove the cause. However, on removing some of the oil from one of the transformer tanks, he noticed the lightness of the deposit on the coils, and began at once to have his doubts. Nevertheless, he proceeded to have the oil removed from the tanks, if for no other reason than "to see what he could see." Meanwhile he took a walk about the plant and had a look at the general lay-out.

The transformers were installed in a separate house, containing, in addition to two banks of transformers, the lightning arresters and arc light regulators. The cooling water was obtained from an artesian well under the engine-room, and was pumped from the well through about 100ft. of iron pipe to the transformers. The iron pipe joined the brass tubing of the cooling coils about 2ft. from where the cooling coils entered the transformers, and the waste water from each transformer emptied into a concrete tail-race in the floor of the transformer house. The cooling water was quite cold, and had a queer but not unpleasant taste. Where it left the waste pipe from the transformers the concrete of the tail-race showed a reddish discoloration. A steel nut and an iron washer which had been in the race for some time were quite clearly outlined in red on the concrete. Probably there was iron in the water. Still, it might not be iron. At any rate, it was worth while looking into, particularly as there was nothing else to investigate until all the oil was removed from the transformers. So a section of the brass tubing at the joint between the cooling coils and the iron pipe was removed and the inside examined. Its entire inner wall was covered with a coating of a reddish-brown material, solid near the brass and softer and slimier towards the centre. The coating was about

* From the *Electric Club Journal* of Pittsburg.

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¼in. thick, which in the ¾in. tubing of which the cooling coils were formed, left about ¼in. clear for the water—just enough to pass a lead pencil. That was why the transformers ran hot.

Now that it was evident that it was not the fault of the oil, the problem presented itself of how to clean the inside of the cooling coils. The deposit was clearly not soluble in water, or it would not have remained. The highest pressure that was available at the power-house failed to remove any particle of it. Various solvents were tried—salt, ammonia, vinegar—but nothing weaker than 50 per cent. hydrochloric acid seemed to attack the deposit. However, the hydrochloric acid attacked the brass. It was evident that if the tubes were to be cleaned without removing them from the transformers (which on account of the arrangement of the high-tension wiring would have been a most arduous undertaking), muriatic acid would have to be used and the job done with the utmost dispatch to prevent the brass being injured. Several gallons of the acid were obtained, mixed with water and poured into the tubes, the coils being filled from the bottom up to prevent water traps. From the sound of the disturbances, violent ebullitions must have taken place. When, after five minutes, the tubes were flushed by turning on the cooling water, the deposit came out in chunks. Such sections of the tubing that could be inspected seemed to have been thoroughly cleansed. The transformers were refilled with oil, and upon being tested under full load showed a perfectly normal temperature, the oil not rising over 35deg. C. The explanation given by the chemist who was consulted was that the artesian well water was acidulated and attacked the iron in the pipe from the well to the transformers, forming a salt of iron which was thrown down in the cooling coils by the heat of the oil. Had the cooling coils been of iron there would have been no such action, but they would have been slowly eaten away by the water.

One interesting feature of this case was the method of obtaining a full load on the transformers for the temperature run made after the cooling coils had been cleaned. As stated above, the maximum load available was about two-thirds of the rated capacity of the transformers. It was, therefore, necessary to find some means of energy consumption outside of the load. There were in the station two banks of transformers of like capacity, one bank which was running hot and another bank with which no trouble had been experienced. The troublesome bank was fed from a water-power plant some eight miles distant, the other from another water-power plant 18 miles away. To obtain full load, the low-tension sides of the two banks of transformers were thrown together and the water-wheels at the plant supplying the bank which was operating satisfactorily slowed down until they drew power enough through the transformers to constitute a full load.

ECCLES ELECTRICITY ACCOUNTS.

From the accounts of the Eccles electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounts to £32,688. Abstracts of the revenue account and balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	1,260	13	9
Distribution of electricity	264	15	9
Attending and repairs to public lamps	72	7	0
Rents, rates, and taxes	98	10	8
Salaries of engineer and clerk (proportion of)	254	16	0
Establishment charges	59	0	6
Insurances	26	16	3
Interest and repayment of loans	1,874	6	5
Interest and commission charged by treasurer	23	1	3
	£3,934	7	7

Cr. Income.	£	s.	d.
By sale of electrical energy for private lighting	2,443	16	5
Public lighting	766	16	6
Meter rents	93	12	8
Sale of cinders	6	0	0
Fittings and repairs on consumers' premises	150	5	9
Balance, being deficit on revenue account	473	16	3
	£3,934	7	7

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount borrowed less repaid	29,521	5	3
Sundry creditors	220	2	0
Balance due to treasurer	1,418	2	1
Sinking fund, less repayment	114	19	9
Amount of loans repaid	3,180	14	9
	£34,455	3	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	32,688	10	6
Sundry debtors	1,133	9	2
Stores in hand	39	8	2
Cash in hands of electrical engineer	5	0	0
Sinking fund investments	114	19	9
Balance at debit of revenue account	473	16	3
	£34,455	3	10

FORTHCOMING EVENTS.

FRIDAY, NOV. 10.

Physical Society.—At 8 p.m., "Temperature and Efficiency of Thermal Radiation," by Mr. J. Swinburne; "Note on Constant-Deviation Prisms," by Mr. T. H. Blakesley.

MONDAY, NOV. 13.

Institution of Mechanical Engineers (Graduates' Section).—"Boiler-House Practice and Design," by Mr. E. Barr.

TUESDAY, NOV. 14.

Statistical Society.—At 5 p.m., "Statistical Skimmings from the International Congress," by Sir J. Athelstone Baines, C.S.I.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., inaugural address by Mr. J. M. M. Munro.

Institution of Civil Engineers.—"Waterways in Great Britain," by Mr. J. A. Saner.

WEDNESDAY, NOV. 15.

Royal Meteorological Society.—At 7.30 p.m. (at Institution of Civil Engineers), "The Rainstorm of Aug. 24-26, 1905, in co. Dublin and co. Wicklow," by Sir J. W. Moore, M.D.; "The Aquameter," by Mr. W. B. Newton, Ph.D., F.C.S.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., "Some Aspects of Electric Traction," by Mr. W. M. Mordey.

Society of Arts.—At 8 p.m., inaugural address by Sir Owen Roberts, M.A., D.C.L., F.S.A.

Dynamicables.—At 7.15 p.m., dinner at Trocadero.

THURSDAY, NOV. 17.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., inaugural address by Mr. S. L. Pearce, M.I.E.E.

Motor Exhibition.—Olympia.

FRIDAY, NOV. 17.

Electro-Harmonic Society.—At 8 p.m., concert (ladies' night) at the Holborn Restaurant.

Institution of Mechanical Engineers.—At 8 p.m., the seventh report to the Alloys Research Committee: "On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys," by Dr. H. C. H. Carpenter, Mr. R. A. Hadfield, and Mr. Percy Longmuir.

Junior Institution of Engineers.—Nov. 18, at 2.30 p.m., visit to Messrs. Barclay, Perkins, and Co.'s Anchor Brewery, Park-street, Southwark Bridge.

Institution of Electrical Engineers (Manchester Section).—Nov. 24, at 7.30 p.m., address by Mr. J. Swinburne, M.I.E.E.

PERSONAL.

Mr. E. Stanley Shoults, A.M.I.E.E., has resigned his position as chief engineer and works manager of Aron Electricity Meter, Limited, in London, which he has held for nearly four years.

Mr. Noel Woodhouse, after being 12 years with the British Insulated and Helsby Cables, Prescot, has resigned his position with the firm as assistant contracts manager, and has commenced business with his brother, Mr. Alfred V. Woodhouse, as electrical engineers and contractors. Mr. A. V. Woodhouse, after being with the Brush Co., was until recently chief assistant engineer at Penarth for the British Electric Traction Co. Messrs. Woodhouse Bros. have taken offices at 20, North John street, to which address all inquiries should be made.

Of the 65 applications received by the South Shields Electrical Tramway Committee for a general manager for the new electric tramway system, the following five gentlemen have been selected for the final election: Mr. Richard Chadwick, A.M.I.M.E., chief assistant, Birkenhead Corporation tramways; Mr. Frederick Taylor, assistant tramway engineer, Bolton Corporation; Mr. John Williams, A.I.E.E., deputy engineer and deputy tramway manager, Rotherham Corporation; Mr. William Ogilvie, assistant rolling stock superintendent, Newcastle Corporation; and Mr. John Wilson, manager, South Shields Tramways Co.

Mr. M. H. Rooney, of the electric lighting station at Londonderry, has been presented by the staff of the local electricity works with a handsome dressing-case, suitable inscribed, on the occasion of his leaving Londonderry to take up the appointment of junior assistant electrical engineer to Limerick Corporation.

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OPENING ADDRESS TO THE DUBLIN SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

BY P. S. SHEARDOWN, MEMBER, CHAIRMAN FOR SESSION.

After some consideration as to what should be the subject matter of the address I am to have the honour of delivering to you this evening, it occurred to me that it might be profitable to try and incorporate in it information given and opinions arrived at by the authors of some papers presented at the recent International Congress at St. Louis, the complete *Transactions* of which, with the discussions thereon, have only recently been placed in the hands of members, and may be therefore considered practically the latest information procurable on the subjects dealt with. The papers read at the International Congress were delivered into eight sections: (A) general theory; (B) general application; (C) electrical chemistry; (D) electric power transmission; (E) electric lighting distribution; (F) electric transportation; (G) electric induction; (H) electric therapeutics. But it is to some of the papers read in Sections D and E and to the discussions thereon that I wish to confine myself this evening.

The first paper presented to Section 2 dealt with the generation of electrical power in Switzerland (Enrico Bignami). Switzerland is deficient in supplies of both coal and timber for fuel purposes, but possessed an inexhaustible supply of *houille blanche* (or white coal) in the Glacier Alps. The development of the electrical power industry makes it possible to develop this store of energy into a commercial commodity. The first water-power plants were the property of private companies. The example was soon followed by the civil authorities. Now the Government, following the example set by the companies and the towns, is beginning also to enter the field, and, having bought up almost all the railroads in the country, is preparing a law according it first right over all the water powers which can be utilised in transforming to electric traction the system of State railroads. The following facts were brought out by the paper. The country possesses 226 electrical stations, 162 being principal stations; together they represented a rated capacity of 180,000 kw. Of the 162 principal stations, 148 generate from water power, five with steam power, and nine with gas. Twenty-five important stations utilise not only water power, but also have installed gas or steam engines as a reserve for an eventual lack of water. The normal capacity represented by these 25 plants is 25,000 kw., with 10,000 kw. for the engine reserve. This necessity for reserve steam power would appear to increase the capital cost very much. The highest voltage directly produced is—for continuous current 2,250 volts, and for alternating current 10,400 volts. The kind of current generated varies largely, but 44 stations generate single-phase alternating and 38 three-phase alternating. The periodicity employed varies very much, but 40 or 50 cycles is most general. The territory provided for by the 120 principal stations referred to is inhabited by only 2,300,000 people, which works out at ·08 unit per head.

In the discussion notice was drawn to the very high load factor obtained in most stations described, there being only five stations of the entire list in Switzerland in which the ratio of average to maximum power is less than one half, and there were five stations mentioned in which the average load is above nine-tenths of the maximum. This result is largely brought about by the very large number of motors connected up on the condition that they are operated only outside the peak load.

The next paper gives some interesting figures dealing with the development of extra high-pressure apparatus for long-distance transmission work (Charles F. Scott). Present statistics show that the apparatus manufactured by the leading American companies for transmission at 10,000 volts or higher provides for the transmission of approximately 1,500,000 h.p., all by polyphase current, whereas 10 years ago there was but one single case of transmission of 200 kw. at 10,000 volts for a distance of less than 30 miles, this by single-phase. At the present time a large amount of power was being transmitted commercially at from 50 to 60 thousand volts, and 100,000 volts was already in view.

In a paper on the high-tension transformer in long-distance power transmission (John S. Peck), it is stated that the increase in manufacture by the Westinghouse Company is as follows: number of transformers, 971; output in kilowatts, 228,000; maximum voltage, 60,000; maximum capacity of any one transformer in kilowatts, 2,500. Transformers for long-distance transmission may be divided up into two general classes—oil-insulated and air-blast; the oil-insulated transformer being again divided into two general classes—self-cooling and artificial cooling. He mentioned that the self-cooling transformer has one great advantage over all other types in that no extraneous devices are necessary for cooling, so that if required for any kind of service where no attention can be given to the apparatus, the self-cooling transformer is the only satisfactory type, but its capacity is limited to approximately 500 kw. A number of different methods have been proposed and tried for carrying off the heat, but one method is now almost always used: this consists in forcing or siphoning water through coils of brass or copper tubes placed inside the transformer case below the surface of the oil. The air-blast transformer, as its name implies, is one in which the cooling is accomplished by means of a forced draught of air. Two separate passages are provided, one for cooling the coils and the other for cooling the iron. The air pressure is usually less than 1oz. per square inch, the power required for cooling being usually from one-tenth to one-fourth of 1 per cent. of the transformer capacity. On account of the difficulty of eliminating static discharges off the surfaces of the coil of the blast transformer, it has been impracticable to use this type of construction for pressures exceeding 33,000 volts, and the greatest successes have been obtained by voltages not exceeding 20,000, above which it is most satisfactory to use oil-insulated coils.

The discussion on this paper was very interesting, it being shown that, although a transformer can be designed for an efficiency of 98 per cent., this will cost twice as much as one with 96 per cent. efficiency, and that it was an open question, therefore, as to how high in efficiency it is commercially economical to go, as the interest on the cost of the transformer might readily be more than the value of the power saved. The discussion dealt very largely with the fire risks of oil-insulated transformers, one speaker drawing attention to the fact that if a fire starts near an oil-cooled transformer, and heats it up sufficient, it will turned into a gas producer, and that sufficient gas can be turned out to melt up all the ironwork and machinery in any power-house. The opinion with regard to relative fire risks of air or oil insulated transformers differed a good deal, but it was generally conceded that the danger of setting the oil on fire internally—that is to say, from the transformer itself—was very small indeed, but the danger of its being set on fire from external sources considerable, and that, therefore, oil transformers should be kept as far as possible away from switchboards or any other place where small fires or arcs are likely to be started. Some speakers went so far as to think that oil transformers should each be placed in fireproof cells, and other designers had made provision in case of a fire being started to let in water from the supply mains to the bottom of the transformers, floating the oil out either into a spare receptacle or away down the sewers. Another fact brought out was that there is very little advantage with regard to radiating heat in ribbing the insides of transformer cases, as the heat is easily passed from the oil to the iron, the heat potential drop being altogether between the outside surface of the iron and the air in contact with it.

A second paper on transformers was also read, being entitled "Notes on Experiments with Transformers for Very High Potentials" (Prof. H. B. Smith), one transformer described being for a secondary potential of 330,000 volts, which under test failed to produce potentials higher than 210,000 volts. The next was a transformer which successfully transformed from a potential of 200 volts to over half a million volts at 60 cycles per second, and was capable of disrupting a 48in. air-gap between sharp needle points.

A paper which created a great deal of interest among engineers connected with high-tension long-distance transmission was read by Prof. F. G. Baum, who has under successful operation the district of the Sierra Nevada Mountains of California, a transmission scheme which had apparently been operating without experiencing the troubles found on many other similar lines in other parts of the country. The paper stated that the system described had continuously in operation about 700 miles of line at 50,000 volts, 70 miles at 40,000 volts, and a great many miles at 3, 16, 10, and 5 thousand volts, and mentioned that in a short time some of these lines would be operating at 100,000 volts. The longest distance to which power is regularly transmitted is 200 miles. The amount of power available on the system is 43,650 kw., which will soon be increased by the addition of two 5,000-kw. generators. The author gave some simple methods of line calculations with regard to (1) circuits; (2) charging or capacity current; (3) rise in pressure due to charge in current; (4) regulation of transmission system; (5) electrical surging, giving in all cases practical examples illustrating the working of his formulæ.

Part 2 dealt with high-potential control, or the apparatus in use, and contained some practical information with regard to insulators, the author mentioning that they had in use glass insulators, porcelain insulators, and combinations of both porcelain and glass; in the mountains, away from fog, 7in. glass insulators with two petticoats did very well up to 40,000 volts, but to go from 40 to 60 thousand volts required a 14in. porcelain insulator with three petticoats. With regard to line operation, they had the lines patrolled from one to three times a week. Their line troubles were due to a few weak insulators, and in some localities they have a good many insulators shot off. Some of their unexpected causes of trouble have been crows or geese flying into the lines, cats crawling up the poles, green hay carried by wind across line, an engine starting up under the

* Delivered on Nov. 9, 1905.

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lines, and a long-tailed rat crossing temporary 'bus bars. Their high-tension transformers had given very little trouble. He recommended that on test the primary of each transformer should stand a test about equal to double the star voltage for which the transformer is made. With regard to switches, they had found that the oil-break switch was the only one that will stand heavy duty, and that this type is less likely to produce violent surging on opening a circuit than has been experienced with the flare type of air-break switch. The writer gave illustrations of a line of cheap and satisfactory oil-break switches that they had designed and manufactured, these operating up to 60,000 volts; the switch referred to being capable of opening 10,000 kw. at 60,000 volts on short-circuit. With regard to lightning arresters, they pinned their faith to simple horn-type arresters made with single or double air-gap. Their general practice was to generate current at 2,300 volts and then step up, the primary of transformer being connected star with earthed neutral, the writer having come to believe that the earthed neutral had more in its favour than against it; and they took advantage of the earthed neutral, and very often installed a single transformer in a sub-station, one side going to line, the other to ground. Where the load was larger but did not warrant three transformers, two transformers were used on two legs of the primary and open delta on the secondary. They are not bothered by unbalancing of load at the power-houses. At the power-houses no fuses or circuit breakers are installed, as they prefer to hang on to a short rather than take the chances of being pulled out for every slight interruption; but at sub-stations the transformers were generally fused. All their energy is developed by water power, the size of unit having developed from 300 kw. in 1897 to the present 5,000-kw. unit. With this latter type they could instal 20,000 kw. in a building 100ft. long by 50ft. wide. Their greatest trouble is occasioned by the fog, and this in districts near the ocean settles on the insulation and reduces the insulation to such an extent that the pins, cross-arms, or poles, if of wood, are sometimes set on fire. In the mountain district with modern insulators their line troubles are nil. The author considers that the weak point of the transmission system is the insulator, and that with an insulator to stand 100,000 volts, in his opinion, this pressure is possible. To sum up, he thought it easier to operate a line, say, from 30 miles up, at 50,000 or 60,000 volts than at half that pressure, assuming that a considerable amount of power is transmitted.

The discussion on the paper confined itself largely to the lightning arrester. On most other systems working at lower voltage the trouble of getting rid of lightning on the line was very considerable. The writer of the paper, however, stated that lightning gave him very little trouble, and that practically all the lightning arresters he had tried provided instead of saving trouble for him, and the only type he used was an ordinary horn lightning arrester with a 4½in. air-gap, which would require a pressure of 90,000 volts to start an arc. The opinion arrived at finally seemed to be that by getting up the voltage as high as 60,000 the insulation of the line has to be made very much more perfect, and that hence lightning discharges which break down insulators on lower voltage systems were rendered comparatively harmless over the very large insulators employed on the line under discussion. A second reason for the immunity from trouble being ascribed to the fact that when transmitting a large amount of energy the higher the voltage the smaller the current, and the smaller the current the less the rise in voltage due to a surging current, and hence static discharges are less frequently produced.

(To be continued.)

APPOINTMENTS VACANT.

Electrician, Burnley Union. Wages, £2. 2s. per week. Applications by Nov. 15.

Switchboard Attendant, Southend Town Council electricity works. Salary, £1. 1s. per week.

Assistant Lecturer and Demonstrator in Electrical Engineering, Leeds University. Salary, £175 a year.

Laboratory and Workshop Assistant, Battersea Polytechnic, S.W. Commencing salary, 20s. a week. See advertisement.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office.

Wireman for electric light and power plant. Applications to Box 29, *Electrical Engineer* Office. See advertisement in last issue.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Junior Assistant. Wages, 30s. per week. Applications to Engineer, Electricity Works, Canterbury, by Nov. 18. See advertisement.

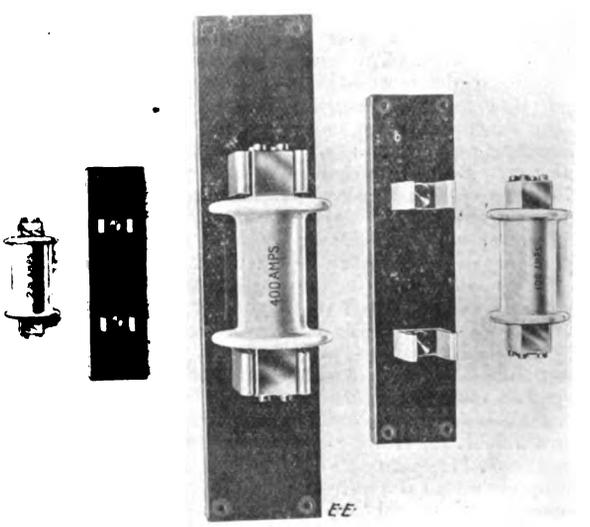
Representatives for an electrical contracting firm. Applications to Box G 33, *Electrical Engineer* Office. See advertisement in last issue.

Junior Charge Engineer. Salary, 30s. per week, rising to 35s. Applications to the Borough Electrical Engineer, 335, High-street, Cheltenham. See advertisement.

TRADE NOTICES AND NOVELTIES.

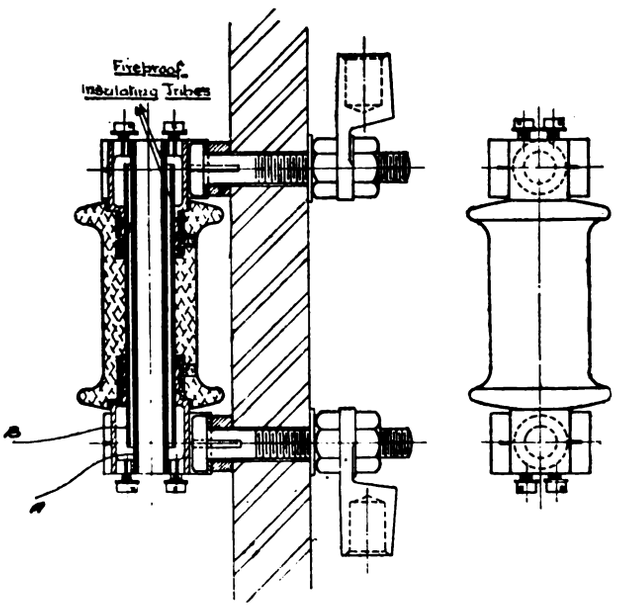
Tubular Fuses.

Accompanying are illustrations of the standard designs of tubular fuses manufactured by Messrs. A. Reyrolle and Co., Limited, Hebburn-on-Tyne. These fuses are made in all sizes from 25 amperes to 600 amperes for use on 500-volt circuits. One of the illustrations shows the construction in section, from which it will be seen that there are two thick asbestos tubes, A and B, inside the porcelain handle. The internal tube, A,



"The Reyrolle" 500-volt Tubular Fuse.

surrounds the fuse wire, and is most effective in causing the arc to be blown out when the fuse melts on a dead short. The external tube, B, is provided in order to keep the porcelain handle cool, and it will be seen from the illustration that an air space is contained between these two tubes. Ventilating holes are provided in the metal contacts on each end, and by this means the heat which must of necessity be generated on a fuse is dissipated, and, keeping the porcelain cool, minimises the risk of breakages. The material used for the fuse is bare tinned copper wire, and cheese-head terminal screws and washers are



Details of "The Reyrolle" 500-volt Tubular Fuse.

provided on each end of the holder so that the holder can be re-fused quickly and cheaply.

Motor-Driven Centrifugal Pump.

We illustrate herewith an interesting, if small, installation in which direct-current transmission is employed for actuating a vertical motor driving a pump at the Alexandra Docks, Newport, Mon. The motor is of the Westinghouse direct-current multipolar type, is supplied with current at 500 volts, and develops 320 h.p. It drives a centrifugal pump at 300 r.p.m., the pump raising a million gallons of water per hour against a head of 25ft. The water is pumped from the river into an adjacent dock for the purpose of keeping up the level of the

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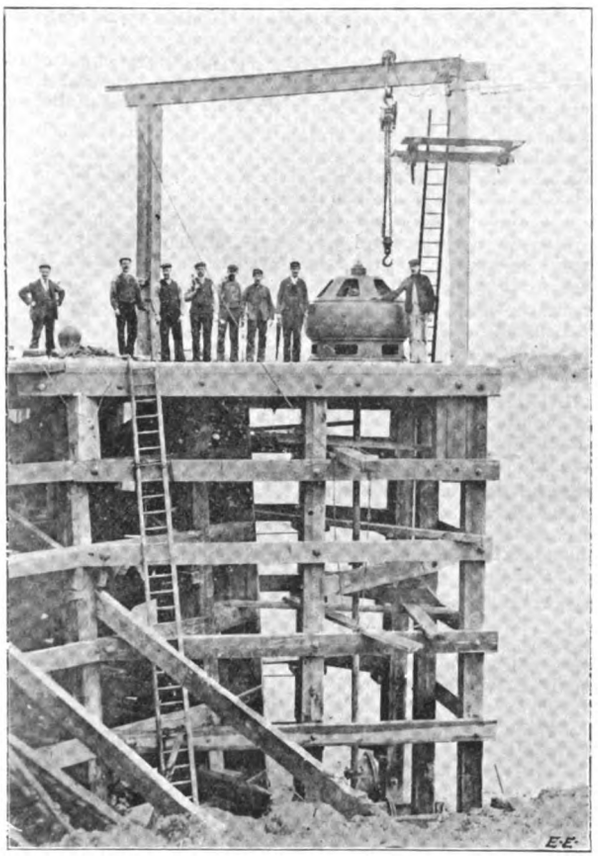
water in the latter. In the power-house a Westinghouse generator of 300 kw. capacity has been installed. This generator is rope-driven at 325 r.p.m., it being of sufficient capacity to work other motors besides that illustrated. The overhead transmission line consists of bare copper conductors of about ·5 square inch sectional area, these being suspended on special



Motor-Driven Pump at the Alexandra Docks, Newport, Mon.

hook insulators supported on steel lattice poles. The work was carried out by the British Westinghouse Electric and Manufacturing Company, Limited, of Manchester and London.

LUTON ELECTRICITY ACCOUNTS.

In the accounts of the Luton electricity department for the year ending March 31, 1905, the total expenditure on capital account is given as £32,607. The following are abstracts of the revenue account, balance-sheet, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	981	4	2
Distribution of electricity	50	3	5
Attending and repairs to public lamps	33	3	7
Rents, rates, and taxes	147	2	8
Management expenses, salaries, etc.	361	0	7
Special charges—insurances	36	13	10
	1,609	8	3
Balance carried to net revenue account	2,045	14	5
	£3,655	2	8

Cr. Income.	£	s.	d.
By sale of current for lighting and power	3,297	9	11
Public lighting	195	12	4
Rental of meters	126	1	4
Charging cells	17	6	0
Sale and repairs of apparatus	18	12	1
Quit rent	0	1	0
	£3,655	2	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	32,067	0	0
Sundry creditors	366	3	10
Balance at credit of net revenue account	270	4	1
Sinking fund account	3,581	4	3
Reserve fund account	101	10	6
Balance due to treasurer	1,041	8	5
	£37,427	11	1

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	32,607	12	5
Stores on hand	22	1	6
Insurance paid in advance	7	15	10
Sundry debtors for current supplied, etc.	1,352	14	6
Sinking fund and reserve fund investment	3,437	6	10
	£37,427	11	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		291,673
Quantity sold { Private consumers by meter	261,771	274,521
Quantity sold { Public lamps	12,765	
Quantity used on works		11,479
Total quantity accounted for		286,100
Quantity unaccounted for		5,673
Total maximum supply demanded (kilowatts)		284

Number of public lamps: 10 arcs, 27 incandescents.

LEGAL INTELLIGENCE.

TRAMWAY CASE.

At the Erith Petty Sessions on Tuesday last the manager of the Erith tramways (Mr. Arthur Coventry) was summoned for allowing a person not then licensed as required by the Act to act as driver of a tramcar. For the defence it was urged that an unlicensed driver or conductor might be employed in a case of emergency. After hearing evidence, the magistrates dismissed the case.

COMPANIES' MEETINGS AND REPORTS

BRITISH THOMSON-HOUSTON.

The ordinary general meeting of this Company was held on Wednesday last, Mr. G. Franklin presiding.

The CHAIRMAN said that the printed accounts and report (which we published last week) were in themselves sufficiently explanatory of the position of the Company, and only went to show that the Company had had a very much longer row to hoe at Rugby than it had expected when it started. The difficulties that arose in connection with manufacturing there, and the difficulties which had since become manifest by severe competition, both home and foreign, made the Company's trials sufficiently serious to require constant attention on the part of the Board. Attention had been called to the increase in the item of interest on loans. Last year the item was £29,047, and in the present accounts it stood at £30,601. The increase was entirely due to the fact that last year the General Electric Co. stood as an ordinary creditor for a large amount which did not carry interest, but as the sum had not been paid off, it now carried interest at the rate of 3 per cent. He was glad that attention had been called to that point, because it enabled the directors to give the shareholders an assurance in regard to the Company's financial position. Since March last the directors had been able to dispose of, at par, £350,000 of securities, part of the securities which stood in the balance-sheet at £518,302. The effect of that operation was to reduce the Company's liabilities on the other side of the account.

The report was adopted.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.

The annual general meeting was held on Friday last, Mr. J. J. Courtenay presiding.

The CHAIRMAN, in moving the adoption of the report (copy of which appeared in our issue of last week), stated that the percentage of expenses to gross receipts was 74·28—a slight reduction compared with those of the previous year. The number of passengers carried was 20,026,548, or an increase of 665,801. Had the change to electric traction been postponed any longer the Company would undoubtedly have entered upon a period of decadence, the signs of which had already made themselves disagreably apparent in their traffic returns. During his stay in Buenos Ayres last autumn he went over the whole system, and he did not think than anyone, after studying the situation as he had done, could fail to recognise the unrivalled facilities for rapid transit which the joint systems would be able to offer the public or to be convinced of the excellence of the Company's prospects. To give an illustration of the extent of their system, he might state that the lines now open and under construction, if they were in London, would extend from Addison-road Station, near Olympia, to the Agricultural Hall and Dalston Junction, *via* the Marble Arch and Oxford-street in one direction, and at right angles in the other direction from Victoria Station to Primrose Hill. Referring to the progress of the "electrification" of the joint system of the Grand National and the New Tramways Companies, he reminded the shareholders that the funds for the work were provided in March, 1904, by the issue of £450,000 of the conversion debenture stocks of the two companies. Owing to accidents actual construction in Buenos Ayres could not be commenced until January, 1905. By Sept. 30 24 miles of line had been converted, and the directors learnt by cable that the total converted to the 31st ult. was 32½ miles, and that the sections opened to public service by electricity at the same date covered a distance of 24 miles. In view of results already obtained, the directors intended to make every effort to proceed continuously with the work of electrification, and to carry it on to completion. A

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scheme had been formulated, which for the present was confined to dealing with the simplification of the Company's share capital, but which also made provision for the future consolidation or unification of the debenture debt as soon as the proper time arrived.

The report was adopted.

MIDDLEWICH ELECTROLYTIC ALKALI.

The annual report of this Company states that the operations for the year ended Aug. 31, 1905 showed a net profit of £4,745. 18s. 7d. To this is to be added the amount brought forward from last year, £1,374. 9s. 4d., making a total of £6,120. 7s. 11d. The directors propose that this amount be applied in paying. on account of the arrears of dividend upon the cumulative preference shares, the amount of one year's dividend at the rate of 7 per cent. per annum on all the preference shares issued prior to April, 1902, and a dividend at the same rate upon all the preference shares issued since that date, calculated, as regards all instalments paid on such shares since Aug. 31, 1902, from the several dates of payment of such instalments up to Aug. 31, 1905. This will absorb a sum of £5 601. 3s. 9d., and leave £519. 4s. 2d. to be carried forward to the next account. The process continues to work satisfactorily, and there is a good demand for the Company's products. Towards the close of the year the erection of additional manufacturing plant was continued, and the Company is now in a better position for dealing with an increased volume of business.

DRAKE AND GORHAM.

The report of this Company for the year ended June 30 last (to be submitted at the meeting on the 16th inst.) states that, after payment of all charges, including bonuses due to staff, there remains a net profit of £10 821, which, with the £1,722 brought forward, makes a total of £12,544, which it is proposed to appropriate as follows: a dividend at the rate of 6 per cent. per annum, £7,500, placing to reserve £3,000 and carrying forward £2,044. The reserve fund will then stand at £12 000. The directors regard the increase of £2,173 in the net profit as satisfactory, for during the period under review there has been little improvement in the general condition of electrical business. The Company has been entrusted with the electrical equipment of a cotton mill in Lancashire, in which steam plant and generators of the latest type will be employed, the power amounting to upwards of 1,000 h.p. being transmitted electrically. It is anticipated that this work, which has been throughout designed by the Company's staff, will lead to important developments in the future. A large number of installations have been carried out during the year, and the work in hand on June 30 was greater than at the corresponding period of the previous year. Negotiations are in progress for the acquisition on lease of further premises for factory purposes, the present arrangements affording insufficient facilities for the manufacturing department of the business. At an extraordinary general meeting, to be held at the close of the ordinary meeting a resolution will be submitted authorising the reimbursement to the directors of expenses incurred in attending Board meetings, etc.

NEW COMPANIES REGISTERED.

P.M. Electric Manufacturing Co., Limited.—Capital, £2,000. Object: to carry on the business of manufacturers of and dealers in electrical apparatus and all accessories of motorcars, etc.

Telegraphic Code Co., Limited.—Capital, £2,000. Object: to carry on the business of authors, compilers, adapters, publishers, and sellers of telegraphic codes or secret ciphers, etc. Registered office: 12, Royal Exchange-buildings, E.C.

Cremorne Motors, Limited.—Capital, £30,000. Object: to acquire and carry on the business of A. E. Dobbs at the Cremorne Motor Works, Lots-road, Chelsea, as the Cremorne Motor Manufacturing Co. Registered office: Cremorne Motor Works, Lots-road, Chelsea, S.W.

Kepong (Malay) Rubber Estates, Limited.—Capital, £20,000. Object: to acquire rubber estates in the Federated Malay States and elsewhere, to adopt an agreement with the Malay Syndicate, Limited, and to carry on the business of rubber and general planters, cultivators, estate owners, etc.

Caoutchouc and General Trading Co., Limited.—Capital, £2,000. Object: to carry on the business of brokers of and dealers in indiarubber (both raw and manufactured) and of goods made wholly or partly thereof. Registered office: Bush-lane House, Cannon-street, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Hull.—The Tramways Committee invite tenders for 34 top covers for the cars.

Cardiff.—The Asylums Committee require tenders for generating plant. Tenders by Nov. 27.

Torquay.—The Town Council invite tenders for generators, booster, traction battery, and switchboard. Tenders by Nov. 20. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply of (*a*) tramcar trucks, (*b*) electrical equipments for cars. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by 1 p.m. on Nov. 11.

London, W.—Messrs. Grice and Co., Addison Wharf, Warwick-road, Kensington, require a 10-ton electric derrick crane with 60ft. to 70ft. jib, continuous current.

Bermondsey.—Tenders for new plant, estimated to cost £5,390, will shortly be advertised for. An estimate is being prepared for condensing plant, for which tenders will be invited.

Ebbw Vale.—The Urban District Council invite tenders for free wiring and supply of incandescent lamps. Tenders by 12 noon on Nov. 25. Full particulars in advertisement columns.

Sao Luiz.—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 15. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Rawtenstall.—The Corporation invite tenders for the electric light wiring and fittings of the new free library. Tenders to Messrs. Lacey, Sillar, and Leigh, 78, King street, Manchester, by Nov. 20. Full particulars in advertisement column.

Bridlington.—Schemes and tenders are invited for lighting the Quay Wesleyan Church, Bridlington, by electricity, also for supply and fixing of electric ventilating fans. Tenders to Mr. Samuel Dyer, architect, Bridlington, by 6 p.m. on Nov. 14.

Harrogate.—The Directors of the Frederick Hotels Co. invite specification and tenders for laying down electrical plant at the Hotel Majestic, Harrogate. Further particulars on application to the Secretary, 8, Bloomsbury-square, London, W.C.

Dublin.—The Dublin and Blessington Steam Tramway Co. invite tenders for the supply of sole-plates, clips, fang-bolts, fishbolts, and dog-spikes. Further particulars from Mr. P. H. McCarthy, civil engineer, 39, Westmoreland-street, Dublin. Tenders by Nov. 15.

Barrow-in-Furness.—The Corporation invites tenders for the supply and erection of a 500-kw. combined steam-engine and generator, balancer booster, switchboard, water-tube boiler, mechanical stoker, economiser, travelling crane, cooling tower, pipes, etc. Tenders by 12 noon on Nov. 13. See advertisement in last issue.

Bray (Ireland).—The Urban District Council invite tenders for the supply and delivery of 220 yards $^{7}/_{16}$ concentric paper-insulated and lead-covered cable for a working pressure of 200 volts, and 10 10-ampere alternating-current induction voltmeters, 100 volts, 60 periods. Tenders to Mr. P. MacDonnel, clerk, by 10 a.m. on Nov. 21

Cape Town.—The Cape Post and Telegraph Office invite tenders for telegraph and electric light material. Tenders will be received by the Chairman of the Tender Board, Control and Audit Office, Parliament street, Cape Town, noon on Nov. 22. Samples may be inspected and forms of tender, copies of specifications, together with any other information required, may be obtained on application to the Controller of Stores, General Post Office, Cape Town.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension to that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

RESULTS OF TENDERS.

Gillingham.—The contract with Babcock and Wilcox, for the supply and erection of a new boiler, etc., has been sealed.

Aston.—The Town Council have accepted the tender of T. Johnson, at £1 387, for the superstructure in connection with the power station extensions.

Stoke-on-Trent.—The Guardians have placed with the Hart Accumulator Co. an order for renewing the battery at the workhouse, Newcastle, Staffs, with 114 of their standard lighting type cells.

Greenwich.—The Guardians have accepted the tender of Pritchetts and Gold, Feltham, at £85, for repairs to the batteries at their installation at Grove Park Workhouse, Lee, S.E., and also for maintenance of same.

Contract.—The Brush Electrical Engineering Co., Belvedere-road, have obtained a contract for 43 motors and a turbine alternating-current set for the equipment of the first cotton spinning mill to be erected in Portugal.

Bury.—The British Westinghouse and Electric Manufacturing Co. have received an order from the Corporation for six tramcars, with complete electrical equipment. The same firm is also supplying six tramcars and electrical equipments for the Mansfield and District Light Railway Co.

Battersea.—The Council have accepted the tender of Cochrane and Son, at £170, for a scheme to clean by occasional discharges of water from the pumps the large pipes in the river from the mud which is occasionally retained in the same. They have also accepted the offer of J. B. Garnham to purchase scrap copper at the central station at the rate of £68. 5s. per ton, and of Oswald and Son to purchase scrap iron at the rate of 20s. and 38s. per ton.

Dublin.—The Corporation have accepted the following tenders for extensions of plant in connection with the electricity undertaking: British Insulated and Helsby Cables, at £15,151, for mains extensions; Ferranti Limited, at £1,879, for sub-station switchboards, and at £160, for feeder panels at Fleet-street station; British Electrical Transformer Co., at £2,000, the city electrical engineer being authorised, if he considers the extra outlay advisable, to order the alternative design of regulating switch with 10 stops, at an additional £180.

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London County Council.—The Highways Committee have received the following tenders for the supply of low-tension electric cables, feeder pillars, etc., for the tramways:

W. T. Glover and Co., Manchester*	£37,860	0	0
British Insulated and Helsby Cables, Prescot	38 060	15	10
W. T. Henley's Telegraph Works Co., London	38,154	13	9
Siemens Bros. and Co., London	38 541	0	9
Western Electric Co., London	38,628	7	7
Callender's Cable and Construction Co., London	39.723	15	0
St. Helens Cable Co., Warrington	40 756	10	5
National Conduit and Cable Co., London (incomplete)	40,197	0	0
Société d'Exploitation des Cables Electriques, Switzerland (incomplete)	45 169	5	0

* Recommended for acceptance.

For the supply of high-tension cables the following tenders were received:

Western Electric Co., London*	£20,549	16	0
Siemens Bros. and Co., London	20,670	16	6
W. T. Henley's Telegraph Works Co., London	20,719	6	6
British Insulated and Helsby Cables, Prescot	21,001	16	3
Callender's Cable and Construction Co., London	21,396	5	0
W. T. Glover and Co., Manchester	21.572	9	7
National Conduit and Cable Co., London	21.804	10	0
St. Helens Cable Co., Warrington	21 950	10	0
Société d'Exploitation des Cables Electriques, Switzerland (incomplete)	24,654	10	6

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Traffic Receipts.—The receipts of the Buenos Ayres Electric Tramways for the past week were £1,335. For the week ended Oct. 22 the receipts of the Havana Electric Railway show an increase of £1,200.

Beckenham.—The Urban District Council have resolved, on the recommendation of a sub-committee, to proceed with the necessary works for providing current for Penge tramways at an estimated cost of £13,000.

Batley.—The electrification of the line between Batley and Birstall is practically finished. It is intended, so it is said, to make the return fare 10d. between Batley and Bradford, which is 8d. less than the railway fare.

Bristol.—Charles Jarman was summoned for committing offences against the tramway company's by-laws and for assaulting a tramway inspector. He was fined 50s. and costs, or in default six weeks imprisonment.

Surbiton.—Among the provisions of the Bill which the District Council intend to promote in the present session of Parliament is one for power to repeal a portion of Section 32 (6) of the London United Tramways Act, 1901.

Dundee.—At the end of three weeks the results of the new four-stage fare system showed a decrease in receipts per car mile and a large increase in the number of ½d. passengers carried in comparison with the same period last year.

Fulham.—The London County Council cannot see their way to pave the tramway track along the route in Fulham with wood, and the Borough Council have again urged upon the County Council the urgent necessity for such a course.

Pontypridd.—At a meeting of Council on Tuesday last it was reported that the Board of Trade had sanctioned the borrowing of £18,000 for tramway purposes, £16,180 to be repayable in 30 years and the remainder in 15 years.

Rhos.—At a meeting of the Parish Council it was explained that the electric tramway company could not come to terms with Mr. Dennis respecting an extension of the system. The Council decided to approach Mr. Dennis on the matter.

Leeds.—Covered tops are to be provided for another 25 electric tramcars within the next fortnight. The work will be executed at the Corporation's depôt in Kirkstall-road, and the covers, it is stated, will be a great improvement upon those now in existence.

Perth.—The tramway system, as reconstructed and electrified by the Corporation, which was formally opened last week, is six miles in length, and has cost between £80,000 and £90,000, including the purchase price (£21,800) for the old system. The plant provides power to drive more than 40 cars.

Middlesex.—Much opposition has been evoked in the Stanmore district by the County Council's tramway extension scheme. The Hendon Rural District Council at a meeting last week passed a resolution against the scheme. The Wembley Council have also decided against an extension of the tramway system to Sudbury.

Southampton.—For using offensive language on a tramcar a man fined at the police court last week. The defendant was in volunteer uniform at the time, and claimed the privilege of changing at a junction without additional payment, though the prosecutors disputed defendant's right. The magistrates on this point decided in defendant's favour.

Cardiff.—The Trades and Labour Council have passed a resolution against the Corporation permitting advertising on tramcars. The Tramways Committee have been asked to receive a deputation from the tramway and vehicle workers' associations with reference to the charges of incivility, etc., made by the general manager of the tramways against the employés.

Glasgow.—The Corporation Tramway Committee and Clydebank Town Council have come to terms about the erection of bridges over the canal at Kilbowie and Dalmuir. It has been agreed that the Corporation construct bridges, 20ft. in width, with pedestrian paths of 5ft. on each side of the bridges, Clydebank to pay towards the cost of each bridge the sum of £300. The bridges will probably cost about £3,000 each.

Colchester.—A little boy, in crossing the road, was knocked down by a passing tramcar. The "life-guard" acted imperfectly, and the child's head seems to have been caught under it. The victim was dragged some 30 yards before the car could be pulled up, for, although the driver acted with the utmost promptitude, the rails were wet and greasy. When extricated the child was found to have been severely hurt about the head.

Darlington.—The tramways manager's monthly report presented to the Council shows that the total revenue on the Harrogate Hill and Eastbourne route for September was £624. 7s. 0½d., 200,242 passengers were carried, and the revenue per car mile was 7·72d.; on the Cockerton and Bank Top route £160. 1s. 7d., 50 625 passengers, and 5·22d. per car mile; on the Haughton route £60. 3s. 0½d., 17,002 passengers, and 5·63d. per car mile.

Wolverhampton.—The connecting of the Corporation lines with those of the British Electric Traction Co. on the Bilston-road has been completed, and one of the company's cars which has been fitted up to run on the Lorain system has made a trial through trip from Wolverhampton to Bilston. A number of the Lorain cars have been fitted with the gear to run on the company's lines, and it is hoped that before long they will be carrying passengers over both systems.

North-Eastern Railway.—In connection with the proposed electrification of the line between Newcastle and South Shields, which we reported some time ago, it is now stated that cable surveys of the line are now being made as a preliminary step, and after these have been completed it is expected that a start will be made with the laying down of the electric rails. It is also understood that the company will afterwards adopt the electric system on the light railway between Gosforth and Ponteland.

Swanage.—The engineer to the promoters of the proposed Bournemouth and Swanage light railway scheme waited upon the Urban District Council last Friday and laid before them plans and maps of the proposed route. A general explanation of the scheme was given, and in the end it was resolved by the Council to refer the matter to the Works Committee, who will report later. Asked by the engineer to express an opinion of the scheme as it stood, the Council intimated its approval subject to points of detail.

Sutton (Surrey).—The British Electric Traction Co. having failed to obtain the consent of the Urban District Council for a double track of trams down the High-street instead of a single one, as provided by their Act of Parliament, have given notice of their intention to apply to the Board of Trade for an order authorising the double track to be constructed. The tradesmen of the district have decided to petition against the proposal, on the ground that the construction of a double line along the High-street would leave insufficient space between the kerb and the outermost rail.

Hastings.—A communication was received by the Tramways Committee from the engineers to the tramways company showing plans of proposed extensions to passing places which the company wished to make, also requesting the sanction of the Corporation to the erection of one additional passing place. The Town Council consented to shifting of the passing places to the proposed new positions, but not to any increase in the length of double track. As regards the additional passing place, the Corporation were prepared to sanction it only on condition that certain constructional modifications were made.

Newcastle.—A special meeting of the Council will be held on Wednesday, Dec. 6, for the purpose of considering a resolution to apply to the Board of Trade for borrowing powers for the purpose of constructing and working by electricity a double line of tramway along the new extension of Market-street from Pilgrim-street to New Bridge street, commencing by the junction with the existing tramways in Market-street, at a point where Market-street joins Pilgrim-street, and terminating by a junction with the existing tramways in New Bridge-street at the point where the new extension of Market-street joins New Bridge-street.

Underground Electric Railway.—At Kensington Police Court last week this company was fined £10 and costs for permitting dense black smoke to issue from the generating station chimneys in Lots-road. For the Chelsea Borough Council a prohibition order was pressed for, but the company said this might compel a stoppage of the electric trains and greatly inconvenience the public. Everything possible was being done to mitigate the smoke nuisance. Mr. Douglas Carce, of Cheyne-walk, architect, said the smuts from the chimneys were as large as one's thumb-nails. The smoke was a discomfort to the whole of the residents in the neighbourhood.

West Ham.—In laying the foundation-stone of the new electric tramcar depôt at Plaistow on Friday last, the Mayor of West Ham (Alderman John Byford) remarked that for the year ended Sept. 30 the tramways earned £47,000, and it was fairly certain that for the second year's working of the undertaking ending March, 1906, the receipts would reach the fine total of £100,000, and that nearly 30 million passengers would be carried. He considered that in the municipal tramways they had an undertaking which had been and was administered on thoroughly commercial lines, as was evident by the most gratifying net profit of over £10,000 on the first year's working.

Leith.—The Corporation electric tramways were formally opened on Friday last. The cars have already been running over three important sections since August last, whilst the work on the Bernard-street swingbridge section is not completed. In addressing a crowd on the route, the Lord Provost stated that the whole system ought to be running in the following week. Owing to the demand that was made at the ward meetings for ½d. fares, he stated that 14 ½d. fares on all

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parts of the system would come into force on Monday. There would also be a 1½d. fare from Bernard-street, Seafield, Bonnington, and the Caledonian Station in Commercial-street to Hanover-street and the Tron Church.

Dunfermline.—A conference took place last week between representatives of the West of Fife Tramways Co. and the Streets and Drainage Committee of Dunfermline Town Council. The intention of the company is to construct a line, starting from the new library at Townhill and running down Townhill-road, along East Port-street and High-street, on to Milesmark. Various minor matters which were raised were amicably adjusted, and on behalf of the company it was agreed that the line should be double where the Council deemed that that was expedient. The only point on which there was serious difference of opinion was regarding the amount of wayleave, on which there is also negotiation with the District Committee, and consideration of this matter was adjourned.

Sheffield.—An electric tramcar, while descending a steep incline, got beyond the control of the driver, and had its front platform smashed, together with the spindle controlling the brakes. The motorman and a passenger were injured. In the opinion of the former the accident was due to the greasy state of the rails, which caused the car to plunge forward. The available brake power did not enable him to pull up the car in time to avoid a collision, and the slipper brake which the conductor in the rear applied was, under the circumstances, not strong enough to stop the car. Until the car had been removed arrangements were made to conduct the service on a single line between Norwood-road and Skinnerthorpe-road, and there was little interference with the ordinary traffic.

Tramways over the Bridges.—We gave last week a list of conditions which the Bridges and Houses Committee recommended the Court of Common Council to impose upon the London County Council as the basis of an understanding between these two bodies relative to the running of trams over the bridges. The Council, by a large majority, adopted the recommendation. A well-attended town's meeting was held last Friday night at the Camberwell Baths, when a resolution in favour of promoting a Bill permitting overbridge tramways was carried unanimously. The committee are losing no time in proceeding with the preparation of a Bill for the running of tramways over the bridges. It has been decided to seek the advice of Sir Benjamin Baker as to whether Blackfriars Bridge should be widened on the east or west side.

Liverpool.—While attempting to replace an electric tramcar which had left the line, a tramway inspector had the misfortune to break a leg by being jammed in between two cars. At a meeting of the City Council yesterday the following motions were tabled for consideration: That children between the ages of three and twelve travelling on the tramcars be charged half fare, and those under three being admitted without charge; that the fare on the Pierhead to Cabbage Hall route be reduced to 1d.; that a 1½d. fare be inaugurated from the Pierhead to the corner of Green-lane, Tuebrook; that a ½d. fare be inaugurated for passengers travelling along Green-lane only; and that the Tramways Committee be instructed to have prepared and laid before the Council, within a period of three months, a scheme of superannuation which may be joined by the whole of the employés under their control.

Bournemouth.—In reply to a memorial presented to the Council complaining of the annoyance caused by the substitution of Poole cars for those generally in use, it was pointed out that old cars would be restored after being repaired and renovated. The Council have applied to the electricity supply company for an increase of power on the line between the County Gates and Poole. A sub-committee are inquiring into the question of tram fares. The municipal elections were fought on the question of running the Corporation electric trams on Sundays, and the results of the polling in eight contested wards showed that six candidates in favour of a Sunday service have been returned and two against. Three retiring members objecting to Sunday trams were returned unopposed. The votes in the working-class districts show large majorities in favour of Sunday running, while the polls in the better-class districts give a preponderance of votes against. There is a large majority against Sunday trams on the Town Council.

Croydon.—Lieut.-Colonel von Donop, one of the Board of Trade inspectors, recently paid a visit to Croydon, and went to South Norwood, where he inspected the newly-laid line from the bottom of South Norwood-hill and over Goat House Bridge to the Penge boundary. For the purposes of this inspection the use of a tramcar was necessary in order that it might be driven over the section. Accordingly, on behalf of Croydon Council, application was made to the secretary of the British Electric Traction Co. for the loan of a car. For some reason or other there was delay in the matter of lending a car, the secretary suggesting the necessity of a reference to the directors, and with a view to the need of saving any loss of time the Corporation officials approached West Ham Council, explained the circumstances, and were readily lent a car, which, on Wednesday, was brought by a steam-engine on a trolley to South Norwood. It was used for the purposes of the inspection. This new section of the tramway system must be completed and taken over before Nov. 30 if the company is to hand over the further sum of £3,000 according to agreement, for that day is the last upon which the Croydon County Council can give notice to the British Electric Traction Co. for the termination of their lease in May next, and this section must be handed over before its inclusion in the lease and the notice.

Belfast.—It is reported that efforts are being made by the contractors, Messrs. J. G. White and Co., to complete the conversion of the city tramway system from horse to electric traction, and it is now expected that the system will be in full working order before the end of this month. Preliminary tests have already been made with one of the two new engines—1,000-kw. triple-expansion steam dynamos by Messrs. Fairbairn, Lawson, Combe, Barbour, Belfast—and further final tests will be made immediately. The boilers are now completed, and the greater portion of the switchgear is finished. The coal-conveying plant inside the power station is almost complete, but there is a good deal of outside work yet to be done. This work, however, will not interfere with the generating machinery, which will be ready when the permanent way is complete. Some interesting figures have been compiled showing the cost of the Belfast tramways up to the 16th ult., and the position of the Corporation with regard to the loan of a million sterling raised for the purpose of buying out the old company and electrifying the lines. The purchase of the undertaking, including compensation to directors and officers (£7,500) and stamp duty on the purchase money, required a sum of £307,878. 19s. 6d. Altogether the sum paid on account of the tramway system up to the date specified is £767,563. 19s. 5d. Against that £9,408 has been received for a portion of the old rails, leaving the net sum expended £758,155. 13s. 1d. Since the date named further payments amounting to some £60,000 have been made.

London Transit.—So far as can be ascertained, few Bills dealing with the extension of transit facilities in London are likely to be promoted in the forthcoming session of Parliament. Notices of a number of schemes have been drawn up, but in view of the uncertainty which prevails with regard to the intentions of the Government respecting the report of the Royal Commission on London Traffic, promoters are disinclined to proceed with the Bills. It was hoped that some statement indicating the attitude which the Government might adopt towards the recommendations of the Commission would have been forthcoming from a Minister in time to permit of notices being lodged on Nov. 15, but this is now regarded as being out of the question, and the general feeling is to postpone further action. Amongst the schemes which are likely to be "hung up" for the present are the following: (1) a new "tube," promoted by the Yerkes group, from Hammersmith to the City, going under the Strand *en route*; (2) the Hammersmith, City, and North-East "tube"; (3) extension of the Central London Railway to Liverpool-street, and a new line by way of the Strand and Piccadilly to Hammersmith and Shepherd's Bush. We understand that the only application which the Underground Electric Railway Co., of which Mr. Yerkes is the head, intends to make is for a deviation of the proposed extension of the Baker-street and Waterloo "tube" to Edgware-road and Paddington. The London County Council proposes to seek powers for important developments of its tramway system, and the London United Electric Co. will probably also promote a Bill. It is probable that the Baker-street and Waterloo Railway will be opened in March. The first train was run from the London-road depôt to Baker-street and back recently. Mr. Chapman (engineer to Mr. Yerkes) and Mr. Manley travelled by it, and the working gave every satisfaction. The carriages are being delivered up to contract time.

Edinburgh.—The violent jerking to which passengers on the cable cars have been long accustomed resulted in a serious accident on the Portobello route. A gentleman standing near the platform was precipitated into the street and rendered unconscious. A special meeting of Edinburgh Town Council was held last week for the purpose of considering the town clerk's report on the tramways policy (which we commented upon last week), and give instructions as to tramway extensions and other matters to be included in the provisional order in the ensuing session of Parliament. The Town Clerk at the outset made a statement on the question, and pointed out that of the total expenditure on tramway matters, amounting to £1,350,000, which he detailed, the only item that would require to be renewed was the machinery. Further, he defended the Corporation against the charge of undue delay which had been made against them in the construction of the system. It was resolved that the Corporation should be the owners, or potential owners, under option to purchase, of all the tramways within the city, and should from time to time make such extensions and new lines within the city as they consider to be required for the public convenience. Resolutions that the Tramway Committee should confer with Leith Council and the Mid-Lothian County Council in view of joint action over any provisional orders for tramways at or near the boundaries of the city, and to report; and that all public tramways in the county outside the city boundaries but within a reasonable distance thereof being the property, or the potential property, of the Corporation, were referred to a special committee. The Town Clerk then explained that they had in their provisional order the Gilmore-place tramway, which ran outside their boundary, and to that extent, though it was insignificant, it was affected by the question of policy they had been discussing. This line was proposed to run out to the hydropathic and return by Fountainbridge to Tolloross. Then there was the Broughton-street and East Claremont-street line. At this point it was not necessary to make up their mind which system they would adopt, but they would have to do it before July. Certain companies were offering to lay down their underground systems at their own risk and cost. There was nothing going into their Bill about the Queensferry tramways, but there was an application from the same company that came before them last year, who were proposing to go to the Board of Trade for an order to go from Queensferry to Comely Bank, and, in addition, a line from Davidson's Mains along Ferry-road to Golden Acre. They asked an agreement on similar lines to the last. He thought they were not in a position to answer that. In the same way they had to consider a suggestion from Leith Council about a line from Pilrig-street by Bonnington along the Ferry-road to Golden Acre and Granton. That also, he suggested, should go to the committee to be dealt with in conference with parties. There were proposals for a tramway by Dalkeith-road and Duddingston to Portobello, a Murrayfield tramway, and a tramway from Leith to Portobello. All these would go down as a matter of course to the committee, and it would be the duty of the committee, in reporting on these schemes, to deal with everyone of them. There was no time now to put them into the Bill.

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London County Council.—At Tuesday's meeting of the County Council the Highways Committee again submitted their recommendation for expending £415,600 on track work, including rails, and £250,000 on rolling-stock, cables, ducts, machinery, plant, etc. In consequence of the reconstruction for electric traction of the tramways in Woolwich-road, the present service of horse cars must be curtailed, and a rearrangement of fares is proposed. The Highways Committee propose that the resolutions of Aug. 1, 1905, and Oct. 17, 1905, to seek authority in the session of Parliament of 1906 for the construction of such of the new tramways authorised by the London County Tramways Act, 1900, the power in respect of which have not been exercised, and for the construction of certain new tramways, be rescinded, so far as regards the three undermentioned schemes: (1) from Cannonbury-road, *via* St. Paul's-road, to Ball's Pond-road; (2) from the existing tramways in Cassland-road to a point near Victoria Park; (3) from Aldgate (existing lines), *via* the Tower Bridge northern approach, to a point near the Tower Bridge. It is further proposed that expenditure on capital account not exceeding £1,750 be sanctioned to cover the cost of acquiring freehold of the property in Poplar for the erection of car-sheds. The Highways Committee will next week recommend that the tender of Messrs. W. T. Glover and Co., amounting to £37,860, for the supply of low-tension electric cables, feeder pillars, etc., for the tramways, be accepted. With regard to the type of car to be used in connection with the tramway subway from Southampton-row to the Strand, the Highways Committee recommend that the Board of Trade be asked to amend regulation No. 2, made by it under the London County Tramways (Electrical Power) Act, and by-law No. 3 made by it under the London County Tramways Act, 1896, so as to enable trailers to be used in connection with the single-deck cars on the Council's tramways, and for the trailers to be used by passengers wishing to smoke. The question of the several car-sheds on the north and south sides of the Thames has been under consideration, and the committee propose that application be made to Parliament in the session of 1906 for authority to make unrestricted use of sites to be acquired in various districts for the erection of tramway buildings. It is further proposed that authority be sought in the session of Parliament of 1906 to enable the Council to make such alterations in the route of the subway authorised by the London County Council (Subways and Tramways) Act, 1902, and to acquire such further property as may be necessary, to enable a station to be constructed in the subway immediately to the south of the Strand, under Wellington-street; and that the usual practice be adopted of inserting in the Bill to authorise such works a clause to provide that improvements made in lands or premises after Nov. 7, 1905, when the scheme was made public, shall not be taken into account in assessing compensation if such improvements be made with a view to obtaining or increasing the compensation payable by the Council. A joint deputation from Forest Hill and Sydenham ratepayers and the Lewisham Borough Council waited upon the Highways Committee of the London County Council for the purpose of urging the adoption of a scheme to extend the tramways route already adopted by the London County Council from Camberwell to Forest Hill Station, through Dartmouth-road, Forest Hill, High-street, Sydenham, Kirkdale, Sydenham-road, Bell-green, and on to the existing tramways at Catford, the proposed route passing within five minutes of the Crystal Palace grounds. The scheme of tramway electrification from Westminster Bridge to Wandsworth on the lower route (*via* Nine Elms-road and Battersea Park-road, and thence to Earlsfield and Tooting, has been commenced. Up to the present there has been no tram communication between Wandsworth High-street, where the new car terminus will be established, and Tooting, a distance of three miles. Electric cars are running between Tooting and the "three bridges." The new link will form an important communication between South and South-West London. The scheme is a costly one, the Council having had to acquire immense blocks of shop and house property to straighten and widen the thoroughfares, and the electrification alone will involve an expenditure of £126,000. The Council offer many sites of building land on lease. When the scheme in hand is completed, the electrification of the higher, or Wandsworth-road, route will be commenced. That will cost over £90,000.

LIGHTING AND GENERAL.

Barton-upon-Irwell.—The Rural District Council intend to apply for an electric lighting provisional order.

Brechin.—An electrical exhibition has been held under the auspices of the North of Scotland Electric Power Co. in the Corono Hall.

Darlington.—The question of altering the scale of charges for the supply of electrical energy for power purposes is being considered.

Birstall.—An inquiry has been held into an electric light scheme. It is contemplated to obtain the current from the Yorkshire Power Co.

Oulton.—The Street-Lighting Sub-Committee have arranged with the Oulton Broad Electric Co. as to the placing of the necessary street lamps.

Wellingborough.—The Highway and Lighting Committee are making progress with regard to a scheme for electric light works, electric lighting, and refuse destructor.

Durham.—At Wednesday's meeting of the County Council a report in favour of a county electricity scheme was submitted, and it was decided to withdraw the same for the present.

Wealdstone.—The District Council have decided to oppose the application for a provisional order for electric lighting of the North Metropolitan Electrical Power Distribution Co.

Amazon Telegraph Co.—The accounts for the year ended June 30 show a net profit, after providing for interest charges and the service of the debentures, of £9,836, reducing the debit balance brought forward to £78,235.

Rhymney.—A request to support a private company for the distribution of electric light in the district has been deferred for the legal opinion of the clerk, who is to report how far such action would involve the Council.

Halifax.—The Special Sewerage Committee have been instructed to go into the question of having the electricity station at Milner Royd combined with the refuse destructor, including provision of pumps for dealing with the sewage.

Stepney.—The Council have invested £1,500, part of the reserve fund of the electricity undertaking, in Lancashire and Yorkshire Railway 4 per cent. preference stock a security calculated to give a return of 3½ per cent. on the money invested.

Aston.—The total number of Board of Trade units sold during quarter ending Sept. 30 was—for lighting, 63,767; power, 71,527; traction, 227 150. In the corresponding quarter of last year the figures were: 42,187, 37,755, and 107,220 respectively.

Liversedge.—The District Council have decided to call in one of the engineers of the Yorkshire Electric Power Co. to advise them on the question of laying mains in a certain part of the district, which has been scheduled under an agreement with the company.

Elstree.—A letter from the Barnet District Council, asking for the opinion of the Elstree Parish Council upon a scheme of the North Metropolitan Electric Co. for the extension of its supply from Arkley to Elstree, will come before the next meeting of parishioners.

Eltradion Athletic Club.—A Bohemian concert will be held at the University Tavern, Chenies-street, Tottenham Court-road, on Nov. 11 at 8 p.m. The chair will be taken by Mr. A. Ewer, president, assisted by Alderman Dan Hennessy, St. Pancras Borough Council.

Wishaw.—An electric lighting installation was formally switched on last week. The cost of the scheme to the burgh is about £10 000, and the price charged to consumers is 3½d. per unit. The supply is taken from the Clyde Valley Co.'s new power station at Motherwell.

Rochdale.—It appears that the site of the electricity sub-station which is being erected at Littleborough for tramway purposes is waterlogged, and, on the recommendation of the borough surveyor, it has been decided to put down a concrete waterproof bed at a cost of about £50.

Kingsway Lighting.—We note that the Holborn Town Council have declined an offer from the Metropolitan Electric Supply Co. to erect and supply with energy free of charge for six months two electric arc lamps at the junction of Kingsway with High Holborn and in Southampton-row opposite Fisher-street.

Hackney.—With regard to the accounts published in our last issue, we desire to correct an item in the revenue account, where energy supplied to refuse destructor is stated as £3,450. 5s. 3d. This should read: "Energy supplied for power purposes—private supply, £2,799. 9s. 9d.; destructor, £650. 15s. 6d.—total, £3,450. 5s. 3d."

Llangollen.—The Council have adopted the tender of the Llangollen Electric Lighting Co. to extend the present system of electric lighting in the centre of Llangollen, and to incorporate the whole of the urban area. Powerful electric lamps will be affixed for wide thoroughfares, and smaller lights in the narrow streets will be attached to the existing gas standards.

Amalgamation.—The firms of Messrs. Arthur Koppel, of 27, Clement's-lane, London, E.C., and Messrs. Orenstein and Koppel, Bush-lane, Cannon-street, E.C., have amalgamated, and henceforth the combined business of the two firms in the United Kingdom, which represents a capital of £1,100,000, will be carried on by Messrs. Arthur Koppel at 27, Clement's-lane, London, E.C.

Ventilator Flaps.—It often happens that the openings made for ventilators have no closure arrangement. The inconveniences arising from this are removed by the "automatic closing flap for ventilators" which has been put on the market by Messrs. Mestern and Co., Nachf, Berlin, S.O. 26, Oranienstrasse 6. The flap, which is transparent, can be easily fixed, and opens and closes automatically.

Exeter.—The mayor (Mr. E. C. Perry), supported by the mayoress and several members of the Corporation and officials, on Wednesday opened an exhibition arranged by the Electric Lighting Committee of the Corporation in the Victoria Hall to demonstrate the advantages of electricity for heating, lighting, and cooking, the arrangements being superintended by Mr. H. D. Munro, city electrical engineer.

Electric Tramways and Omnibus Company of Bordeaux.—The Compagnie Française des Tramways Electriques et Omnibus de Bordeaux announce that a dividend for the half-year ended June 30, 1905, will become payable on Nov. 15, 1905, as follows: 3s. 9d. on registered shares, by endorsement on the certificate; 3s. 6d. on bearer shares, against coupon No. 8, at the current rate of exchange of the day.

East Molesey.—The Twickenham and Teddington Electric Supply Co. are now making good progress in laying their cables, but are applying to the Urban District Council for consent to the exclusion of some of the roads they originally intended to cable. A site has been selected for a transformer station. It is intended to bring the cables across the river in troughs suspended under the footpath of the bridge, subject, of course, to the consent of the County Council on either side.

Wrexham.—The borough electrical engineer's last report gives the following details: total consumption during the month of September, 41,886 units; new consumers connected, three; additions to connections, 250 8 c.p. lamps; total number of consumers, 191; total private supply, 14 070 8-c.p. lamps. The Great Central Railway Co. and the Great Western Railway Co. have been asked to delegate their respective engineers to discuss the question of supply of current and charges.

Dublin.—The necessary enlargement of the Mansion House sub-station will be carried out by the Corporation staff under the direction

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of the city architect. A list of the tenders appears in another column. The Lighting Committee are thoroughly satisfied so far with the manner in which the tenders have worked out in comparison with the estimates. The Council last week received a deputation from the Dollymount Improvement Association urging the electric lighting of the Clontarf district.

Surveying and Drawing Instruments.—Messrs. W. F. Stanley and Co., 4 and 5, Great Turnstile, Holborn, W.C., have just issued a new edition of their catalogue, which has been much improved and enlarged. The last edition contained 80 pages only, the new list makes a handsome volume of 148 pages. The firm, whose goods are too well known to need description, is expanding also. Now they have passed their jubilee, they have succeeded in obtaining 286, High Holborn, adjoining their works, and have transferred their sale-rooms to that address.

London Gazette.—The partnership between James Mellanby Morrish and Ernest Tumber, electrical engineers etc., 26, Linthorpe-road, Middlesbrough, Yorks, has been dissolved by mutual consent. William Evans, King-street, Newcastle, Staffs, has been released from trusteeship in the estate of Harry Cooke, electrical engineer, 102, Buccleuch-road, Normacot, Longton, Staffs. The partnership between George Alfred Rowland and William Robinson, carrying on business as electrical engineers at the Falcon Works, Virginia-street, Southport, under the style of the Virginia Electric Co., has been dissolved by mutual consent.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 22 special settling day for Johnston and Phillips's 6,635 ordinary shares of £1 each, fully paid, Nos. 1 to 6,635, and £116,667 5 per cent. first mortgage debenture stock; and have ordered the Indian Electric Supply and Traction Co.'s partly-paid provisional certificates for £120 500 6 per cent. construction debenture stock to be quoted in the official list. Application has been made to the committee to allow Amazon Telegraph Co.'s further issue of £35 900 5 per cent. debentures of £100 each, Nos. 1,251 to 1,609, to be quoted in the official list.

Telephone Kiosks.—The National Telephone Co. on Wednesday applied to the Holborn Council for permission to erect additional kiosks for call offices in suitable spots in streets under the control of the Council. At present there are four such kiosks in the borough, for which the company pay an annual rental of £15 each kiosk. This payment is considered quite inadequate, and we understand that permission has only been granted in one case at an annual rent of £30, and that the rental of the existing kiosks in the borough will be increased from £15 to £30 per annum each, at the conclusion of the current rental year."

Heckmondwike.—The report for month ending Oct. 31, 1905, contains the following figures: units generated on lighting, 1905, 41 189 (1904 25,082, increase 16,107); units generated on traction, 20,389 (16,015, 4,374); total units generated, 61,578 (41,097, 20,481); units sold—private lighting 8 431 (6 568 1,863), street-lighting 7,527 (7,064, 463), power 16 188 (2 631 13 557), traction 17,407 (15,247, 2 160); total units sold, 49,553 (31 510 18 043); units used on works, 5,833 (4 378, 1,445); total units accounted for, 55,376 (35,888, 19,488); station efficiency, 90 per cent. (87·3 per cent.); battery efficiency, 75 per cent. (71 per cent.); number of consumers, 199 (159, 40); equivalent 8-c.p. lamps connected, 22,913 (14,085, 8,828); maximum load on plant in kilowatts, 437 (257, 180); maximum load on feeders in kilowatts, 569 (244, 325).

Victoria Falls.—A Reuter's telegram states that the African Concessions Syndicate has been in consultation with the leading American and Continental engineers and experts on the subject of the transmission of power from the Victoria Falls to the Witwatersrand. These authorities have unanimously expressed the opinion that the scheme is not only quite feasible but would be commercially successful, especially as the climate of South Africa is one of the most suitable in the world for the transmission of power. There is no ice in the rivers to interfere with the working of the turbines, and no snow to break down the transmission lines. The extreme dryness of the climate is also greatly in favour of the project. The experts consider that there is absolutely no difficulty in the way of the scheme so far as the distance of transmission is concerned.

Birmingham.—The Nechells destructor was opened on Tuesday, and the electric transmission system in connection with the sewage farm at Tyburn was inaugurated. In 1901 the city of Birmingham obtained from the Tame and Rea Drainage Board two acres of land at Saltley for £400 per acre. The Drainage Board agreed to build and equip the boiler-house and to pay 10s. per horse-power per annum. By obtaining steam from the destructor the Board could dispense with five portable engines and pumps, two gas-engines, and certain farm-yard machinery, besides getting rid of gas and water bills amounting to nearly £400 per annum, and altogether they will save more than £1,000 per annum by substituting electricity for steam. Mr. Watson prepared the plans, and the principal contractors were Messrs. Lee and Son for the whole of the buildings, £15,615; the British Thomson-Houston Co. for the whole of the electrical work, £8,314; and Messrs. Heenan and Froude for the furnaces, £4,589. The total cost of the scheme is £35,829. 2s., of which the Corporation pays £17,691. 10s. and the Drainage Board £18,137. 12s.

Gillingham.—The engineer's last report shows that the equivalent of 177 8-c.p. lamps has been connected with the mains since the last meeting of the committee, making a total of 47,268 8-c.p. lamps with 258 consumers. An estimate of cost of laying street-lighting mains, including seven columns and brackets fitted with 32-c.p. lamps, amounting to £56 and of £10 for attaching an arc lamp to the tramway standard at Victoria Bridge, has been approved. The committee are considering an application from the Kent Electric Power Co. for a reduction in the price of the bulk supply of electric current provided the company enter into a contract with the Council up to September, 1906. The committee intend to apply to the Inspector-General for the extension of their contract to the Naval Hospital for another year in consideration of the fact that the Admiralty did not commence to take electric current until 12 months after the time mentioned in the contract, and the Inspector-General's attention is to be called to the fact that the hospital is not taking the amount of current which the Council were led to suppose they would require.

City of London.—At the last meeting of the Court of Common Council, the chairman of the Streets Committee was asked whether they would consent to the withdrawal of the notices recently served on the City of London Electric Lighting Co. requiring them to remove their lamps and standards in various important streets of the City pending the result of the present experiment in incandescent gas lighting, as either proving or disproving the contention that such lighting was more efficient and satisfactory than the electric light. Mr. A. C. Morton replied that the three months' notices to remove the electric lamps in Fleet-street, Queen Victoria-street, and elsewhere were served on the company some time ago. Since then the company had appealed to the Corporation to cancel the notices, but it had declined. The committee would report carefully and impartially on the experiment now being made, and the Corporation could take any action it liked in the matter. An invitation by the London County Council to the Corporation to a conference to consider the supply of electrical energy in London on the 20th inst. was referred to a committee.

Horsham.—On Nov. 2, Mr. Lintott, as chairman of the Electric Lighting Committee, when starting a new engine at the electricity works, said that last year the undertaking had shown a profit of more than £1,000, which had paid off nearly the instalment of loan and interest. Next year he hoped they would do very much better. Mr. Morgan then supplied particulars concerning the undertaking since he took it over two and a half years ago, and expressed the opinion that in the course of a few years the undertaking would be one of the most sterling assets the town possessed. Their capital expenditure, which two years ago amounted to £13,000, had now doubled. But whereas their horse-power in machinery was then 225 it was now 711, including the new engine, and while they then had 3,800 lamps connected and 85 consumers, they had now 9,500 lamps and 260 consumers. Five miles of mains had increased to 16½ miles. The earnings had risen from £1,244 to £2,400, and the profits from £249 to more than £1,000. The new engine would give 220 h.p. continuously, if necessary, for a month or two. It took 300 gallons of water an hour and consumed 7 cwt. of coal. Against that expenditure it had an earning capacity of £2. 10s. per hour. The British Westinghouse Co. were the contractors.

Awards.—The 500-b.h.p. Diesel engine exhibited at the Liége Exhibition has been awarded the "Grand Prix." We are informed that at a recent test carried out by the purchasers of this engine, the extremely low figure of ·38lb. per brake horse-power hour was obtained for fuel consumption at full load. This, with oil at 42s. per ton, represents a cost of 0·096d. per brake horse-power hour, or 11½ brake horse-power hours for 1d. The Diesel Engine Co., of London, have recently secured an order for an engine of this power (500 b.h.p.) to drive the new extension of the works of Messrs. Craven and Speeding Bros., Sunderland, where a small Diesel engine of 240 b.h.p. has been used to drive the existing works for nearly two years. Among other contracts recently obtained, the Diesel Engine Co. report: 150 b.h.p. for Messrs. Bartram and Sons, Sunderland; 225 b.h.p. for Messrs. Binny and Co., Madras; 160 and 140 b.h.p. for Messrs. Bradbury, Brady, and Co., Bombay; 90 b.h.p. for Messrs. Gibson, Battle, and Co., Sydney; two 33-b.h.p. for the Guildford Electric Lighting Co., Australia; two 20-h.h.p. for Messrs. Haupt, Biehn, and Co., Rio de Janeiro. The Horsfall Destructor Co., of Leeds and London, have been awarded a Diploma d'Honneur in Class 3 (Hygiene) at the Liége Exhibition for their exhibit of refuse destructor plant.

Bermondsey.—At Tuesday's meeting correspondence was submitted with regard to the offers of the County of London Electric Supply Co. and London Electric Supply Corporation. The former company offered (*a*) to supply the Council with current in bulk for distribution by the Council within the area of supply at a price cheaper than it can be generated by the Council; (*b*) to take over the Council's undertaking on lease and to work same for a period of years, the company guaranteeing the Council a sum sufficient to provide sinking fund and depreciation on the capital expended. The latter proposed a meeting between their engineers and those of the Council. Both offers were declined, and in doing so the town clerk pointed out that the Electricity Committee was not aware that in any sense had a cutting policy been adopted by them, as suggested in one of the letters. The electrical engineer has been asked to bring up an estimate for condensing plant at the next Council meeting. A cooling chamber is to be constructed for cooling clinker from the destructor at a cost of £125. The consumption of current at the Bermondsey Baths for the quarter ending September, 1905, is returned as 4,206 units (868 units for light and 3,338 units for power) as against 4 208 units (889 units for light and 3,319 for power) for the corresponding period of last year.

Carlisle.—The Council have received a special report on the details of the station working as follows: "The sale of current in 1904 5 showed an increase upon that of 1903 4, but the result of last year's working gives an actual loss of about £400, excluding, of course, the amounts due for interest and sinking instalments upon the increased capital account. It is unfortunate that just as these increased payments had to be met we were faced by an abnormal expenditure, payable out of revenue, for maintenance and repairs, a series of accidents to the plant costing a large sum in the aggregate. The sub-committee are assured by Mr. Burnet that the engines and plant are now in a thoroughly good condition, and that he has every reason to hope that there will be a very substantial reduction in the cost of maintenance and repairs in 1905 6. Every care will be taken to keep down expenditure, and taking into account that the engines and electrical plant are now insured, and charges which last year had to come out of revenue will

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now be recoverable, there is reason to believe that the result of this year's working will be very much better. It should be noted that up to last year the yearly deficit has been steadily reduced year by year, the loss upon 1903-4 being nominal. Last year the new capital charge created extra interest and sinking instalments, but your committee hope that this will also be rapidly reduced in view of the continued applications for current."

Dundee.—The Tay Ferries Committee have decided to light the Craig Pier by electricity. The estimate for overhead wiring is £80. A remit has been made to the engineer to place the contract. The last report of Mr. O. F. Francis, the engineer, on the electric light department, shows that 26 new consumers were connected between May 15 and Sept. 30, or an average of 5·8 per month, and applications were being continually received from old consumers for additional lighting. The units sold this term, as compared with the same period last year, were: private lighting—1905, 17,100; 1904, 11,326—increase, 5,772; private motors—1905, 28,100; 1904, 9,327—increase, 18,773; total—1905, 45,208; 1904, 20,653—increase, 24,545. The increase in lighting units was very satisfactory, and if it continued during the remainder of the year, the income to the undertaking would be increased by at least £40 more than what was anticipated in the estimates. The working costs show a satisfactory decrease over the same period last year, and he anticipated that they would be as low, or lower, for the current year as those obtained in any similar sized town in its third year of working. The engineer says that on the whole the electric lighting department is in a very satisfactory position, and he believed that, instead of a deficit of £397, which was estimated last May for the current year, they would be able to show a net profit after paying a final balance of £517 for the costs and order, and next year they would be able to so reduce the cost of current to the tramways as to practically cover the expenditure on them.

Swanage.—The Council have approved of a report in regard to a scheme to be promoted by the Bournemouth and District Electricity Supply Co. for obtaining powers to supply electric lighting within the parish of Swanage. The company stipulate that the provisional order should provide that the Council should have power to purchase after 21 years from the date of confirmation of the order, allowance being made or the goodwill of the undertaking; that the authority should have the same power at the end of 28 or 35 years from the date of the confirmation of the order; and that if the option to purchase were not exercised until after 42 years from that date, the purchase should be at a fair market value at that time, but without any addition in respect of compulsory purchase or of goodwill, or of any profits which may or might have been made from the undertaking, or any similar considerations. The maximum price of electricity supplied for lighting purposes is set out at 7d. per unit, and of electricity supplied for power purposes at 2½d. per unit. The area has been fixed, and all cables and supply wires will be laid underground, and where practicable under footpaths. Any roads or paths disturbed by the company are to be reinstated by the Council at the expense of the company—the cost to be calculated according to a schedule of prices to be agreed on. A clause is to be inserted in the provisional order providing for what is known as a "stand-by" supply in cases where householders have already an electric installation. The Council have sanctioned an agreement on these terms, reserving the right to make any other stipulations or conditions which may appear necessary after the draft provisional order has been received and considered.

Battersea.—The Lighting Committee reported at Wednesday's meeting receipt of a letter from the London County Council with reference to fires caused by short-circuits on cables, stating that they do not consider it necessary that immediate notification of all fires occurring in the borough should be given to the electricity department, but that it is the practice of the fire brigade to notify the Battersea electricity department without delay of any fires due to electricity or involving electric cables or apparatus that may occur in the borough. Two representatives were appointed to attend a conference at the County Hall on Nov. 20 in reference to the question of the supply of electricity in bulk. The accounts of the electricity undertaking during the year ended March 31 last show a great advance, and that after deducting all expenses a profit of £294. 17s. 10d. has been made. There has been a considerable increase in the demand for electrical energy both for lighting and motive purposes, and a material saving in the cost of working. When it is remembered that the repayment of the loans, which was suspended for three years, began during the year in question, causing an increase in payments of £3,500, the results achieved are very gratifying. In connection with the accounts, the committee have considered a letter from the London County Council suggesting the establishment of a reserve or renewal fund in re electric lighting undertaking, and they recommended that the County Council should be informed that whilst this Council are in favour of the views expressed in their letter, they do not see their way to carry out the wishes of the County Council at this stage. The amount received for meter rents during the past year has been £62. 14s. 10d., as against the total receipts of £23 698. 6s 9d., and having regard to the disproportion in the receipts for meters and the total receipts, and in consequence of complaints received, the charges for meter rents are to be abolished after the Michaelmas quarter readings of the meters have been taken.

Hammersmith.—The annual report of the borough electrical engineer upon the working of this department for the year ending March 31, 1905, states that during the year 320 consumers were connected and 212 disconnected, and there are now 1,577 consumers taking current from the mains, a net increase of 108 over the previous year. This increase is not quite so large as usual, the increase in equivalent 8-c.p. lamps connected being 6,859. The units sold per 8-c.p. lamp connected have increased from 26 for the 12 months ending March, 1904, to 32 for the year under review. During the year 2,948,633 units were sold, or 724,710 more than the previous 12 months, this increase being nearly double that mentioned in my last year's report. Of the extra units sold 414,601 were used for power purposes; 146,175 were used for public lighting; 163,934 were used for private lighting. The maximum demand upon the generating station has risen from 1,596 kw. to 2,246 kw., which occurred during the period of the motorcar exhibition at Olympia. It is interesting to note that this maximum demand is equivalent to the total output of all the plant installed at the generating station, thus showing that the plant has been well maintained so as to be able to meet this demand. The question of efficiency of generation by means of this plant is another matter. The ordinary maximum demand upon the station—*i.e.*, excluding the period of the motorcar exhibition—was 2 068 kw., an increase of 472 kw. over the previous year. The average price per unit sold for private supply is still decreasing, being only 2·94d., against 3 43d. for the previous 12 months, a decrease of practically ½d. per unit. This is caused by the reductions obtained by several of the largest consumers under special contracts, and the extra consumption which these rates induced. The use of electricity for power purposes has considerably advanced in Hammersmith, and there are now 180 motors of 1,207 h.p. connected to the circuits, an increase of 289 h.p. on last year's figures. This increase is doubtless owing to the low price at which current is now supplied for power. It is interesting to note that the output of current used for power purposes for the year ending March, 1904 was 611,049 units, whereas for the year ending March 31, 1905, this figure has increased to 1,032,871 units. The charges for current remain the same as during the previous year, but after September, 1905, the charge for current used for lighting will be reduced to a uniform rate of 3d. per unit. It is anticipated that this reduction will induce a large number of residents to adopt electricity for lighting purposes, and it is already having the desired effect, as several of the present consumers have intimated their intention to extend their installations. The statement of units generated and sold is as follows: quantity generated in Board of Trade units, 3,456,570; sold—public lamps 472,906, private consumers 2,475,727—total, 2 948,633; quantity used on works, 456 306; total quantity accounted for, 3,404,939; quantity not accounted for, 51,631; number of public lamps, 223 arcs and 63 Lofcus; total maximum supply demanded, 2,426 kw. In conclusion, Mr. Bell mentions that the year in question has been the most successful since the commencement of the undertaking. The expenditure has been actually less than for the year ending March, 1904 whilst the revenue has increased by about £3 000. The net result is a profit of £5,282 on the year's working, which has been arrived at by improved and economical working of the plant.

London County Council.—On Tuesday tenders were opened for the supply and delivery of steel conductor tee rails required in connection with the reconstruction of certain of the Council's tramways north of the Thames. These were referred to the committee concerned. It was agreed to lend the Hammersmith Borough Council £13,700 for electric light installation. Sanction to borrow £991 for electric light installations and street lighting was given to the Woolwich Borough Council. The following important report was submitted by the Finance Committee with regard to the Fulham loan noted in our last issue: "We submitted on Oct. 31, 1905, a recommendation that a loan of £25 000 should be advanced to the Fulham Metropolitan Borough Council for electric light installation, but the Council postponed for one week the consideration of our recommendation. In our report we stated that, in view of the uncertainty as to the method of generating electrical energy in London in future, we should have preferred that large works of extension of generating plant should not be undertaken by the borough councils at the present time, but that, having regard to the fact that the work which formed the subject of the application had been commenced, we thought the loan should be granted. In support of the adoption of our recommendation without delay, we would state that we understand that the plant already installed is only just sufficient to supply the estimated maximum demand during the coming winter, and it, therefore, appears necessary that an immediate addition shall be made to the existing generating plant. Under these circumstances we do not think that the Council should refuse to sanction the loan now under consideration. We may state that the proposal to supply to distributing authorities of electricity in bulk is receiving our careful consideration in connection with applications from local authorities for loans for electric lighting purposes. Should the Council decide to grant the loan it would be convenient for it to be advanced without delay. We have, therefore, included the amount in the list of proposed payments, and submit a recommendation as to the sealing of the order sanctioning the borrowing. The adoption of the recommendation will not, of course, be moved unless the Council decides to grant the loan. We recommend that the seal of the Council be affixed to an order (in duplicate) sanctioning the borrowing by the Council of the metropolitan borough of Fulham of the sum of £25,000 for the installation of the electric light within the borough, repayment to be made within a period of 42 years." This was agreed to after discussion. The Highways Committee reported that Messrs. J. Westwood and Co., who had in accordance with the resolution of July 28, 1903, erected the steelwork required in connection with the first portion of the Greenwich electricity generating station, had rendered themselves liable under the provisions of their contract to deduction by way of liquidated damages in respect of delay in the completion of the work. The contract price was £36,808. 14s. 6d., and, after making allowances for causes not within the control of the contractors, it was computed that the Council might claim as damages a sum of £2,500 in all. Having very carefully considered the matter, they had arrived at the conclusion that, in view of all the circumstances, a fair arrangement would be for the Council to retain a portion only of the £2 500 above referred to in respect of the delay occasioned. They suggested, therefore, that £500 of the

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£2,500 should be retained, and recommended accordingly. In connection with the construction or reconstruction of the New Cross to Rushey Green tramways, the Battersea and Wandsworth lines, and the Vauxhall Bridge-road, etc., tramways, it will be necessary to supplement the switchgear at the existing sub-stations from which the lines will be worked. For this purpose additional low-tension feeder panels are to be provided at a cost of £850 at the New Cross, Elephant and Castle, and Brixton sub-stations. Notices of intention to lay low-tension mains from the County of London Supply Co. in Green-lane and from the London Electric Supply Co. across Westminster Bridge were approved. Similar notices from the St. Pancras and Islington Borough Councils were also received.

PROVISIONAL PATENTS, 1905.

Oct. 30.

22037. Electric switch (two-way or more) for motor cycles, cars, stationary combustion engines, and the like. William Andrew Ewbank and Frederick William Barnes, 91, Moor-street, Earlsdon, Coventry.

22061. Improvements in and connected with folding up telephone stations. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Aktien-Ges. Mix und Genest, Germany.)

22086. Improved candlestick which can also be used for electric lighting. Ernest Brown, 55, Lant-street, London.

22088. Improvements in or connected with lifeguards on tramway vehicles either in combination with sanding gear, magnetic or rheostatic brakes, or independently thereof. Mark Cummins, 8, Peel-terrace, Chester-road, Old Trafford, Manchester.

22119. Improved method of controlling lifts electrically. Edmond Meyer Tudor Boddam, 23, Savernake-road, London.

22121. Improvements in actuating devices for magneto-ignition apparatus. Magnetzünder-Gesellschaft Unterberg und Cie., 322, High Holborn, London. (Date applied for under Patents Act, 1901, Feb. 28, 1905, being date of application in Germany.) (Complete specification.)

22129. Improvements in or relating to alternating-current distributing systems. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

22130. Improvements in the manufacture of magnetic materials. Robert Abbott Hadfield, 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, June 8, 1905, being date of application in United States. (Complete specification.)

22132. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

Oct. 31.

22149. Improvements in telephone receivers. James McMillan, 65, Chancery-lane, London.

22195. Improvements in braking polyphase induction motors. Rudolf Braun, Westinghouse-building, Strand, London.

22197. Electrical safety device against burglary. Eugenia Amadea d'Urbino, 321, High Holborn, London.

22198. Improvements in contact apparatus for electrical igniters. Charles Aubrey Day, 321, High Holborn, London. (Fabrik Elektrischer Zünder, G. m. b. H., Germany.)

22231. Improvements in apparatus for controlling the supply of electrical energy from alternating-current electric generators to alternating-current electric motors. Robert Stafford McLeod, 34, Castle-street, Liverpool.

22261. Improvements in systems of electrical distribution employing rectifiers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22262. Improvements in alternating-current dynamo-electric machines. British Thomson-Houston Company, 83, Cannon-street, London. (The General Electric Company, United States.)

22263. Self-testing safety code for telegraphing and cabling. Charles Judge Mitchell, 8, Colborne-street, Toronto, Ontario, Canada.

Nov. 1.

22290. Improved combination gear applicable for speeds starting and lifting power and other electrical and mechanical purposes. William Henry Walter Lucy, 28, Thornton-street, Brixton, London.

22314. Improvements in or relating to the electrical production of heat for cooking and other purposes. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

22334. A method of auto-regulation for dynamo-electric generators subject to fluctuations in speed. Henry Wright, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22343. Improvements in transformers, reactances, and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22349. Improvements in or connected with starting and driving mechanism suitable for use with gas-engines, electromotors, and other engines. Charles Baxter, 37, Essex-street, Strand, London.

22353. Improvements in or relating to electric incandescence lamps with metallic filaments. William Phillips Thompson, 322, High Holborn, London. (Deutsche Gasglühlicht Aktien-Ges. (Auergas), Germany.) (Complete specification.)

22357. An improved electric signalling system for railways. A. Gardiner, 40, Chancery-lane, London.

Nov. 2.

22404. Improvements in electric incandescent lamps. Harry King, Seymour Villa, West Bridgeford, Nottingham.

22419. An improved form of electromagnetic mechanism for giving a signal, actuating a switch or the like under certain predetermined conditions of current flow in an electric circuit or circuits. Henry Pierson, the Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

22450. Improvements in electrical measuring instruments. Charles Alfred West, 18, Southampton-buildings, Chancery-lane, London.

Nov. 3.

22460. Improvements in electrodes. Mataichi Yasuda, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, Jan. 21, 1905, being date of application in United States. (Complete specification.)

22472. An improvement in and relating to electric lighting. John Bolton, 2, Maygrove-road, West Hampstead, London.

22505. An improved weatherproof combined watch-holder and electric light for use on motor and other vehicles, the same being applicable for holding a speedometer, mileometer, or the like. Arthur Thomas Hawkes, 306, High Holborn, London.

22531. Apparatus for wireless transmission of telegraphic, telephonic and autographic messages by Hertzian waves. Gregorio Pansa, 7, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 4, 1904, being date of application in France.) (Complete specification.)

22544. Improvements in self-acting load resistance for the comparison or standardisation of current tension and effects. Martin Kallmann, Passauerstrasse 1, Berlin, Germany.

Nov. 4.

22578. Improvements in connection with trolley heads employed upon electrically-propelled vehicles. Maurice Paterson McLaren, 15, Hart-street, Edinburgh.

22585. Improvements in electric switches. The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham. (Complete specification.)

22616. An improved electrical circuit-closing device operated by the depression of the rail on railways or tramways. John Francis Dineen, 4, South-street, Finsbury, London.

22618. Improvements in and relating to apparatus for heating iridium filaments for incandescent lamps. Robert Jacob Gülcher, 231, Strand, London.

22620. Improvements in and relating to electric meters. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

22622. Improvements in electric switches. Frederick Millington and Albert Hugh Muller, 322, High Holborn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 23.

1904.

23952. Telegraphic and other transmitting apparatus. Armstrong and Orling.

24699. Electric motor control and apparatus therefor. British Thomson-Houston Company, Limited. (General Electric Company.)

25386. Single-phase commutation electric motors. von Zweigbergk.

26290. Control of alternating-current motors and apparatus therefor. British Thomson-Houston Company, Limited. (General Electric Company.)

26391. Mechanism for use in conjunction with apparatus for utilising electromagnetic or Hertzian waves. Smith.

27683 Instruments for the measurement of wave lengths in wireless telegraphy. Fleming.

28749. Telephones for the use more particularly of divers. Lacey and Holman.

29057. Electric insulation. Meirowsky.

29065. Electric dry batteries. Butler.

29074. Metal reflectors for use with electric lanterns. Rey.

29377. Fuses for electrical circuits. Field, and Ferranti Limited.

29448. Arc lamps. Könitzer.

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1905.

1563. Electrical measuring instruments. Field.

1891. Contact breakers of induction coils. Codd.

2030. Method and means for eliminating or reducing the influence of disturbing currents on telephone circuits. Jacobs.

3347. Switch apparatus for coin-freed electricity meters. Tourtel.

5149. Telephone and like transmitters Cutmore.

9991. Electric switches. Electric Ignition Company, Limited, and Hall.

11036A. Alternating-current measuring machines. Conrad and Bradshaw. (Date applied for under International Convention, May 27, 1904) (Originally included in No. 11,036, 1905.)

11036B. Alternating-current measuring instruments. Conrad and Bradshaw. (Date applied for under International Convention, May 27, 1904) (Originally included in 11,036, 1905.)

11702. Dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

12424 Electric telegraphy. Kitsee.

13063. Electric clock and alarm systems. Rausch and Gondolf.

13093A. Electric drills. Boult. (Duntley). (Date applied for under Rule 5, Patents Rules, 1905, June 24, 1905.)

14663. Central battery telephone transmitters. Scales.

16772 Connection or electric coupling boxes for electric cranes or other electrically-operated machines Siemens Bros. and Co., Limited, and Huddleston.

20371. Apparatus for sound transmission by means of electrically-produced light and heat rays. Siemens Bros. and Co., Limited. (Siemens-Schuckertwerke G. m. b. H.)

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Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2¼-2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	93-97
—— 4½ per cent. 2nd Debenture Stock	100 ..	78-81
Callender's Cable, Debentures	100 ..	109-111
—— Ordinary	5 ..	11-12 xd
—— 5 per cent. Pref.	5 ..	5⅜-5⅝
Crompton and Co.	3 ..	1½-1⅝
—— 5 per cent. Debentures	100 ..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1⅜-1⅝
—— "A" Shares, 01-017,139	5 ..	2-2½
—— 5 per cent. Debentures	100 ..	92 97
—— 4 per cent. Deb. Stock, Red.	100 ..	85 90
Electric Construction, Nos. 1 to 112,100	2 ..	⅝-¾
—— 7 per cent. Cumulative Pref.	2 ..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref...	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	12 13
—— 4½ per cent. Preference	5 ..	5⅛-5⅜
—— 4½ per cent. Debentures	100 ..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	33 35
—— 5 per cent. Bonds	100 ..	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	12¼-12⅜
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10¼-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11¾-12⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	107-109
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105 xd
Brompton and Kensington, Ordinary	5 ..	9¼-10
—— 7 per cent. Preference	5 ..	9¼ 9⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9-9¼
—— Nos. 60,001-80,000	5 ..	9 9¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13¼
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	105-108
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	7-7¼
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5
—— ditto (1903) 40,001-80,000	5 ..	4⅜-5
Chelsea Electricity Supply	5 ..	5⅜-6¼
—— 4½ per cent. Debentures	100 ..	110-112
City of London, Ordinary	10 ..	12-12⅛
—— 6 per cent. Cumulative Pref.	10 ..	13¼-14½
—— 5 per cent. Debenture Stock	100 ..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	104-106
County of London Electric Supply, Ordinary	10 ..	9⅜-10¼
—— 6 per cent. Cum. Pref.	10 ..	12⅜-12⅝
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	102-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	6-6¼ xd
—— 4½ per cent. First Mort. Deb.	100 ..	109-111
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Havana Electricity, 1-15,000	10 ..	9¼-10¼
Hove Electric Lighting, Ord., 1-13,000	5 ..	8¼-8⅜
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	98-102 xd
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	15/16-1 1/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11¼-12¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1⅞-2⅛
—— 6 per cent. Pref.	5 ..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 100,001-300,000	5 ..	10-10¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 4½ per cent. Cum. Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	99-102
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5 ..	8-8¼
—— do., 57,0 0-75,000	5 ..	8-8⅛
—— 5 per cent. Pref., 1-57,000	5 ..	6¼ 6⅜
—— do., 57,0 0-75,0.0	5 ..	6¼-6⅜
Notting Hill Electric Lighting	10 ..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6⅜ 6⅝
—— 4 per cent. Debenture Stock	100 ..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	76-80
South London, Ordinary	5 ..	3½-4
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16-15/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-108
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13¾ 14¼
—— 7 per cent. Pref.	5 ..	8½-8¾
—— 3½ per cent. Deb.	100 ..	88 100
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅛-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5½
Westminster, Ordinary	5 ..	12⅛-12⅞
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½
Electric Tramways.—		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5 ..	5⅞-6⅛
—— Ord.	5 ..	8⅛-8⅞
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	105-107
Barcelona Tramways, Ord., 1-20,000	10 ..	13⅞-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9-10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101
—— 4½ per cent. Red. Deb. Stock	100 ..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3⅜-4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	95-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	124-127 xd
—— Ord. Pref.	100 ..	111-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	106-109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c. xd
—— 4½ per cent. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11-11½
—— 5 per cent. Perpetual Debenture Stock	100 ..	120-122
—— 4½ per cent. 2nd Deb. Stock	100 ..	98-100 xd
Buenos Ayres and Belgrano Trams.	5 ..	5 11/16-5 15/16
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5½
—— 5 per cent. Deb. Stock, Red.	100 ..	106-108
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	98-100
Calcutta Tramways, 1-102,268	5 ..	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-108
Cape Electric Tramways, Nos. 1-480,000	1 ..	1-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	3¼ 4¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14⅛
—— 6 per cent. Cum. Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 ..	2¼-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8 8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	£1,000 ..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum. Pref.	10 ..	9⅜-9¾
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100 ..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100 ..	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,132 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 ..	91-93
—— 4 per cent. Pref.	100 ..	101-103
—— " " deferred	100 ..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	105-103 xd
—— 5 per cent. Pref. Stock '91	100	118-121
—— " " " '95	100	117-120
—— " " " '01	100	113-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3⅜-4½
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	–	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99'-100;
Waterloo and City, Ordinary	100	87-89

Name.	Amount paid.	Last price
Telephones.—	£	£
National Telephone, Preferred	100	111(-112½
—— Deferred Stock	100	106)-107½
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	99-101
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1¼-1⅜ xd
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 4	1,219	1,201	+ 48	—	25½	20½	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	" 4	181	187	– 5	—	8	8	" 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	" 5	987	1,021	– 34	– 697	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2 338b	6·03
Birmingham Corporation	" 4	388	308	+ 80	—	2	2	" 31	17,133	4,709,738	265,525	·85	14·5	8 866	—
Blackburn Corporation	" 1	889	854	+ 34	+ 1,003	24	24	" 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	" 2	340	350	– 10	—	17½	17,	" 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	" 4	249	334	– 85	– 1,014	16½	16½	Dec. 3	31,846	2,325 677	579,264	3 28	13·19	—	7·27
Bolton Corporation	" 5	1,841	1,691	+ 147	+ 2,837	40	38	March 31	95 765	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	" 1	1,339	872	+ 467	+ 8,116	16 82	16 82	" 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7 19
Bradford Corporation	" 4	3,952	3 926	+ 26	—	96	77	" 31	230,085	47,168,000	5,053,392	1·172	10 9·7	2.396	—
Brighton Corporation	" 5	799	854	– 55	+ 476	9	9	" 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	" 3	4,711	4,659	+ 52	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	" 4	1,164	956	+ 103	—	10 60	10·60	March 3	—	—	—	1·32	10·6	2,768	8·18
Burton Corporation	" 5	275	310	– 35	– 1,290	8½	8½	" 31	17,950	3,878 269	454,082	1·07	9 21	2 068	6 76
Cardiff Corporation	Oct. 28	1,866	1,857	+ 8	+ 141	26†	—	" 31	112,209	24,134 363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	Nov. 4	163	171	– 8	– 648	8·5	8·5	Dec. 31	10,713	2,935 00	359,756	—	7 14	—	5·18
Central London Railway	" 4	6 8·5	6,833	+ 6	– 1,208	6	6	" 31	347,598	44,875,547	1,281,214	1 86	65 10	57,931	35 80
City and South London Railway	" 5	3,035	2,801	+ 234	– 71	6½	6½	" 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	" 2	414	457	– 43	+ 675	15½	15½	" 31	24,895	5,814,376	882,256	1·01	6 61	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Oct. 21	2 5	198	+ 7	—	4½	4½	" 31	11,250	2,853,200	281,743	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Nov. 3	96	111	– 15	– 12·	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·76	942	7·33
Dublin U. T., electric cars	" 3	3,841	4,756	– 915	} —	47	46	" 31	267,489	50,050,949	7,077,372	1 2·	9 07	5,691	5 55
Dublin S. District, electric	" 3	795	838	– 43											
Dundee City Tramways	" 1	821	817	+ 107	—	2·	2·	May 15	44,695	11,611,525	933 005	·90	1·49	1,913	7 13
East Ham Corporation	" 6	703	6 6	+ 127	—	23	23	March 31	36,652	13,689,658	863 816	64	0·18	2,994	6 79
Glasgow Corporation	" 4	15,799	14,529	+ 870	+ 17,113h	144½	143	May 31	756,480	195,767,519	17,9·5,595	—	10 12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8 56
Huddersfield Corporation	Nov. 4	1,313	1,180	+ 130	+ 1,372	35	35	" 3·	69,938	12,838,150	1,666 262	1 24	9·71	1,923	—
Hull Corporation	" 4	2,195	2,172	+ 23	+ 544	27	26	" 31	112,651	27,102,921	2,9·0,69·	1	9 29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	" 31	—	—	—	—	—	—	—
Ilkeston Corporation	" 1	108	116	– 8	– 795	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Oct. 18	185	208	– 23	—	7½	7½	May 15	12,201	3,632,855	434,3·6	·775	6·519	—	7·649
Leeds Corporation	Nov. 4	5,546	5 361	+ 185	+ 3,858	89	89	March 25	298,233	64,223,656	7,1·1 0·8	1·10	10·02	3,351	—
Leicester Corporation	" 4	1 974	1,673	+ 293	—	42	—	Dec. 31	26,011	12,039,252	1 223,507	1	9·79	—	4·82
Liverpool Corporation	Oct. 28	10 222	10,177	+ 45	—	103	103	" 31	547,625	116,642,663	12 166,419	—	—	—	—
Liverpool Overhead Railway	Nov. 5	1,340	1,488	– 148	– 1,272h	6·57	6·57	June 30	8·,302	11,171,865	1,024,275	—	—	—	—
London County Council	Oct. 28	11 324	10,552	+ 772	+52,430	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	Nov. 4	165	150	+ 15	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	" 2	97	126	– 29		2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	" 4	12 681	12,·30	+ 651	+ 16,415	149	131½	March 31	631,856	126,900,875	14,123,124	1 19	10 73	4 299	6 99
Metropolitan District Railway	" 5	7,601	6,581	+ 720	+ 330	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	" 5	17,152	16,979	+ 223	+ 549	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	" 4	127	103	+ 24	+ 400	—	2⅜	" 31	6,159	1,972,647	206 358	·84	7·14	2,233	—
Newcastle-on-Tyne Corporation	" 4	3 884	3,655	+ 229	+ 3,695	50	45	" 31	197,849	43,069,934	4,3·6,152	1·07	10 98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	" 5	1 606	1 2 0	+ 365	—	—	34	" 25	65,553	13,466,245	1 504 740	1·16	10·45	1,886	—
Portsmouth Corporation	" 4	1,662	1,543	+ 19	—	—	29	" 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Oct. 26	545	623	– 78	– 398	—	33½	" 31	—	—	—	—	—	—	—
Rochdale Corporation	Nov. 4	782	352	+ 430	—	6½	4½	" 31	14,881	2 837,110	336,517	1 24	9·24	1,102	7·92
Rotherham Corporation	" 2	447	415	+ 31	—	9½	7½	" 31	23,569	5 251,472	593,054	1 07	9 55	2,612	7·49
Salford Corporation	" 6	4,050	3,837	+ 153	—	70†	—	" 31	214,111	39,213,560	4,884,5·0	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	" 5	4 6·6	4,4·1	+ 175	+ 7,071	6··½	52½	" 25	240,565	63,952 283	6,043 8·9	903	9·543	3,653	6·477
Southampton Corporation	" 1	895	879	+ 13	– 457	—	18	" 31	49,365	9,294,772	1,108,3 9	1· 7	11 0·	—	7 85
Southend-on-Sea Corporation	—	—	—	—	—	—	9	" 31	—	—	—	—	—	—	—
Stockport Corporation	Oct. 27	755	527	+ 228	—	—	10½	" 31	—	—	—	—	—	—	—
Sunderland Corporation	Nov. 5	1,187	1,117	+ 70	+ 1,153	20	20	" 31	64,858	15,364,463	1,495,685	1 00·	10 36	—	6·37
Swindon Corporation	Oct. 18	171	—	—	—	—	4½	" 31	4,937	1,315,757	102,751	0 87	11·53	1,371	
Wallasey U.D.C.	Nov. 4	682	662	+ 20	+ 669	11·85	10 5	" 31	38,768	7,412.881	778,851	1 30	11 94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	" 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	" 3	1,834	1 074	+ 860	—	46	8 62	" 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	" 1	949	—	—	—	—	7½	" 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

The Electrical Standardising Institution.—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of this institution yesterday upon "Direct-Current Motor Construction." The lectures will be delivered on every subsequent Monday and Thursday for the remainder of the term.

Northampton Institute Engineering Society.—This society has just been formed by the students connected with the Northampton Institute. The first meeting will be held on Saturday, Nov. 18, at the institute, when a paper will be read by Mr. S. M. Hills on "A Comparison between Gas and Electricity in regard to their use as illuminants." Dr. R. Mullineux Walmsley will take the chair at 7.30 p.m.

Electrical Navigation.—Experiments were recently carried out in Bilbao Harbour by Señor Torres Quevedo with a view to ascertaining the possibility of maritime navigation by means of power transmitted by Hertzian waves. The propellers of a boat were worked in the harbour by electric waves transmitted without wires. The inventor considers it feasible to apply his system to special navigation.

Junior Institution of Engineers.—As the annual dinner of the Institution of Electrical Engineers has been fixed for Friday, Dec. 8, it has been decided to postpone the reading of the paper on "Electrical Mains for Power Transmission Work," by Prof. John T. Morris, M.I.E.E., to the following Friday, Dec. 15. In connection with the paper a visit has been arranged to the works of Messrs. Johnson and Phillips at Charlton for Saturday morning, Dec. 16.

Wireless Telegraphy.—From particulars to hand relative to the working of the Marconi wireless telegraphy on the s.s. "Inkosi," whose installation with this system we announced in a previous issue, we learn that the last message reached the "Inkosi" when she was 764 miles south of the Lizard. In the opinion of the operator, however, the vessel would have been able to receive messages for another 300 miles, but circumstances made it impossible to test the apparatus quite so fully as is expected to be done in future voyages.

Milan Exhibition.—Those who wish to take advantage of the grant of £10,000 made by the British Government in aid of the British section for this exhibition are invited to make application for space and other particulars to Mr. Arthur Serena, 1 and 2, Oxford-court, Cannon-street, E.C. The commission are most anxious to secure a representative exhibit of British manufactures at the forthcoming exhibition, and are willing to afford information to manufacturers and presidents of chambers of commerce interested therein.

Dick-Kerr Engineering Society.—This society has been formed at the Preston works of Messrs. Dick, Kerr, and Co., and has for its object the discussion of engineering matters of a general character. It is hoped by means of this society to promote greater social intercourse among the members of various departments to their mutual benefit. Papers have already been read and discussed on such diversified subjects as "Tramway Tracks," "Petrol Engines," "Electric Trams *v.* Motor 'Buses," "Single-Phase Motors," and "Incandescent Electric Lamps," further papers being promised throughout the session.

Tramways and Light Railways Association.—In the *Official Circular* for November is given a list of lectures and visits for which arrangements have been made. On Nov. 23 Mr. W. L. Green will deliver a lecture on "The Paving of Roadways." A paper will be read in March, 1906, by Mr. S. Sudworth "On the Upkeep of Tramway Electric Motors," the date of which will be announced later. The Society of Motor Manufacturers and Traders have invited the members to visit the exhibition at Olympia at noon on Nov. 21. The long-deferred conference at the Board of Trade, when a joint statement was submitted by representatives of the three tramways associations, took place on Nov. 1, and a full report of this meeting will appear in due course.

Submarine Signalling.—The Cunard Steamship Company have already five of their North Atlantic steamers fitted with the submarine signalling apparatus, and we understand that the "Carmania," the largest turbine-driven steamer in the world, and the first to run between Europe and the United States, will also be possessed of an equipment. Trials have been made on board the German steamer "Deutschland," from which the bell at the Outer Weser lightship was located at a distance of five nautical miles, while the noise made by the propeller of a large passing steamer was distinctly heard at a distance of $1\frac{1}{2}$ miles, though the "Deutschland" was steaming 19 knots. This latter fact, says Lloyds, is very important, and should be of great assistance to navigation in foggy weather.

Electricity in Mines.—Higher education in mining continues to engross the attention of the Notts and Derbyshire Education Committees, the Midland Counties Institution of Engineers, and the Midland branch of the National Association of Colliery Managers, under whose collective auspices a lecture was delivered in the large theatre of Nottingham University College on Saturday last by Mr. W. C. Mountain, who, in the course of his remarks, gave a general explanation of the electrical units used in practice, formulæ for ascertaining losses in cables, current necessary for transmitting power at different voltages, a description of generating machinery suitable for colliery requirements, and of electric winding plants at present in use, illustrated by photographs of Continental and English installations, and ventilation by means of electric fans. In conclusion, he said that it would not pay to put in electric winding. The Chairman, in proposing a vote of thanks to the lecturer, said the information afforded was corroborated by a mining engineer, who stated, after going very critically into the question in Germany, he came to the conclusion that electric winding, from an economical point of view, was not adaptable to conditions here. We disagree with both of these experts, and leave the decision as to which is right for time to prove.

Electric Locomotives.—Extensive tests are being made with a view to ascertaining the relative merits of electricity and steam as motive power for railways, and the trials recently concluded in New York have conclusively determined the superiority of the former over the latter. In a competitive test an electric locomotive easily outdistanced a steam-propelled train, the load of each being equal. A New York Central locomotive, built by the General Electric Company and the American Locomotive Company, is now being tested at the Schenectady experimental track, and recently completed the first half of the 50,000-mile test to which it was subjected. The motors on the locomotive are at the present day those with which the test began; the commutators are perfectly smooth, the brushes having run the 25,000 miles with a wear of only $\frac{3}{8}$in., and appear quite capable of completing the second half of the distance. During these tests the locomotive has been in service regardless of weather, and a speed of 85 miles an hour has been indicated. The total cost of all repairs on the locomotive, excluding injury caused when

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the shed in which it was housed took fire, has been slightly over £85 for the 25,000 miles, but there is every indication that the expense of the second portion of the journey will be materially reduced.

Engineering Standards Committee.—We are informed that a conference of incandescent lamp makers will be held at the Institution of Civil Engineers on Friday, Nov. 24, at 11 a.m. The subject, which is now being dealt with by the Sub-Committee on Physical Standards, presided over by Dr. Glazebrook, the director of the National Physical Laboratory, has recently come under the notice of the Incorporated Municipal Electrical Association, with the result that Mr. C. D. Taite, of Salford, and Mr. George Wilkinson, of Harrogate, have been appointed to represent the association on this committee. A circular dealing very completely with the various questions affecting the standardisation of carbon-filament incandescent lamps has lately been issued to the manufacturers, and we understand that very valuable information has been placed at the disposal of the committee. In view, however, of the many difficult questions involved, the Sub-Committee on Physical Standards have decided that before formulating any recommendations to be put before the Electrical Plant Committee for transmission to the main committee, the interests of all concerned would be best served by convening a conference, and, in a friendly manner, discussing those points which appear to be somewhat difficult from the point of view of standardisation.

Telephony.—The resolution passed at the recent Liége meetings of the Association of Chambers of Commerce in reference to proposed extensions of long-distance telephony to France and other foreign countries has evoked a reply from the Postmaster-General, in which he states that it is at present impossible to afford more extended facilities. The telephone service, he points out, is unlike the telegraph service, inasmuch as telephonic conversation is dependent upon minute variations in a small electric current; and although a double copper wire line is used in most cases, the effect of outside disturbances and the attenuation of sound is very marked when the line extends over long distances. There is, therefore, a limit beyond which it is at present impossible to carry on conversation. This limit varies according to circumstances, the presence of a section of submarine cable having a considerable effect in shortening the limit. In the case of telegraphs it is possible to use more powerful electric currents and to insert relays in the circuit, which have the effect of augmenting the current at regular distances; but neither of these alternatives is at present practicable to the same extent in telephony. Should further experiments advance the science and invention of telephony, the Post Office will readily attempt to meet the views expressed in the resolution.

Society of Arts.—We have received from the secretary a list of meetings arranged to be held during November and December, which include the following: Wednesday, Nov. 22 (ordinary meeting), F. Martin-Duncan, "The Cinematograph and its Applications"; Monday, Nov. 27, (Cantor lecture), J. A. Fleming, D.Sc., F.R.S., "The Measurement of High-Frequency Currents and Electric Waves" (Lecture I.); Wednesday, Nov. 29, (ordinary meeting), Sir William H. Preece, K.C.B, F.R.S., "The British Association in South Africa"; Monday, Dec. 4 (Cantor Lecture), J. A. Fleming, D.Sc., F.R.S., "The Measurement of High-Frequency Currents and Electric Waves" (Lecture II.); Wednesday, Dec. 6 (ordinary meeting), Sigmund Stein, "The Manufacture of Sugar from British-Grown Beet"; Thursday, Dec. 7 (Indian Section), Sir James A. Bourdillon, K.C.S.I., "The Partition of Bengal"; Monday, Dec. 11 (Cantor Lecture), J. A. Fleming, D.Sc., F.R.S., "The Measurement of High-Frequency Currents and Electric Waves" (Lecture III.); Tuesday, Dec. 12 (Applied Art Section), Louis N. Parker, 'Historical Pageants"; Wednesday, Dec. 13 (ordinary meeting), W. F. Mitchell, "The Commerce and Industries of Japan" (his Excellency the Japanese Ambassador will preside); Monday, Dec. 18 (Cantor Lecture), J. A. Fleming, D.Sc., F.R.S., "The Measurement of High-Frequency Currents and Electric Waves" (Lecture IV.); Wednesday, Dec. 20 (ordinary meeting), Charles L. Burdick, "The Aerograph Method of Distributing Colour."

Incandescent Lamps.—In a paper which he read before the Ohio Electric Light Association, Mr. Francis W. Willcox treated of the subject of high-efficiency electric incandescent lamps. In view of the fact that about 95 per cent. of the energy supplied to a lamp is heat, the importance of utilising the remaining 5 per cent. in such a way as to obtain a proper diffusion of light is obvious. Mr. Willcox enumerated several requirements which in his opinion a standard lamp should satisfy, and in illustration of his remarks he described the "Meridian" lamp as an attempt to provide an efficient unit. In this new lamp the feature of special interest is the improved carbon filament, which gives a true 2½ watts per candle-power lamp. This is a clear gain of 20 per cent. in efficiency for the same life and candle-power performance over the present standard 3·1 watt lamp. The improvement is secured with the ordinary carbon filament subjected to special process, and does not involve the use of any rare metals, or impose any new conditions. The new filament is subjected to additional processes of heating in the electric furnace at temperatures of from 5,400deg. to 6,700deg., resulting in the production of an exceedingly pure form of carbon with a considerable less specific resistance than the ordinary type, and a temperature coefficient which is positive instead of negative. The new filament is capable of withstanding a higher temperature than the old for a given rate of depreciation, and can thus save a greater amount of light per unit of surface. The colour of this new metallised filament is dull grey, and it is claimed to be more stable at high temperatures than is the ordinary carbon.

Hypochlorite Production.—Mr. W. Pollard Digby read a paper at the last meeting of the Faraday Society on "Some Observations respecting the Relation of Stability to Electrochemical Efficiency in Hypochlorite Production," in which he drew attention to the fact that in all electrolytic methods of producing hypochlorite solutions, only a small portion, rarely more than 18 per cent., of the chlorine usually present in the form of chloride is converted into hypochlorite, and suggested that the amount of available chlorine produced from a sodium chloride solution depends upon the relation which the amount of unconverted sodium chloride actually present between the electrodes bears to the current density. As regards stability, particulars were given of two tests in which the rate of depreciation, although only 0·3 grm. to 0·4 grm. in 12 hours per litre for solutions containing 8 grm. of available chlorine per litre, caused a very great depreciation in the yield per kilowatt-hour supplied. The suggestion was advanced that no test of the efficiency of any apparatus for the electrolytic production of the hypochlorites could be regarded as complete without an estimation of the losses through instability, and a mention of the volume of the contents of the electrolysing tank. While stability of solution does not greatly affect the efficiency of any continuous type of apparatus (in which the sodium chloride is fed in at one end and drawn off at the other end ready for continuous use), it would materially affect the efficiency in any non-continuous

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apparatus, or in any apparatus in which the electrolyte is circulated through an external cooling tank and returned to the electrolyser to be further worked up. Mr. Digby suggested that the presence of minute quantities of iron in the solution have also a bearing on the depreciation.

Rand Power Scheme.—It is reported that the African Concessions Syndicate have been informed by leading American and Continental engineers and experts that the transmission of power from the Victoria Falls to the Witwatersrand is not only quite feasible but would be commercially successful, especially as the climate of South Africa is one of the most suitable in the world for the transmission of power. There is no ice in the rivers to interfere with the working of the turbines, and no snow to break down the transmission lines. The extreme dryness of the climate is also greatly in favour of the project. With reference to statements that the volume of water in the Falls is not sufficient to produce the necessary power, it is pointed out that even in the driest season yet experienced there is sufficient water to produce 500,000 h.p., while at present the Rand only consumes some 150,000 h.p. At the Falls there is an available head of about 330ft., and if more than 500,000 h.p. were needed, it could easily be obtained by cutting a canal, 15 to 20 miles in length, to a point lower down, where there would be a head of 1,000ft., which would be sufficient to produce 1,000,000 h.p. The construction of such a canal would present no difficulty. By the adoption of this scheme it is further pointed out power could be supplied to the mines more cheaply than in any other way. The importance of this can be gathered from the fact that at present over £3,000,000 is spent annually on power on the Witwatersrand, and anything which tends to cheapen this yearly toll would necessarily have a great effect on the profits of the mines. The scheme is regarded as a potential factor towards a South African revival, for the reduction of working costs resulting from its adoption would, it is urged, go far to re-establishing public confidence in South African enterprises.

Single-Phase Railway Working.—In our issue of Oct. 20 we described some of the advantages of single-phase railway working which were communicated to the American Street Railway Association by Mr. C. F. Scott. At the same meeting Mr. W. B. Potter read a paper on the same subject, in which he revealed some of the changes which extended application of the system had necessitated. For the control of equipments aggregating 200 h.p. and over, the type M control, consisting of electrically-operated controllers or switches, is being very generally used. Mr. Potter claims that by it it is not only possible to handle heavier currents and a higher voltage, but a further advantage lies in the fact that the master controller occupies considerably less space than a cylinder controller handling the full motor current. It was found difficult to provide space for an automatic circuit breaker on large equipments where the circuit breakers had to be set for 1,000 amperes and above, and, as a substitute on this heavy class of work, a fuse composed of thin copper strip, enclosed in an insulating chute and surrounded with enough iron to provide a magnetic field, was found to be quite reliable, and is now generally used on large equipments with excellent results. Car wiring is now receiving more attention than formerly, and the recognised practice is to install all wiring in iron conduits, with the ends of the pipes fitted with bellmouths to avoid abrasion of the wire. Though his experience has been gained with direct-current apparatus, Mr. Potter asserts that the essential principles of single-phase working apply equally to the alternating railway equipment. He considers that alternating-current motors can perform any service now done by direct-current apparatus, and, regarded in the light of the recent installations of alternating railway equipments, the outlook for this class is promising.

Electricity in China.—The opening out of Japan is likely to be followed by rapid developments in China. This vast empire, with its enormous resources, kept in the background by the ancient superstitions and indolence of its inhabitants, cannot remain permanently invulnerable to the wave of regeneration which is sweeping over the Far East, and soon the country will be ready for the exploits of the electrician. The United States agent, Mr. Burrill, who was specially detailed to investigate the commercial situation in the Far East, has issued a report in which he urges Americans to push with vigour the sale of electrical goods in China. Although the country generally is not yet ready for an extensive application of electric lighting or traction, the conditions in the large cities are such as would readily lend themselves to the adoption of electricity. There is need not only for electric light and power plants, but for electric railway and tramway equipments. At present there are only a few small lighting plants in the principal cities and one or two insignificant electric railways, but this supply will soon be totally inadequate to meet the expanding requirements of the country. Under the aegis of Japan the development of China cannot be long delayed, and signs are already imminent that the Chinese are about to make an effort to emulate the example of their progressive neighbours. To be forewarned is to be forearmed, and Britishers would do well to keep an open eye on China as a fruitful field in which to display their commercial activities. Not only will we have to compete with America and Europe in that market, but it is morally certain that Japan will not let slip any opportunity for profitable expansion of her commerce in the Far East, and it is a case of those who are first in the field reaping the richest harvest.

Switch-Throwing Device.—In the *American Street Railway Journal* a description is given of an automatic switch-throwing device which the British Columbia Electric Railway Company have been using successfully during the last two years. The switch has been thoroughly tested under all conditions of service and weather on streets where traffic is heavy, and many advantages have been established. The switch can be operated from any distance without stopping the car or without requiring either the motorman or the conductor to leave their positions to attend to it. The result is a saving of time and a less liability of accident. The danger of collisions at switch points or crossings is to a great extent obviated, inasmuch as the motorman is able to see the switch point move over before the car enters the switch. The services of special switchmen are not required, and the cost of maintenance and repairs is a very trifling consideration. The company has spent 3s. 5d. on the first switch installed, the same having been in continual use since installation. The switching device consists of two parts: the switch-throwing lever attached to the car body, and the device installed on the street railway track between the rails. The tongue switch is drilled about 22in. back from the tongue, making a rectangular hole 1½in. by 1½in.; the dog is fitted to the tongue, and connected to the lever in cast-iron box by a connecting rod. The 1½in. wrought-iron pipe which serves as a cover for the long connecting rod is then placed in position, fitting one end into a square box and the other into a long casting, driving the pipe into place to the mark on the pipe. The levers and the chain are then connected up to the two triggers, so as to ensure that all parts are in line, and work easily, before spiking down. A short length of rail, about 6ft. long, is spiked down for the shoe on the

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switch thrower to run on. The operating rod in the floor of the vestibule can be off set to bring it into the best position for the motorman's use, though the position will naturally vary with the different types of vestibules.

Overhead v. Underground Wires.—The deputy stipendiary of Cardiff, Mr. E. Milne Jones, who sat as arbitrator in the dispute between the General Post Office and the Cardiff City Council respecting the laying of trunk telephone cables on the outskirts of the city, has now given his award. The Post Office authorities have been granted permission to lay down the cables without the imposition of the condition required by the Corporation, the costs of the reference to be borne by the Corporation. The facts of the case were: The Postal Telegraph Department applied for permission to lay down a 3in. line of pipes for a distance of about 1,000 yards on the outskirts of the city running parallel with an existing line of poles carrying a large number of overhead wires. The Corporation consented to the underground pipes being laid on condition that the Telegraph Department would at the same time remove all their overhead wires for this same distance, and while they were excavating for one line of pipes lay the whole of their wires on that particular section underground. This the Postal Telegraph Department declined to do, their chief contention being that the laying of long-distance telephone cables underground very seriously impaired the efficiency of the service. The chief witness of the Postal Department admitted at the inquiry that their long-distance cables ran for a distance of 4 to 4½ miles underground, and on approaching large provincial centres they have the same cables running from 1 to 1½ miles undergrounnd, so that on these lines of service he said there was as much as six miles of long-distance cable underground. The contention, therefore, that 1,000 yards of underground cable in Cardiff would seriously impair the service seems hardly consistent. The Corporation argued that if such long distances of underground cables were necessarily elsewhere, the laying down of 1,000 yards of similar cables in Cardiff could not be a serious matter to the service. The postal telegraph authorities in declining to meet the Corporation in a reasonable spirit have exceeded the powers granted to them by the Telegraph Acts, and in the present instance appear determined to make full use of their privilege regardless of the public convenience.

London Traffic.—Volumes II. and III. of the report of the Royal Commission on London Traffic have been published, and contain evidence, with appendices, tables, and maps. Though the volumes are rather bulky and contain a huge amount of statistical matter, reference to them has been greatly facilitated by the excellent system of indexing adopted, whilst the idea of adding a digest of the evidence of each witness is a good one. The most important proposal which is revealed in the evidence is for the establishment of a Central Traffic Board. There was a remarkable unanimity of opinion that the absence of such a body in the past had been responsible for the complexity and difficulty of the problems which now have to be faced, and that the remedying of this defect was a necessary preliminary to any adequate and durable improvement of the situation. Adopting as their general principles the views set forth by a preponderance of the opinion consulted, the Commission proposed that the Board should consist of from three to five members, should be nominated by the Government, should sit continuously, and should be entrusted with consultative and advisory functions. Among the subjects to which it was suggested that the new authority should give its consideration were the preliminary examination of all private Bills dealing with locomotion in Greater London, the improvement of the main roads leading out of London, the building laws as affecting districts not yet built over within the area of Greater London, the revision and amendment of the laws regulating the breaking up of the streets, and the consolidation and amendment of the laws affecting traffic. A number of eminent tramway authorities alleged that the deficiency in tramway communication was almost entirely due to the existence in the hands of all local authorities of the power of veto over tramway proposals, and the abolition of the power of veto, which could not be brought about without legislative intervention, was emphatically advocated. It is evident that the Government do not intend to pass over the report without action, for, in reply to an enquiry from the chairman of the Central London Railway (Sir Henry Oakley), it was authoritatively announced by the Board of Trade that the Government have sanctioned the preparation of a Bill relating to London traffic, and involving the establishment of a Traffic Board, as recommended by the Royal Commission.

Sydney Trams.—We have received a copy of the *Sydney Daily Telegraph* for Oct. 6, in which appears an article by our old friend, Mr. E. Kilburn Scott, on the cost of running the Sydney trams. We gather from this that an attack has recently been made on the system (which has been introduced and is run by the Government) on the ground that the total operating costs amount to about 9d. per car mile. It is difficult to gather from Mr. Scott's article whether he justifies or excuses this figure, as compared with an average of 6¼d. for ten of the largest tramway systems in the United Kingdom. He gives, however, a great deal of gratuitous advice to the tramway engineers and to the Government, such as the necessity for improvements in track construction, the easing of gradients, the use of regenerative control, and the advisability of having double-deck cars instead of single-deck. These criticisms are no doubt interesting to the officials in question, though we doubt whether they contain anything that is new. What surprises us, however, is to find that Mr. Scott, in dealing with the working costs of the Sydney trams, makes no reference whatever to the conditions which tend to keep the figure so high, and which are the potential factor to be taken into consideration when making comparisons with systems in the United Kingdom. The cost of labour—skilled and unskilled—is much higher than in any of the towns in the United Kingdom. Engineers, for example, whose weekly wage in the United Kingdom averages from 32s. to 35s., were in 1903 paid about 56s. 6d. per week in Sydney. The remuneration for all grades of labour is in Sydney much higher than it is in England, and when it is mentioned that blacksmiths are paid at the rate of 62s. per week, fitters 55s, and foremen fitters about 77s. per week, the unjustness of the comparison becomes evident. These are the rates of wages which were paid in 1903, and, as is well known, they have since risen. Then the fact that nearly all the materials required in the construction and upkeep of the tramways have to be imported accounts in a measure for the increased working and maintenance charges. Notwithstanding that all electrical goods and most machinery required by the State are now imported duty free, the prime cost must be, after all, higher in Sydney than it is at the centre of production, and in this respect the authorities do not enjoy the advantages of their contemporaries in the United Kingdom. After due allowance is made for these considerations, it will doubtless be conceded that the tramway undertaking in Sydney is not an extravagant one, and that the results compare favourably with those of undertakings at home.

Institution of Electrical Engineers.—There was a large gathering of members and associates at the opening

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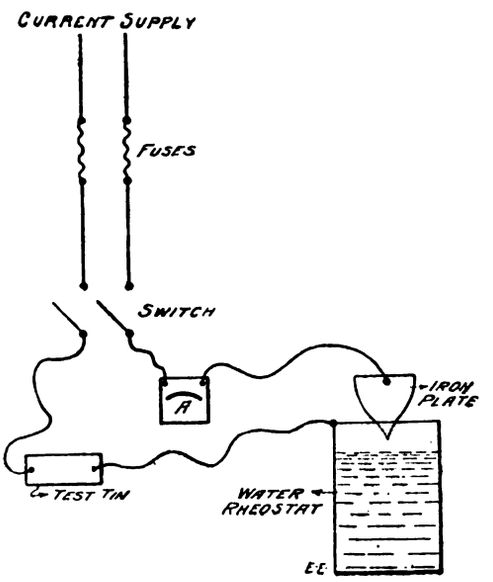
of the session last Thursday week. Mr. Alexander Siemens presided over the earlier part of the proceedings, and after presenting the prizes awarded for papers read during the session 1904-5, he formally inducted the incoming president, Mr. John Gavey, C.B., whose inaugural address is appearing elsewhere in our columns. A vote of thanks to the retiring president was carried with acclamation, on the motion of Sir Wm. Preece, K.C.B., seconded by Prof Ayrton, F.R.S. Mr. Gavey, in his presidential address, dealt principally with telephony and telegraphy, and reviewed the more recent developments of these industries. At the close he was accorded a hearty vote of thanks, on the proposition of Prof. Silvanus Thompson, and seconded by Mr. James Swinburne, who remarked that many of the apparently small details connected with telephony and telegraphy afforded infinite scope for engineering. The President briefly acknowledged the vote of thanks, and granted permission to reproduce his discourse in the *Transactions* of the Institution. The following is a list of premiums awarded for papers read during the preceding session: the Institution premium, value £25, to Mr. E. H Rayner for his paper, "On the Effect of Heat on the Electrical and Mechanical Properties of Dielectrics" and "On Temperature Distribution in the Interior of Field Coils"; the Paris Electrical Exhibition premium, value £10, to Prof. H. S. Hele-Shaw, F.R.S, Dr. A. Hay, and P. H. Powell for their paper, "Hydrodynamical and Electromagnetic Investigations regarding the Magnetic Flux Distribution in Toothed-Core Armatures"; the Fahie premium, value £10, to Mr. D. Murray for his paper, "Type Setting by Telegraph"; an extra premium, value £10, to Mr. R. Goldschmidt for his paper, "Temperature Curves and the Rating of Electrical Machinery"; an extra premium, value £10, to Mr. Miles Walker (Manchester Local Section) for his paper, "Compensated Alternate-Current Generators"; an extra premium, value £10, to Messrs. D. K. Morris and H. K. Catterson-Smith (Birmingham Local Section) for their paper on "Some Uses of the Oscillograph"; an extra premium, value £5, to Messrs. J. B. Henderson and J. S. Nicholson (Glasgow Local Section) for their paper, "Armature Reaction in Armatures"; an original communication premium, value £10, to Mr. A. B. Field for his communication on "The Dissymmetry of a Three-Phase System"; an original communication premium, value £5, to Mr. T. Baker for his communication, "The Magnetic Properties of Some Alloys of Iron and Silicon"; the first students' premium, value £8, to Messrs. E A. Biedermann and J. B. Sparks for their paper on "E.M.F. Wave Forms"; the second students' premium, value £5, to Mr. J. W. Anson for his paper, "The Present Electrical Equipment of the London County Council Tramways"; the third students' premium, value £5, to Mr. A. C. Anderson for his paper on "The Applications of Electricity in Mines"; an extra premium, value £4, to Mr. A. E. Jepson for his paper on "Electric Heating"; an extra premium, value £3, to Mr. R. F. Chaffer for his paper on "The Equipment of a Modern Generating Station, with Special Reference to the Chelsea Station of the Underground Railways." The Council has awarded three Salomons scholarships, value £5 each, to Mr. A. E. Clayton, Mr. E. A. F. Goodfellow, and Mr. F. C. Prentice. Two David Hughes scholarships, value £50 each, were awarded to Mr. E. A. Biedermann, and Mr. J. B. Sparks.

Insulating Paints—Mr. Arthur B. Weeks in a contribution to the *Street Railway Review* deals with the different qualities of varnishes on the market for insulating purposes, and emphasises the importance of a discriminate selection by electrical engineers. Some varnishes contain as much as 32 per cent. of resin, and the result is that by their use "permanent elasticity" or a great resistance to electric current is not obtained. The use of clear varnish is now being largely replaced by black insulating paint, on account of the corrosion caused by the former owing to the inevitable presence among its properties of acid. Mr. Weeks considers that there is no especial reason for baking armature coils, if they have first been dried in an oven and then dipped while hot into a good air-drying paint. Such a paint, however, should have plastic qualities sufficient to cement the wires of the coils, and not become brittle even after baking for many days. To obtain baking tests, the baking must be allowed to proceed continuously for several days, and in order that the insulation of the coils be not damaged, the temperature of the oven should not exceed 195deg. F. One of the specimens which came under the notice of Mr. Weeks has withstood a temperature of 240deg. F. for over 24 hours, and it probably would have continued to do so indefinitely without becoming brittle. This varnish, which was black, protected the paper on which it was placed from carbonisation. When a good air-drying paint is desired, and its finish is not sufficiently glossy, a coat of finishing paint can be afterwards applied with a brush. The ideal finishing paint should be air-drying and sufficiently hard in an hour to be handled if



required. Mr. Weeks claims among the advantages of an air-drying paint that nothing is gained by baking when the same results can be attained by means of an air-drying paint; air-drying finishing paint decreases the cost of construction and repairs; an armature coil or field coil gets plenty of baking when in actual service, and baking in ovens, as ordinarily done, lowers the insulation resistance. With a view to observing the actual condition of the paint on a working coil, experiments can be made by taking a sheet of iron from ½in. to ¾in. wide, and punching holes at each end for ¼in. stove bolts. Then it is necessary to procure a water rheostat with connections, as shown in the accompanying illustration. The test tin must be covered with the paint to be tested, and, after it has dried, current passed through the tin. Ammeter readings are then noted, and, by means of a tube thermometer placed on the tin and covered with waste at the point of contact, temperature readings can be taken. By passing a current which will produce 195deg. F., and keeping it as steady as possible for some time, it will be observed that the ideal paint becomes plastic, whilst by cutting off the current for a time the paint becomes hard again. Mr. Weeks insists upon the necessity of obtaining elastic and longer lasting qualities out of paints.

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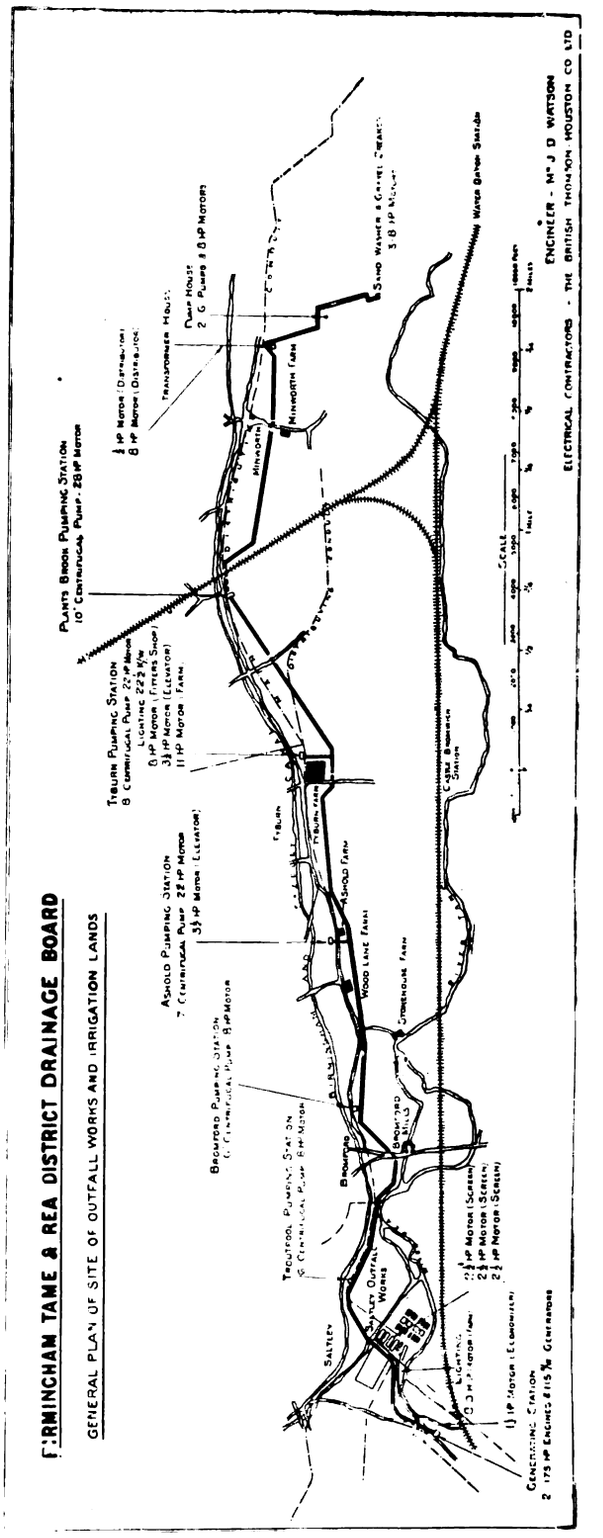
ELECTRICITY AND SEWAGE DISPOSAL.

Birmingham Tame and Rea District Drainage Board.

Among the most recent developments of the use of electrical power is the installation of a complete electrical power transmission scheme extending from Birmingham down the valley of the Tame for a distance of about six miles. The object of the scheme is to enable the Birmingham Tame and Rea District Drainage Board, for whom the work has been done, to pump sewage up to a strip of land adjacent to and situated at a higher level than the main conduit which conveys the sewage from the outfall works situated within the city of Birmingham to the sewage farm located in the Tame Valley, and extending from Birmingham to Curdworth. The inception of the scheme, which was first suggested in 1900, was due to the enterprise and initiative of the engineer to the Board, Mr. John D. Watson, M.I.C.E. The Drainage Board's estate comprises a total area of 2,830 acres, nearly 2,000 of which are used for irrigation, the remainder being land unsuitable for irrigation, or land occupied by roads, streams, buildings, tanks, cottage gardens, etc.

Apart from pumping sewage, the power transmission scheme is employed to drive motors at various places along the valley, to drive sewage screening rakes, sludge elevators, sewage distributors, workshop appliances, farmyard machinery, lighting, etc. The contract for the entire undertaking was provisionally let to the British Thomson-Houston Company, Limited, of Rugby, in July, 1901. As, however, the scheme involved the erection of a destructor by the city of Birmingham on land belonging to the Board, parliamentary powers had to be obtained before the undertaking could be proceeded with, and, owing to various difficulties encountered, which delayed parliamentary sanction, but which were not connected with or incident to the scheme itself, it was not until June, 1904, that the contract was finally confirmed and the work begun. The plant is now in full operation, and when the fact is taken into consideration that, besides the destructor, a generating station and five brick pumping stations, with provision for a sub-station in each, five miles of overhead line with crossings underground under public roads, together with the complete equipment of the generating station, sub-stations, and sundry machinery on different parts of the estate were involved, it will be apparent that no time has been lost in carrying out the undertaking. The generating station is situated near the Saltley boundary of the Drainage Board's estate. It contains two B.T.H. 115-kw. alternating-current generators (Fig. 2), each of which is coupled to a high-speed Belliss and Morcom engine. The generators are designed to give their output at 2,250 volts 50 periods, each being fitted with a direct-connected exciter, so that the unit is self-contained. A small continuous-current steam set of 15 kw. 220 volts is also installed in this station. This latter set is used to operate a number of B.T.H. enclosed arc lamps on the sewage beds at Saltley, to light the station, and, in case of necessity, to excite the alternating-current generators. The steam is supplied to the engines from Lancashire boilers combined with the destructor, which is adjacent to the generating station. The destructor, as before mentioned, was erected by the city of Birmingham, and steam is supplied to the Drainage Board under an arrangement with the authorities of the city of Birmingham. Thus the cost of power required is reduced to a minimum by the utilisation of material that would otherwise be valueless, or even objectionable. Messrs. Heenan and Froude were the contractors for this destructor, which is of their well-known type. Steam is raised in three Lancashire boilers made by Messrs. Taylor and Sons, of Marsden, 30ft. long by 8ft. diameter, constructed for 160lb. pressure. The economisers are of the Clay Cross type.

The engine-room and boiler-house are lighted from the generating station, and there are two alternative systems of lighting—one from the continuous-current side, and one from the alternating system of supply from the main generators. In the latter case suitable transformers are provided in a transformer chamber under the generating station to reduce the pressure from the primary 2,250 volts to 220 volts, which is the pressure of the lighting circuits. The main switchboard (which is illustrated in Fig. 3) contains two generator panels, each of which carries complete apparatus for one of the alternators, including the main switch, which is of the British Thomson-Houston Company's well-known "oil-break" type, ammeter, and voltmeter, together with the field rheostat for varying the excitation of the alternator. There is also one feeder panel



controlling the supply to the overhead line, and to the station power and lighting transformers, one meter panel containing a B.T.H. three-phase wattmeter for measuring the total output of the alternators, and a B T.H. continuous-current wattmeter measuring the output of the small continuous current set.

The 'bus bars are connected to the overhead line by means of three high-tension cables, separately supported from the walls of the generating station by heavy porcelain insulators, and led up to the outlet, which consists of three

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separate porcelain outlet tubes built into the wall. Through these tubes high-tension insulated cables are led, and connected outside on shackle insulators to the overhead line, which consists of hard-drawn copper of special high tensile strength, supported throughout its entire length by high-tension insulators of the triple-shed type. The section of the copper in the overhead line is so graded that a drop in pressure of only 7½ per cent. over the whole line is obtained at maximum load. Throughout the length of the overhead line a barbed wire is run on the top of the poles, and earthed at frequent intervals for protection against lightning.

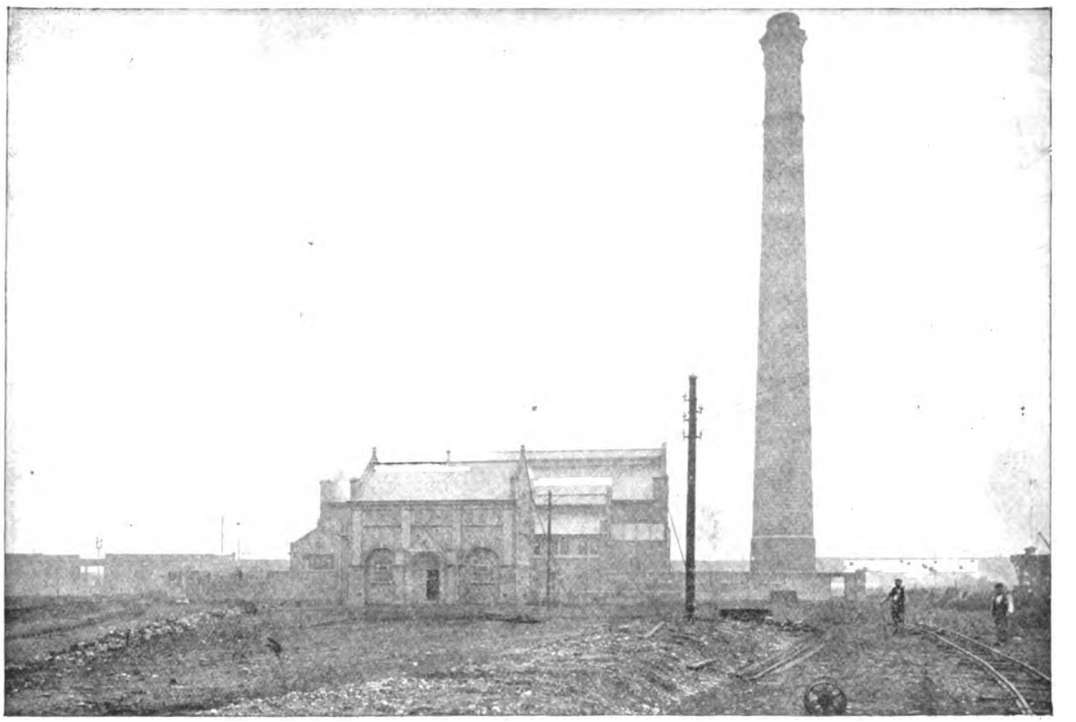

FIG. 1.—Destructor and Main Generating Station at Saltley.

In all cases where the overhead line enters or leaves a building, lightning arresters of the standard B.T.H. alternate-current type have been installed.

For the underground road crossings a special form of steel terminal pole (Fig. 4) has been designed, on the top of which is fitted a dividing box into which the high-tension overhead wires are led, and there connected to a three-core high-tension cable which is led down the inside of the pole and brought out at the bottom into the connection box. The cable from this point is laid in solid bitumen to the steel terminal pole on the opposite side of the crossing, where it is connected through another dividing box to the high-tension line. It then proceeds overhead up to the next crossing. The rest of the poles (Fig. 5) are of creosoted wood, and are set in concrete on account of the soft character of the soil in which they are planted, most of the land being under irrigation.

From the generating station the line proceeds to the

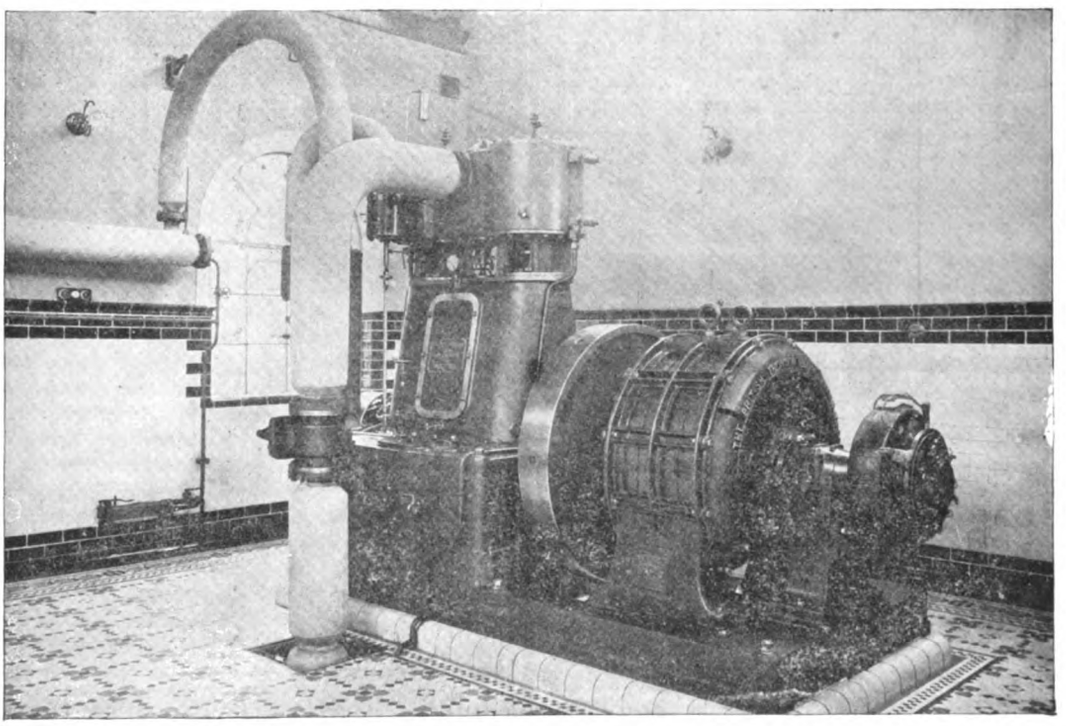

FIG. 2.—115-kw. B.T.H.-Belliss Generating Set.

Drainage Board's Saltley farm. At Saltley the line is tapped and led into a sub-station which is a portion of the old farm buildings converted for the purpose. This sub-station (Fig. 6) contains three B.T.H. transformers, each of 5 kw. capacity, and the necessary controlling switchgear. These transformers are used for supplying power to three 2½-h.p. B.T.H. motors driving sewage screens, and one

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8-h.p. B.T.H. motor driving farm machinery through a countershaft, and for lighting the offices and the house of the superintendent of works. The 2½-h.p. motors for driving the screens are 200-volt, 50-cycle machines, running at 1,420 r.p.m., and are connected to the screens through spur reduction gearing. From Saltley the high-tension line proceeds towards Minworth to the Troutpool pumping station. All the pumping stations are of artistic appearance, and do not in the least detract from the landscape. They were designed in the offices of the engineer to the Board, as was also the generating station and destructor at Saltley. Each pumping station is divided into two rooms, one containing the pump, motor, starting gear, and high-tension switchgear, and the other the transformers.

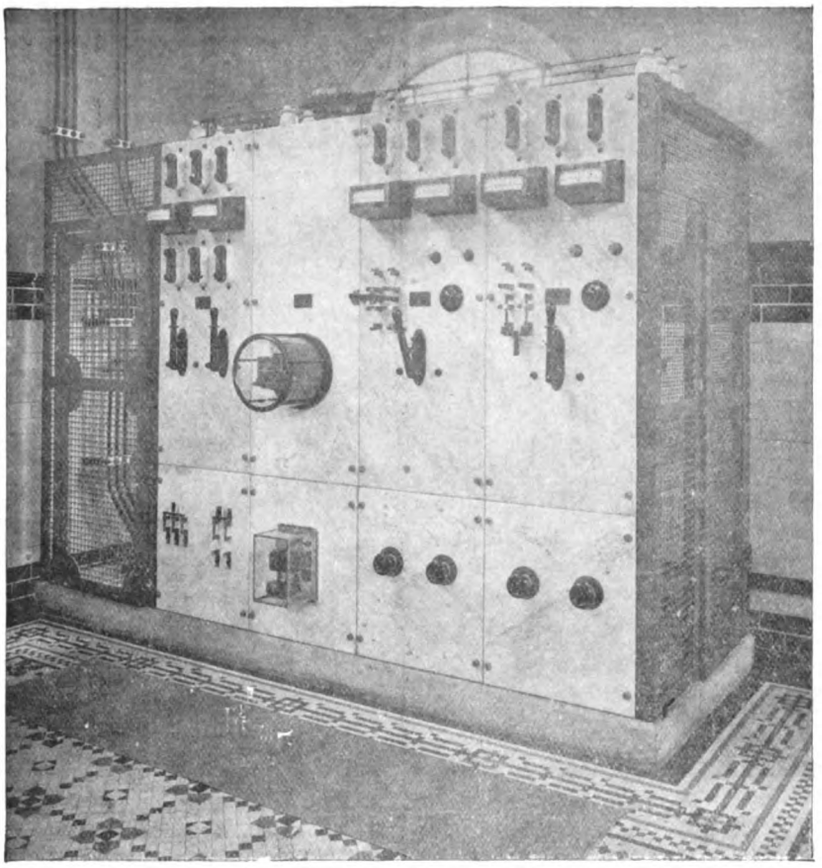

FIG. 3.—Main Switchboard, Saltley.

The Troutpool pumping station contains one 6in. Gwynne centrifugal pump (Fig. 7) designed to raise 696 gallons per minute against a head of 16ft. It is direct-connected to a B.T.H. 8-b.h.p., 712-r.p.m., three-phase motor. The starting arrangement for this motor is supported on brackets from the floor immediately adjacent to the motor, and the same plan is followed in all the other pumping stations. The switch panel (which in every case includes a B.T.H. high-tension oil switch for isolating the station

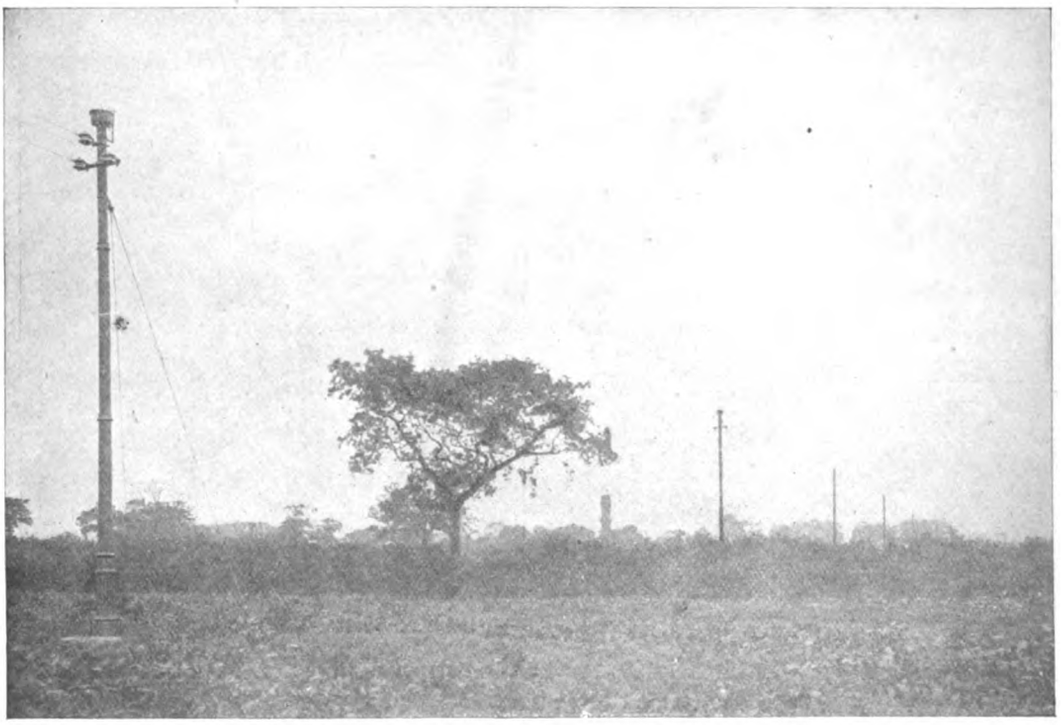

FIG. 4.—Underground Road Crossing, showing Steel Terminal Poles.

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from the line) is built into the wall, so that the back of the panel is accessible from the transformer chamber only. All parts carrying high-tension current are on the back of the panel, and it is, therefore, impossible for accidental contact to be made with the high-tension gear from the front of the panel. The transformer chamber at Troutpool contains two 4-kw. single-phase transformers having a ratio of 2,200 to 200, and is divided from the pump-room by a brick partition, the door between being kept locked, and access to it obtained only by the authorised staff of the Board; thus the risk of accident due to ignorance or carelessness is reduced to a minimum. Similar precautions are taken at all the other stations. In all the pumping stations the cables connecting the transformers to the switchboard are run in special trenches, covered by chequered plates and readily accessible. The back of the switch panel projects into the transformer chamber in such a manner that the switch panel itself really forms a portion of the dividing wall between the pump-room and the transformer chamber. This ensures the most efficient and shortest length of cable connections possible between the transformers and the controlling gear. All the pumping and sub-stations are arranged in a similar manner, the only difference being in the number of circuits controlled from the sub-station to meet the requirements of the particular area supplied from it.

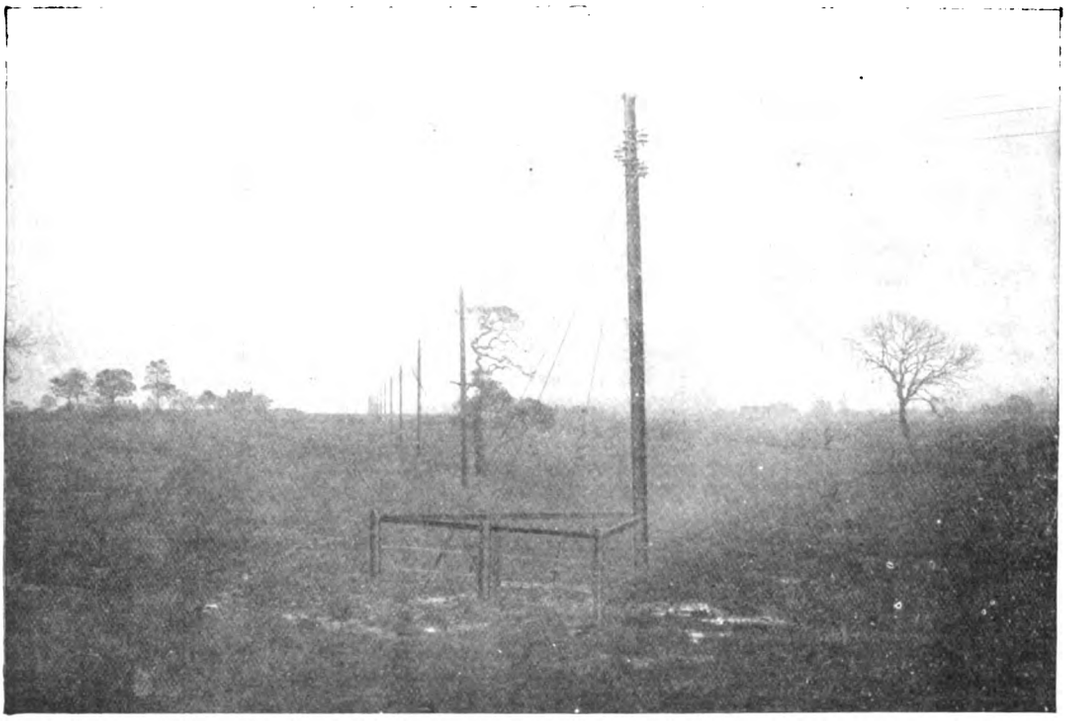

FIG. 5.—High-Tension Main Pole Line.

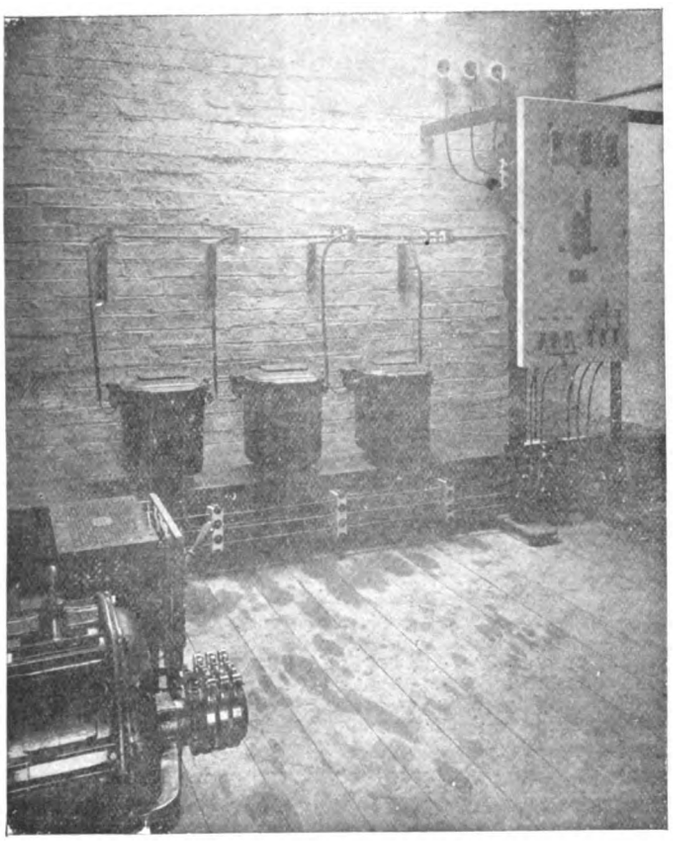

FIG. 6.—Saltley Sub-Station Transformer Room.

From Troutpool the line proceeds to a pumping station at Bromford, which, like the Troutpool pumping station, is equipped with a Gwynne 6in. centrifugal pump designed to raise 696 gallons per minute against a head of 16ft. and direct connected to a B.T.H. motor of 8 b.h.p. capacity. The transformer equipment in this station is similar to that at Troutpool. From Bromford the high-tension line proceeds to a pumping station at Ashold. This station contains one 7in. pump designed to raise 896 gallons per minute against a head of 32ft. It is direct-connected to a B.T.H. motor of 22 b.h.p. capacity, working at 575 revolutions per minute. The transformer chamber at the Ashold sub-station, which is designed in a manner similar to those already described, contains three single-phase transformers of 10 kw. capacity each, and a switchboard built in the wall for controlling the high-tension current from the line to the transformer and thence to the motor. In the case of this sub-station, however, the high-tension line is brought into the station underground, whereas in the

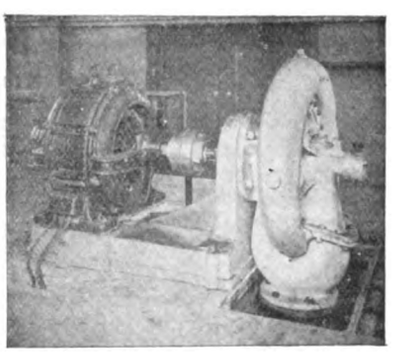

FIG. 7.—Motor and Gwynne's Pump.

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case of the others the high-tension line is tapped immediately opposite the sub-station, an offset being taken, and the line led into the sub-station from shackle insulators, to which are connected three highly insulated cables, which are led through the wall of the sub-station through a special type of porcelain duct. There are two low-tension circuits at Ashold, one for the pump motor and one for the 3½-h.p. motor driving an elevator similar to that at Tyburn. From this station the high-tension line proceeds direct to Tyburn, where the largest pumping and sub-station is situated. This station is also connected to the high-tension line by underground cable. The transformer chamber contains three 15-kw. single-phase transformers and three 7½-kw. single-phase transformers, each being arranged for a ratio of 2,200 to 200 volts. The 15-kw. transformers are for the power circuits, and the 7½-kw. transformers for the lighting circuits. They are all of the B.T.H. standard "oil-cooled" type.

At Tyburn the three power circuits are as follows: Circuit No. 1 controls one B.T.H. motor of 8 h.p. running at 960 r.p.m., and one 11-h.p. motor running at 965 r.p.m. These motors are used for the operation of general farm machinery and for driving machinery in the mechanics' and joiners' shops, where the mechanical repairs required to the existing plant on the Board's estate are carried out and any special tools required on the estate are made. Circuit No. 2 controls the pumping station proper, which, as in the case of the other stations, is immediately adjacent to the transformer chamber and contained in the same building. This station contains a Gwynne 8in. centrifugal pump designed to raise 963 gallons per minute against a head of 30ft. This pump is direct-connected to a B.T.H. three-phase induction motor of 22 h.p. running at 575 r.p.m. Circuit No. 3 controls one 3½-h.p. motor running at 1,420 r.p.m. and driving a sewage elevator. The cable supplying this motor is partly underground and partly overhead. The general arrangement of the motor and gearing is shown in Fig. 8. The secondaries of the lighting transformers are connected to a special switchboard, from which the circuits for the offices, engineer's residence, and the home farm buildings are controlled. The cables for supplying these circuits are laid underground from the sub-station to the various buildings.

The high-tension line continues from Tyburn to Plant's Brook, which has the heaviest duty of any of the pumping stations on the estate. This station is a pumping station only, and contains one Gwynne 10in. centrifugal pump designed to raise 1,900 gallons per minute against a head of 17ft. It is direct-connected to a 28-h.p. three-phase B.T.H. induction motor running at 475 r.p.m. The transformer chamber contains three 10-kw. single-phase transformers having a ratio of 2,200 to 200, and the usual controlling switchboard. Near this station the high-tension line is led into a conduit laid for the purpose under the Midland Railway in 1900, and thence to Minworth Greaves, where at present it terminates. The sub-station at Minworth Greaves is used for supplying power to operate two sewage distributors, which were previously operated mechanically, and are used for distributing sewage over circular bacteria beds. This sub-station contains three transformers having a ratio, as before, of 2,200 to 200 volts and the necessary switchboard. Provision has been made under a new contract to extend the high-tension line from this point one half-mile further towards Curdworth, where the Drainage Board are carrying out very extensive works in the building of bacteria beds, and where it is intended to light the beds with arc lamps and to electrically operate the gravel-washing machinery, consisting of a pump, stone-crusher, and winch. It is also intended to extend the use of the electric power thus obtained by installing silt pumps 400 yards from the Minworth Greaves terminus.

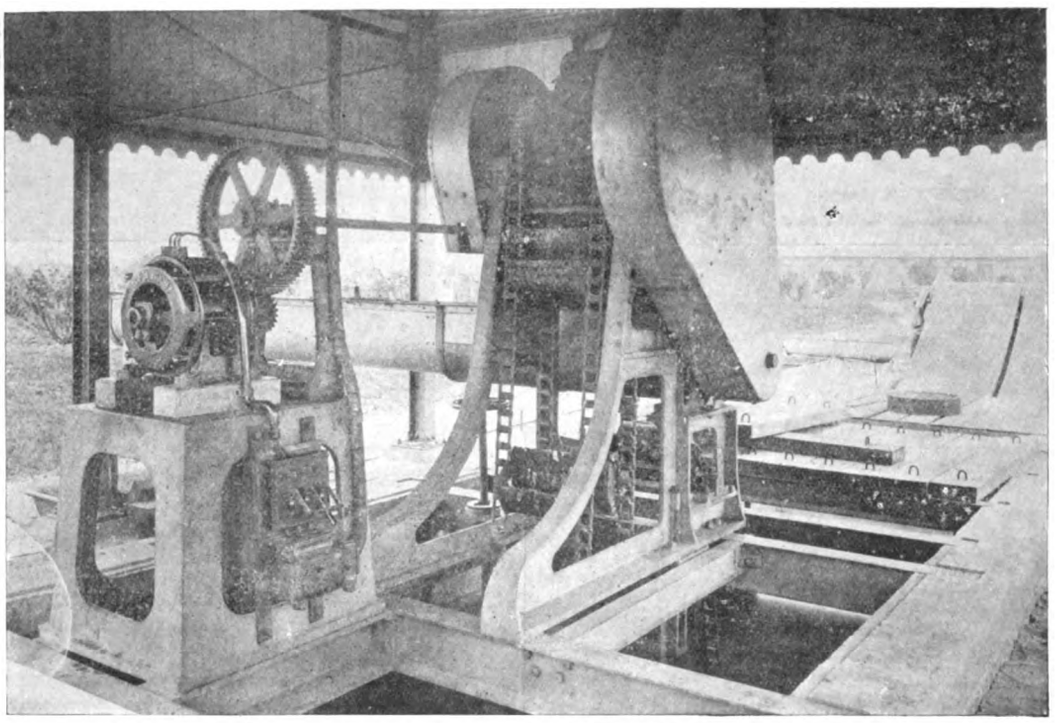

FIG. 8.—B.T.H. Motor driving Sewage Elevator.

The estimated cost of the whole scheme is made up as follows:

Corporation of Birmingham.			
Buildings—comprising destructor house, inclined roadway, furnace chimney, two cottages, boundary walling, entrance gates, and weigh office	£11,647	0	0
Two acres of land	800	0	0
Paving new road, etc.	1,000	0	0
Refuse furnaces, air heaters, and fans and engines	4,244	10	0
Total for Birmingham Corporation carried to summary	£17,691	10	0
Drainage Board.			
Boiler-house and main generating station buildings, three Lancashire boilers, one economiser, and all steam pipes, together with two boiler feed pumps, and one feed-water heater	£5,380	12	0
Overhead travelling crane	128	0	0
Electrical work in the main generating station	3,035	0	0
Power transmission line	2,177	0	0
Saltley sub-station	270	0	0
Five pumping stations complete, including pumping mains	6,076	0	0
Minworth Greaves sub-station	170	0	0
Lighting and sundries	900	0	0
Total for Drainage Board carried to summary	£18,137	12	0
Summary.			
Corporation of Birmingham	£17,691	10	0
Drainage Board	18,137	12	0
Total cost of scheme	£35,829	2	0

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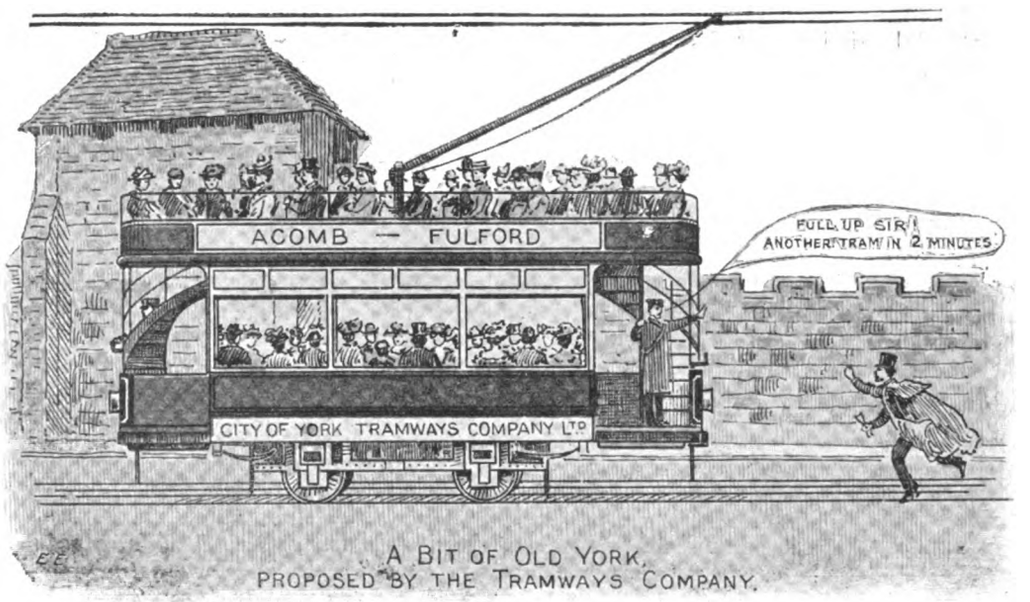
There is no doubt that the undertaking of the Birmingham Tame and Rea Drainage Board, embodying as it does all the features of a comprehensive high-tension power distribution scheme, is one of the pioneer undertakings of its kind in this country, and it is the first scheme of its kind in the world. Developments arising of a direct outcome of the undertaking will undoubtedly be watched with considerable interest by all those interested in the application of electrical power to the complex problem of sewage disposal and other industrial purposes.

YORK TRAMWAYS.

We should like to have headed this article "York Electric Tramways," but are unable to do so. It must be remembered that York is one of the most ancient and honourable cities in the United Kingdom. Its Corporation resembles the city in its characteristics for doing business, but when describing the Corporation most emphasis must be laid on the word "ancient." We remember in the nineties, when electric lighting was first proposed for York, the matter was taken up most thoroughly. The Corporation obtained reports year after year from one and then another of the leading consulting engineers until they had exhausted even the talent of Westminster. They then tried to sell their undertaking to two or three companies without being able to decide which offer was the most favourable. The net result was that while the electric lighting order for York was granted in 1890, it was on April 1, 1900, when the supply commenced. We do not suppose the date was chosen for any particular reason, but it is amusing to notice that after 10 years' delay they started their municipal supply on April 1. Having settled the large question of electric lighting, which undertaking has since developed, as was to be expected, the question of tramways arose, and still arises periodically without any result. The post cards reproduced herewith show that certain inhabitants appreciate the humour of the situation. The first card we reproduce is not really the first which was issued, but as we were unable to find the name of the publisher of it we could not reproduce that one without infringing copyright. The history of the tramways is as ancient and as interesting as that of electric lighting. A tramway company owns the horse trams, and the period of their original order has expired. They can be bought out in consequence at the end of periods of seven years. The company in 1897 obtained necessary parliamentary power to work their tramways by electricity or other mechanical means other than steam, but these powers are subject to the approval of the Corporation. The same thirst for knowledge and lack of decision have characterised the Corporation in this matter. Their officials have, we gather, informed them of the advantages of a good system of electric trams owned and worked by the Corporation. The tramway company has offered repeatedly to equip their lines electrically, and asked for the approval of the Corporation, but the result is nil. In 1901 the Corporation woke up, and entered into an agreement with the company to purchase their undertaking.

A BIT OF OLD YORK,
RETAINED BY THE CORPORATION.



A BIT OF OLD YORK,
PROPOSED BY THE TRAMWAYS COMPANY.

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subject to obtaining powers to do so from Parliament. The Corporation Bill, however, was rejected in March, 1902, because a poll of the ratepayers showed that the general feeling was against the spending of the requisite money. The actual result of the poll was that 6,673 ratepayers were against the Corporation undertaking tramway work, as against 5,381 in favour. After such a decision one would have expected the Corporation to fix up an agreement with the company for the electrification of the tramways, subject to the company purchasing all the energy required from the Corporation electricity department. Such expedition, however, would not be in keeping with the ancient customs of York. The matter has been shelved again, and now certain of the inhabitants have started the circulation of libellous post cards with an object of ridiculing the tramway company. We trust that this ridicule will rebound on the City Fathers, who should surely understand that horse tramways in 1905 are not a sign of progress. When these tramways were designed some 30 or more years ago they were considered suitable for the then population. Now a wide network of lines is needed to serve York and the outlying suburbs, and we trust that the Corporation will either decide promptly to do the whole of this work themselves, or else arrange for the tramway company to do it on terms favourable to the inhabitants. Perhaps, however, it is too much to expect that the tramway question should be settled under the 10-year period which it took to put the electric lighting order in force.

BARKING ELECTRIC TRAMWAY.

Inspection and Opening.

The urban district of Barking Town, which has recently embarked upon a tramway scheme, has an area of 3,813 acres, and the population is estimated at 27,500. The town is rapidly developing as a residential district, and many large works have been and are being established within its area. In 1898 the Council applied to the Light Railway Commissioners for power to construct a line about 1½ miles in length from Barking Town to the Beckton gasworks, where a large number of men resident in Barking Town are employed, and which necessitated the construction of a lifting bridge over the River Roding. The entire cost of this bridge has been debited to this short section of line, and it is, therefore, not surprising that it has hitherto prevented this light railway undertaking being financially successful. In November, 1898, application was made to the Board of Trade for a tramway provisional order authorising the construction of 7½ route miles of tramways, but some of these lines were subsequently struck out by the Council, and eventually 3½ miles were authorised.

Owing to difficulties in land purchase, etc., the Beckton Light Railway was not opened till Dec. 1, 1903, and the Council had meanwhile determined to abandon the tramway powers and proceed with an extension order under the Light Railways Act. This course was adopted partly in order to simplify the keeping of accounts and partly because the district had by this time considerably developed, and new streets had been laid out giving better access to Ilford. In May, 1902, therefore, the District Council applied for powers under the Light Railways Act to construct lines connecting the Beckton line with the East Ham and Ilford tramways systems About the same time the London, Tilbury, and Southend Railway Company applied to Parliament for certain powers, and to meet the opposition of the Council agreed to replace the level-crossing in East-street with a bridge. The property required for this bridge is now purchased and the actual construction will shortly commence, but until this is completed the through line cannot be constructed In the autumn of last year, however, contracts were placed for the construction of a line connecting with the Ilford system at Loxford Bridge and running down Fanshawe-avenue to Longbridge-road, and for a line connecting with the East Ham system at the district boundary in London-road and running along London-road to North-street, and this was subsequently extended through North-street and East-street to Ripple-road. Thus the section still to be constructed when the railway bridge is completed has a length of about a quarter of a mile along Longbridge-road from Ripple-road to Fanshawe-avenue. The Fanshawe-avenue line line was completed and opened for traffic in the spring of this year, and has since been worked by the Ilford Urban District Council by agreement with the Barking Town Council. The London-road section now opened will be similarly worked by the East Ham Corporation. With the completion of the short section above referred to joining the East Ham and Ilford portions, a very important link will be made in tramway communications in the East-end of London, as there is very little doubt that after a short time a circular route will be opened from Aldgate *viâ* West Ham, East Ham, and Ilford on the old Eastern Counties coaching road, through Ilford-lane and Barking, returning *viâ* the line just opened through East Ham and West Ham, and *vice versâ*.

The line is approximately two-thirds of a mile in length, practically all double track. The track consists of 100lb. British standard No. 3 girder rails laid on 6in. of concrete to a 4ft. 8½in. gauge. The joints are made with standard fishplates 1ft. 6in. long, and four 1in. fishbolts and Cooper and Howard-Smith's patent anchor joints, and are double bonded with 3/0 B & S gauge crown type solid copper bonds. The paving is of selected Norway granite, except a short length in front of the Council offices and Wesleyan Church, where jarrah blocks are employed. The points and crossings are of Era manganese steel, while the overhead work is mainly of span construction. The feeder cables are laid on the solid system, current being supplied from the Barking Town Urban District Council's power station in East-street, which was erected in 1899. It contains 600 kw. of plant in Babcock and Wilcox boilers, and high-speed, double-acting, condensing engines by Messrs. W. H. Allen and Co. and the Sunderland Forge Company coupled to direct-current lighting or traction generators, which with the opening of the new tramway section will be completely loaded up. A 400 kw. set is being installed by Messrs. Davey, Paxman, and Co., with a Johnson and Phillips generator, while a new Babcock and Wilcox superheating boiler, feed pump, and water softener have just been started up. The bulk of power generated in the station is being utilised in factories in the neighbourhood, some 500 h.p in motors being connected to the mains. Power is also supplied for the Barking-Beckton Light Railway with its electrically operated lifting bridge, besides the section of Ilford tramways in Barking.

The contractors were: rails, track construction, and cable system, Mr. Daniel T. Jackson, of Barking, with sub-contractors; Messrs. Bolckow, Vaughan, and Co., for rails; Messrs. W. T. Henley's Telegraph Works Company, for cables; Messrs. Burgess, Burgess, and Co., for setts; and Messrs. Hadfield's Steelfoundry Company, for points and crossings. The overhead construction on the London-road section was carried out by Messrs. Dick, Kerr, and Co., and Messrs. Robert W. Blackwell and Co. equipped the North-street and East-street section. Messrs. Hawtayne and Zeden acted as consulting engineers, and associated with them in the work were Mr. C. J. Dawson, consulting surveyor to the Council; Mr. C. F. Dawson, the Council's surveyor; and Mr. A. Hugh Seabrook, the Council's resident electrical engineer.

Many local improvements have been carried out in conjunction with the laying of the lines, and much extra work has devolved on the Council, their committee, and officials. The principal road improvement completed is the new bridge across the River Roding in the London-road, constructed by the County Council, and the general improvement of this road as regards levels and paving. Mr. J. N. Reeson was chairman of the Council when the work was commenced, but on the shoulders of Mr. J. Wilson, the present chairman, and of Mr. L Crow, who has for three years been chairman of the committee, the principal work has devolved. Mr. Hargreaves, the able clerk to the Council, has also had much to do with the successful carrying through of the work.

The official inspection of the London-road section took place on Wednesday last, and was conducted on behalf of the Board of Trade by Colonel von Donop. Accompanying the inspector were Mr. W. C. C. Hawtayne (of Messrs.

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Hawtayne and Zeden, the consulting engineers); Mr. Daniel T. Jackson, the contractor; Mr. A. Hugh Seabrook, the electrical engineer; Mr. Ullmann, electrical engineer, East Ham tramways; Mr. Owen, traffic superintendent; Mr. Blain, traffic superintendent of the West Ham tramways; and several members of the Barking, East Ham, and West Ham Councils. A tour was made over the new line, and the Board of Trade representative expressed his satisfaction with the system. The inspection being over, the company adjourned to the public offices, where light refreshments were partaken of. Mr. W. C. C. Hawtayne proposed success to the Barking Town Urban District Council, and congratulated the committee upon the successful completion of the undertaking, which, he said, would pay handsomely as soon as a linking up of the neighbouring boroughs was effected. Soon, he added, the connection between Barking Town and Ilford would be completed, and then would follow the completion of a route extending from Aldgate to West Ham and on to East Ham, returning by way of Ilford, Barking, East Ham, Poplar, to Aldgate. Mr. Hawtayne acknowledged the services rendered by the officials in the employ of the Council, and the assistance which had been given by members of the committee. On behalf of his firm and the contractor he presented Mr. Councillor Wilson, chairman of the Barking Town Urban District Council, and Mr. Alderman Savage, the chairman of the East Ham Tramways Committee, with silver salvers, suitably engraved, as tokens in remembrance of the opening of the new route. Both recipients responded, and Mr. Councillor Crow, in acknowledging the toast on behalf of the Barking Urban District Council, paid tribute to the work of the consulting engineers, Messrs. Hawtayne and Zeden, and to the contractor, Mr. D Jackson He referred to the impending departure of their electrical engineer, Mr. A. Hugh Seabrook, who is about to fill a similar office under the West Ham Corporation, and stated that in the four or five years during which that gentleman had served the Council he had been able to turn a deficit on the electric light undertaking into a balance of 7 per cent. on the capital. Several other speakers referred to the growing feeling of amity between the borough councils of the district, and the proceedings were brought to a close. It may be mentioned that the track and equipment were provided by the Barking authorities, and the undertaking leased to the East Ham Corporation for a period of five years. The East Ham, West Ham, and Ilford Councils' tramways have all running powers over the track. The line will be opened for public traffic this morning (Friday).

FREMANTLE TRAMWAYS.

The work of converting the present antiquated 'bus service into an up-to-date electric tramway system is progressing rapidly, and in a very short time the conversion should be complete. The power-house was formally opened some time ago, and the first completed portion of the machinery set in motion. It is located at the South Mole, on the water edge, and is a substantial brick structure. The interior is divided into a boiler-room and an engine-room, the former being 87ft. long by 45ft. wide and 20ft. high; the latter is 87ft. long by 30ft. wide and 14ft. high. At the end of the power-house is another building, 60ft. long by 28ft. wide, which is to be used for housing the battery. The brick stack is located in one corner of the boiler-room, and is 109ft. 6in. high, 13ft. 3in. outside diameter at base, and 8ft. 9in. outside diameter at top.

The boiler-room contains four Babcock and Wilcox boilers, each capable of evaporating 4,278lb. of water per hour, and are built in two batteries of two boilers each. The feed pumps are two in number, and are of the Worthington duplex type, while a Guttmann water softener is installed on account of the hardness of the local water. In the main flue from the boilers is located a Green's economiser, divided into two sections. There are 96 tubes in each section, arranged in eight rows of 12 tubes, each being 9ft. long and 4½in. diameter. A small Westinghouse motor is located on top, and drives the scrapers through a wormed gear. The condensing system consists of a Worthington surface condenser, 12ft. long, 2ft. 7in. wide, and 4ft. 8in. high, mounted on concrete piers. The air-pump is by the same maker, vertical, three-throw, single-acting, and is driven by a Westinghouse 500-volt variable-speed motor. A centrifugal pump directly connected to a Westinghouse 500-volt variable-speed motor is installed. This pump supplies the circulating water for the condenser.

There are four Bellis and Morcom engines and four Westinghouse generators, two being for direct current for the tramways and two for alternating current for the lighting. The engines are of the very latest high-speed English type. They are each capable of developing 235 b.h.p. running at 430 r.p.m. on steam at 150lb., with superheat up to 150deg. F., and vacuum of 27in. They are of the enclosed type, having forced lubrication, which is supplied by a small valveless pump located in the base of the engine and connected to the main shaft. They are double-acting, and controlled by a piston valve, which is governed by an enclosed governor located at the end of the main shaft, and which is capable of hand adjustment for speed when the engine is running. The efficiency of these engines when in operation under the conditions they are to operate here will be higher than engines of twice their size as in ordinary use. The direct-current generators are of the latest Westinghouse type, and are 550 volts, 430 r.p.m. each, having a capacity of 150 kw., one capable of standing a 50 per cent. overload for short periods and a 25 per cent. overload for five hours. They are directly connected to the engine shaft, and are compound wound for automatically increasing the voltage for the tramway load. The two alternating-current generators are of the Westinghouse two phase type, having a capacity of 150 kw. each. The voltage is 2,200, periodicity 50, and run at 430 r.p.m. They have revolving fields, which are excited by a small exciter which is directly connected on the generator shaft, the main generator being, like the direct-current generator, directly connected to the engine shaft. The armature is stationary, is well insulated, and is protected by an open cast-iron frame.

The direct-current switchboard for the control of the direct-current generators, and for the distribution, is composed of five panels. There are two generator panels, one battery panel, and two feeder panels. The generator panels are composed of two sections of the best blue Vermont marble. The lower section contains the field resistance and controller handles, the upper section having a main switch, a circuit breaker for the negative and equaliser wires, an ammeter and voltmeter plug. The battery panel has one double-pole switch and single-pole switch, one single-pole double-throw switch, a circuit breaker, a differential voltmeter, a differential ammeter, resistance for the shunt field of the exciter of the booster. The two feeder panels have provision for two feed circuits each. Each panel has two circuit breakers and two single-pole switches, two ammeters, and the usual accessories. The board has also a Thomson recording wattmeter for measuring all the power sent out, a voltmeter and ammeter for measuring the total voltage and currents. The alternating current switchboard is composed of six panels, having two generator panels, one arc lighting panel, and three feeder panels. Each generator panel contains one four-pole double-throw oil switch. These are of the very latest design, breaking all the high-tension currents under oil. There are two ammeters, one in each phase, voltmeter plugs, and receptacles. The feeder panels contain oil switches, ammeters, and Stillwell regulator for each feeder circuit. The arc lighting panel contains ammeter, oil switch, etc., for the control of the arc lighting system. The board also contains all recording instruments for the measuring of power.

There is a motor-booster set installed for assisting and charging the battery. It consists of a 500 volt, 925-r.p.m. Westinghouse shunt motor, directly connected to the booster and the booster exciter. The booster and exciter are of the usual standard Westinghouse type. The storage battery consists of 265 cells, and is located in the room adjoining the power-house.

The erection of the power station was carried out by Messrs. Noyes Bros., contractors, of Melbourne and Sydney, and the engineer was Mr. G. Ayres.

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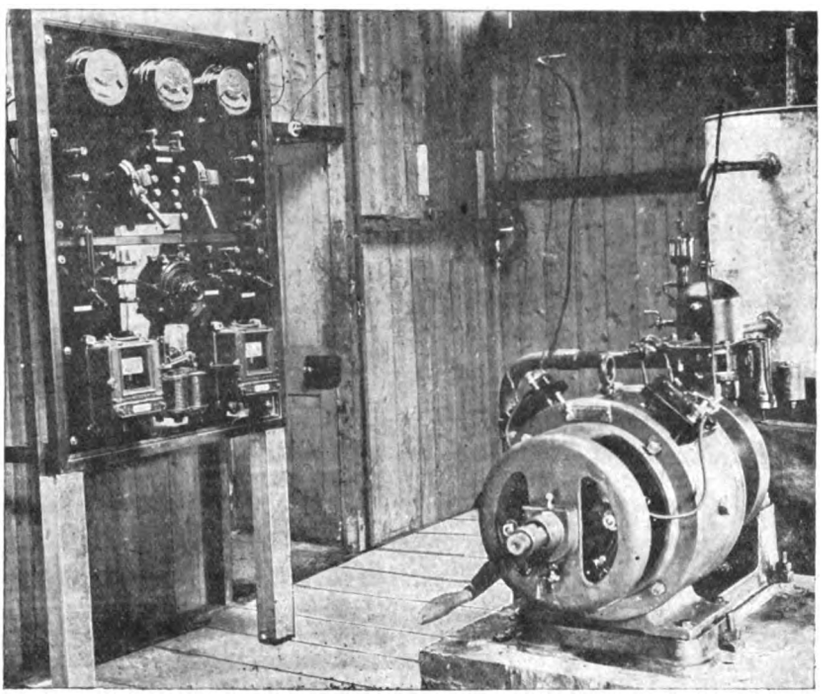
COUNTRY-HOUSE LIGHTING.

The illustration shows a very compact little electric light installation recently carried out by Messrs. R. J. Nicholson and Co., of 26, Cannon-street, Manchester, at a country house in Cornwall. The plant consists of a 55-cell seven-plate section storage battery, a direct-coupled dynamo and petrol engine, and switchboard. The petrol engine is of the two-cycle type, giving 4 b.h.p. at 1,000 r.p.m. The switchboard, which was built by Messrs. Nicholson and Co., is specially designed for installations of this description, and, in addition to the usual instruments, is mounted with a charge and discharge ampere-hour meter. We understand that the firm make a speciality of small country-house plants, for which their type of petrol engine



appears to be eminently suitable. Prices for these engines can be obtained on application.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.*

BY JOHN GAVEY, C B, PRESIDENT.

(Continued from page 665.)

ORDINARY TELEGRAPHS.

In considering the question of ordinary telegraphy, it may almost be appropriate to apply to it the old adage, "Blessed is the country that has no history," if this be interpreted as signifying freedom from subjects of heated debate, or controversial troubles, financial or political, which so frequently retard the development of new enterprises, it being, however, understood to imply steady progress and the full growth that is necessary to meet the requirements of the public and to spread the civilising influences of modern life into the dark corners of the world. Telegraphic statistics have been furnished on previous occasions in presidential addresses and in papers presented to the Institution, and it may not be amiss here to compare former figures with those now available.

First dealing with telegraphs for the use of railways in the United Kingdom, I am able, through the courtesy of the various companies, to submit a table which illustrates the growth since the year 1879, up to which date definite information was supplied in a paper read by the late Mr. E Graves in May, 1880.

* Delivered at the meeting on Nov. 9.

Comparison of Railway Telegraphs in 1879 and in 1904.

	1879.	1904.
Mileage of poles	14,889¼	19,484½
,, wire	62 009½	161,741¾
Number of telegraph instruments	13 128	19 978
,, telephone ,,	Nil.	27.960
,, block ,,	22,411	56,176
,, repeater or signal instruments	11,308	81,682

This table illustrates in a forcible manner the readiness with which our great railway companies avail themselves of the resources for the regulation and safeguarding of their traffic placed at their disposal by the electrical profession, and it is not too much to claim that the comparatively absolute freedom from serious railway disasters in this country is largely due to this wise policy.

Turning to the question of ordinary commercial telegraphy, the following figures may prove interesting:

Telegraphs and Telephones provided by the British Post Office.

	March 31, 1880.	March 31, 1905.
Mileage telegraph poles, underground and cable	25,675	38,032
,, telephone ,, ,, ,,	Nil.	14,898
,, telegraph wire	114,242	338,120
,, telephone ,,	40	253,521
Number of telegraph instruments	12,754	33,267
,, telephone ,,	61	48,118

The growth of the traffic was until recently proportioned to the growth of plant, and although the ordinary telegraph traffic has now been checked by the advent of the telephone, that young and lusty child threatening to monopolise the greater portion of the short-distance work in all countries where it has free play, still for long distances the questions of cost and the physical limitations of the telephone will check the rivalry of the latter, and there appears to be but a small prospect of serious interference or serious competition between the two methods of communication after a certain critical distance is reached. It may be convenient at this point to refer to the general statistics relating to the plant in use for telegraphs and telephones in those countries from which returns are obtainable, and so far as I have been able to gather them, they were represented by the following figures, at the end of the year 1902:

Telegraphs.—Mileage of overhead and underground telegraph wire.

Aerial.	Underground.	Total.	Instruments.
3,433 911	225,748	3,659,659	265,835

Telephones.—Mileage of overhead and underground wire.

Aerial.	Underground.	Submarine.	Total.	Stations.
4,197,416	2,530,215	11,145	7,467,417	3,534,036

The statistics showing the growth of the telephone systems in the United States are, perhaps, the most remarkable. The following table repeats the figures given by Sir

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William Preece in a paper read before the Institution in 1894, and those which appear in the American Bureau of the census report for 1902:

	1893.		1902.
Mileage of wire	532 256	.....	4,850,486
Telephones in use	276.360	.....	2 315,297
Telephone subscribers	232 140	.....	2,178,366
Number of talks	600,000,000	.....	5,070 000,000
Capital at par	—	.....	348,031,058

The growth from the year 1902 to the present time has shown no signs of diminution, so that it is difficult even for the most skilled experts in the States, or those best acquainted with the general situation, to forecast the ultimate development.

As to the amount of capital expended on telegraphs and telephones, the full facts are not forthcoming, as so much of the plant has been provided by the various Governments which do not keep ordinary commercial capital accounts, but it certainly amounts to hundreds of millions of pounds sterling. A consideration of these facts, however, tends to show that whether in capital invested in plant provided, in staff engaged, or in commercial activity, both the telegraph and its daughter the telephone show no signs of lagging behind the other branches of electrical engineering; and so far as the telephone is concerned, notwithstanding the progress it has made up to the present date, there is every reason to think that we have only seen the commencement of its development in the United Kingdom. Much of its future success depends, however, on the action of local authorities, who will have to show a more accommodating spirit than many of them have done in the past, unless they desire that the constituencies that they represent shall lag behind the remainder of the world in the enjoyment of the facilities for intercommunication that science has placed at their disposal. For these bodies to insist that all telephonic connections shall be laid underground without regard to the number of wires to be provided, to the capital cost involved, or to the fact that long telephone trunk lines must in the present state of our knowledge be provided by means of overhead wires, is to place an insuperable bar to the provision of a cheap and efficient service. In its own interest and for the good of the service which it controls, a telephone administration will always place its wires underground where it is either possible to work its circuits satisfactorily or it is not absolutely uneconomical to do so, but for local authorities to insist on this method being followed in every case simply means either the stifling of the industry or its provision at a cost beyond the reach of the ordinary user. When a corporation has to provide the capital expenditure for public undertakings it takes good care to see that no waste of funds takes place, but when the cost has to be provided by others there is a tendency to make demands that would not be considered in carrying out its own works, the authorities appearing to be oblivious of the fact that the expenditure must be ultimately met in some form by those whom they represent.

If we now consider the actual apparatus by means of which commercial telegraphy is effected, perhaps the most surprising fact that strikes the observer is the predominance of the use of the ordinary Morse code and Morse apparatus throughout the world. At first it seems surprising that, notwithstanding the innumerable inventions of printing, writing, and drawing telegraphs, the original system—of course, much improved—still holds the field generally, notwithstanding the partial use of the Hughes and Baudot printing systems on the Continent of Europe. On consideration, however, it will no doubt be seen that, in comparing the Morse with other systems that at first would appear to be superior, its simplicity, its relative freedom from trouble, electrical or mechanical, the ease with which its alphabet is learned and a skilled telegraphist is trained, and its adaptability to high-speed or multiplex working, all help to maintain it in the forefront, and undoubtedly qualities will for a long time prevent or delay its general replacement by other types of instrument where the speed of working that is necessary is not greater than can be achieved by an operator manipulating a key. Where high-speed automatic Morse apparatus, however, is in use, the want of a means of automatic transcription which would save the labour and delay of manual transcription has long been felt, and extremely promising systems have been devised whereby the problem has been solved in two different ways. In one which was recently illustrated in a paper read before the Institution a perforated slip is used for transmission, as in the ordinary Wheatstone system, but instead of the signals being received in Morse characters at the far end, a second slip is perforated, the exact counterpart of the original; this is placed in an automatic typewriter, which prints the message on ordinary typo. Two different methods of applying this system are now under the consideration of the Post Office. In others the transmission is effected by means of a perforated tape, the message, however, being printed by the receiving instrument, either by a direct impression from a type-wheel, or in one case by a photographic reproduction of each letter as the type-wheel revolves.

It is interesting to note how the practice in the ordinary telegraph service has materially benefited by the development of other branches of applied electricity. Thus for testing and localising faults, and in order to obtain control over the large mass of wires entering the principal offices in this country, these were formerly attached to screw terminals fixed in a test box, which was bulky, and which occupied much valuable space in a costly building. The practice in the Post Office now is to terminate these wires on telephone jacks, and to provide for connections for testing, crossing, or other purposes by means of plugs and flexible cords, the modern arrangement only occupying one-third the space of the old type. Again, the extended introduction of secondary cells charged from lighting plant by means of motor-generators has resulted in the last few years in the abolition of about 150,000 primary cells in the Post Office service, this change leading to a proportionate saving of space, and to a great economy in generating energy and in upkeep. Again, the great extent of modern London necessitates a very considerable amount of local telegraphic traffic. The number of inter-metropolitan messages — viz., those from one part of London to another—some time ago amounted to 18,000 per diem. These were all retransmitted at the Central Office, for it was obviously impossible to provide direct connecting wires between every one of some 600 telegraph offices. The Post Office therefore determined to revert to the system of switching lines through to one another as required, a method which had proved a failure when tried on long and costly trunk circuits, as these could obviously deal with a much larger percentage of traffic when a constant stream of messages was fed into them than was possible when switching connections had to be made. Where local circuits are concerned which are short and inexpensive, and in the majority of cases not filled with traffic, the conditions are altered, and it is a wise policy to increase the number of wires where necessary and to save the delay and cost of retransmission. A special switching board based on telephonic lines was therefore designed to meet telegraphic requirements, and a section providing for 138 lines was fitted up at the Central Telegraph Office and brought into use experimentally on Nov. 13, 1902. Now any office connected to the switch which wants to communicate with another similarly connected merely calls the latter, and the switch clerk, hearing the call, simply joins the two lines through in the manner adopted for telephonic service. Suitable signals are provided to indicate when lines are engaged, and the number of wires to important offices has been increased. In designing the arrangement provision has been made for working all the wires from a secondary battery installed in the Central Telegraph Office, so that the large number of primary cells previously installed in each office has been dispensed with. The result has been so satisfactory that the whole of the metropolitan circuits are now being treated in a similar manner, and this handling of 18,000 messages twice over each day is about to be entirely obviated.

In submarine cable work the same progress may be noted as in other branches of telegraphy. The growth in half a century is represented by the following figures:

1852	87	nautical miles.
1892	139,594	" "
1902	212,894	" "

and it goes on without interruption.

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Types of submarine cable have in practice not been materially changed, and with the one exception of the air-spaced submarine cable designed for telephone purposes by Mr Willoughby Smith, one of which was laid by the Post Office between Nevin, in North Wales, and Newcastle, in Ireland, in the year 1892. The problem of devising submarine cables for long-distance telephones is, however, still to be solved. The longest telephone cable of the old Paris type was laid by the Post Office in the year 1902 for communication between London and Brussels. It is 47 knots in length, and this is about the practical limit of distance over which satisfactory telephonic speech is possible under existing conditions when allowance is made for the addition of the connecting land lines and of the local subscribers' plant.

As one of the results of cable enterprise, it may not be inappropriate here to refer to the extended knowledge of the character and constitution of the sea bottom which has been derived from the extensive soundings and surveys that have been made in the Atlantic and Pacific Oceans, preliminary to the laying of deep-sea cables. On a reference to Admiralty charts, the track of deep-sea cables can be followed along the continuous lines of soundings at short intervals which appear where cables have been laid, whereas other portions of the sea bottom are comparatively uncharted. I have especially in mind some of the admirable charts and reports prepared by Mr. R E. Peake in connection with cable enterprises with which he has been associated.

Wireless Telegraphy.

Wireless telegraphy—so called—has attracted a great deal of intermittent attention for many years past. The various possible methods of communication between two localities not directly connected by wire may be divided under five heads: (1) leakage across the earth or water between two parallel wires erected on opposite sides of a position which has to be bridged; (2) electromagnetic induction between coils placed vertically or horizontally; (3) the combination of the two above systems by the erection of two parallel overhead wires connected to earth at their extremities; (4) electrostatic effects from vertical conductors; (5) the Hertzian system.

Many attempts have been made to establish communication across rivers, arms of the sea, etc, by the first method, and they have met with varying success, but the system is one the application of which has a limited scope. The second method has but a limited range; it has only been rendered possible by the use of telephones, but inasmuch as the effective energy available for signals diminishes as the cube of the distance between the coils, the limit beyond which no signals can be received is very rapidly reached. The third method, which, prior to the invention of the Hertzian method, was fully investigated by the Post Office, has met with a certain measure of success, and at the present time there are two installations still at work in this country. One of them connects Rathlin Island with the mainland at Bally Castle, the parallel wires being at an average distance of eight miles apart. The second instance is an installation establishing communication between the Skerries, a series of rocky islets off the coast of Holyhead, with the telegraphic service on Holyhead Island itself. The parallel wires are at an average distance of three miles apart. The latter installation is worked telephonically—*i.e.*, the wires are fitted with telephone transmitters and receivers, and telephonic speech is actually transmitted from wire to wire. The fourth system of communication by purely electrostatic effects without the emission of free waves has not been developed on a practical scale. The fifth, or Hertzian, system has created world-wide interest, and its development in the course of the last few years has been very marked. As is well known, the method is based on the classical researches of Hertz. It was made possible in the first place by the original inventions of the coherer by Branly, improved later by Lodge, and finally developed into a practical system by Marconi.

It may be of advantage to briefly review the gradual development of the art from the date of Marconi's early work. It will, no doubt, be remembered that after a period of experiments, first in Italy, then in this country, a crucial trial was made in the year 1896, under the auspices of the Post Office, across the Bristol Channel, from Lavernock Point, first to the island of Flat Holm, and then to Breamdown, near Weston-super-Mare. At that period, what has by some been termed the "whip-crack method" only had been tried—that is to say, a powerful spark coil was connected, one terminal to the vertical conductor, the other to the earth. This arrangement emits a very powerful impulse which is damped down almost immediately, and it is probably the first single impulse alone which affects the receiver at a distance. Elementary attempts at tuning were made by various experimenters during this period, but the art was not sufficiently developed to admit of any really useful results being obtained. The coherers were probably far too sensitive, and the difficulty experienced in the early days was rather due to their not decohering than to their failing to respond to the electrical waves. In course of time this difficulty was remedied by the use of an oscillating transformer in the receiving circuit, which admitted of the use of less sensitive coherers, and excellent results were obtained, but owing to the fact that every receiver within a certain definite range of a given transmitting apparatus responded to each impulse, and all receivers were affected by all transmitters within range, it appeared at first as though Marconi's attempt to increase the effective limit of his apparatus would tend to restrict rather than to extend the use of the system He and others interested in wireless telegraphy, therefore, turned their attention to the establishment of syntony between the transmitting and the receiving apparatus, and a marked degree of success has attended their efforts This syntony is usually effected by connecting one or more closed oscillating circuits to the source of energy and coupling these either direct or through an oscillating transformer with the vertical antennæ, the closed oscillating circuit and the vertical antenna being in unison—*i e*, having the same frequency. A closed oscillating circuit includes a capacity and an inductance, and, therefore, for each primary impulse a train of waves is generated The first portion of the wave has not such an amplitude as when the whip-crack method is used, but this is more than counterbalanced by the effect of the long train of oscillations, which results in restricting to a great extent the visible effect to receivers tuned in harmony, other receivers not so tuned not responding when a certain critical distance is passed. In the next place, by a judicious combination of oscillating circuits with antennæ of suitable capacity, the amount of energy that can be utilised for the transmission of signals may be increased from the small limits imposed when an ordinary induction coil is used to practically any given amount—an utter impossibility with the original method of working. Of course, where a very powerful exciting system is in use, the radiating surface must be increased proportionately, and the well-known method of multiple antennæ has been designed to achive this end. At the receiving station the tuning is effected by the addition either of inductance or of capacity, the receiving installation being brought into as perfect syntony with the transmitter as is possible. In addition to this, special devices have been introduced in the receiving circuit for the elimination of waves of other periodicities so that even whip-crack transmission can to a great extent be eliminated. The effect of having the transmitting and the receiving apparatus in harmony was shown in an admirable manner by the Post Office experiments, recently carried out and described by Messrs. Duddell and Taylor, which gave graphical measurements of the energy received under both conditions.

The receiving apparatus has undergone many modifications since the original filings coherer was invented. There is, for example, the single-point contact, consisting of a pointed carbon lightly resting on a slightly oxidised steel surface; the Brown radioscope, consisting of a lead electrode resting lightly on a surface of peroxide of lead; the Lodge-Muirhead revolving disc, touching lightly on a mercury surface; the Schaffer, so-called, anti-coherer, consisting of a fine razor slit across a silvered glass surface; the Italian navy coherer, in which one or more globules of mercury are enclosed between carbon and steel contacts—all of which are dependent for their action on imperfect contacts; the bolometer and electrolytic methods claimed by different inventors; and, finally, Marconi's electro-

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magnetic receiver. Many of these have been associated with variations in the original method of combining the different electrical elements of each circuit, and have been denominated "systems." I will not, however, enter the thorny path of attempted discrimination between those that may be considered as systems or those that can only be described as methods.

A great deal has been said by rival inventors as to the possibilities of wireless telegraphy, and some exaggerated claims have been made on their behalf which have led to counter statements by some interested in other methods of communication. Whilst, on the one hand, it may be fairly assumed that wireless telegraphy is not, under any circumstances, likely to supplant, or even to compete seriously with, inland methods of intercommunication, there is no doubt that there is a very distinct and important sphere of utility awaiting its further development. For intercommunication between ship and shore, and ship and ship, much has been done, although much remains to be done. For intercommunication between neighbouring coasts there is also a possible future, but this depends almost wholly on the further development of the methods of syntony or tuning. There appears to be doubt that in cases in which the wave-lengths used on two systems differ to a considerable extent, a very marked degree of success has been obtained in the avoidance of mutual interference. Where the wave-lengths, however, are not very widely apart in frequency, there is in each case a definite range within which interference arises, and simultaneous working is impossible. That the tuning methods will be improved I think there can be very little doubt. The progress that has been made between the year 1896 when it took a week to receive a few elementary signals over a distance of nine miles, and the present time, when such remarkable results have actually been obtained, is so great that it does not imply the possession of an unduly sanguine disposition if one ventures to predict further improvements, which may be expected to increase the freedom from mutual interference, the speed, and the reliability of this method of communication. It does not appear to be very probable that it will seriously compete with the highly-developed cable communication in the near future, although it may in many instances supplement that service.

(To be continued.)

KING'S LYNN ELECTRICITY ACCOUNTS.

From the accounts of the King's Lynn electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounts to £46,466. Abstracts of the revenue account and balance-sheet, etc., are given herewith.

Revenue Account.

Dr. Expenditure.	£	s.	d.
To generation of electricity	1,519	3	5
Distribution of electricity	672	14	2
Attending and repairs to public lamps	230	7	11
Rents, rates, and taxes	332	6	4
Management expenses, salaries, etc.	364	2	1
Law and parliamentary expenses	22	5	6
Insurances, etc.	33	3	9
	3,164	3	2
Amount carried to net revenue account	3,323	1	6
	£6,487	4	8

Cr. Income.	£	s.	d.
Sale of current per meter	3,753	1	3
Public lighting	1,796	19	11
Under contracts	30	3	3
Rental of meters and other apparatus	178	10	10
Sale and repairs of lamps, etc.	728	9	5
	£6,487	4	8

Balance Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—mortgage debt	37,277	0	0
Sundry creditors	79	0	3
Due to treasurer	4 444	7	5
Surplus assets	8,208	19	2
	£50,009	6	10

Cr. Assets.	£	s.	d.
Capital account—amount expended on works	46 465	19	2
Stores in hand	638	4	9
Sundry debtors for current, meter rents, etc.	1,771	12	4
By net revenue account	1,133	10	7
	£50 009	6	10

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			491,629
Quantity sold: Private lighting by meter	145,114		
By contract	2 600		
Public lighting	174,507		446,112
Motors	123,891		
Quantity used on works			11.105
Total quantity accounted for			457 217
Quantity not accounted for			34 412
Maximum supply demanded (kilowatts)			3o1

Number of public lamps: 457 pairs 16-c.p. incandescents, 33 Nernst, 10 arcs.

ABERDEEN ELECTRICITY ACCOUNTS.

Herewith we give abstracts of the revenue account, balance-sheet, etc., from the accounts of the Aberdeen electricity department for the year ended July 31, 1905. The total expenditure on capital account to that date amounts to £236,860.

Revenue Account.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	5,875	11	4
Oil, waste, water, and engine-room stores	473	11	9
Wages at generating station	1,779	8	8
Repairs on buildings	493	1	11
Repairs on plant	934	6	1
Main and service repairs	987	16	8
Meter repairs	67	9	3
Repairs on motors and depreciation	840	9	5
Rents and feu duty	95	4	0
Taxes	3,402	6	1
Management	235	0	0
Engineer's salary (proportion)	513	2	8
General establishment charges	219	11	5
Engineer's travelling expenses	73	8	11
Stationery, printing, and advertising	139	18	11
Insurance	44	6	2
Inspector's wages	77	16	9
Auditor's fee	15	0	0
Bad debts	96	4	0
Abatements	217	5	6
Special services	362	17	4
Lamps	44	0	10
	17 037	17	8
Balance carried to net revenue account	22 009	15	6
	£39,047	13	2

Cr. Income.	£	s.	d.
By sale of current per meter	23 664	2	8
Public lighting	2 319	16	7
Traction (Corporation)	9 890	9	2
Traction (Suburban)	1,367	15	10
Sale of lamps	102	17	9
Hire of motors	840	9	5
Attendance on harbour and fish market lamps	617	17	9
Rents and feu duties	64	4	0
	£39,047	13	2

General Balance Sheet.

Dr. Liabilities.	£	s.	d.
Amount borrowed on mortgage	215 313	7	6
Mortgages redeemed by sinking fund	21 547	0	0
Reserve fund	16,165	0	4
Amount due to sundry creditors	2,494	9	7
Excess paid for current due to tramway department	1,137	1	3
Amount deposited in security for current	473	7	4
Temporary loans	17,976	8	2
Balance due to bank	391	16	6
	£275,443	10	8

Cr. Assets.	£	s.	d.
Amount expended on works, less depreciation	237 447	1	10
Sundry debtors for current supplied	13,367	5	5
Stores on hand	11,222	13	4
Reserve fund invested	13 411	10	1
	£275 448	10	8

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			4,893,050
Quantity sold: Private consumers by meter	1,709 012		
Traction	2 115 279		4,069,831
Public lamps	255,540		
Quantity used on works and subway			317,793
Total quantity accounted for			4,447 624
Quantity not accounted for			451,426
Number of public lamps (arc)			192

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ENGINEERING ESTIMATES AND THE LOCAL GOVERNMENT BOARD.

Before we leave the subject of the Local Government Board policy, and the method in which their inspectors conduct inquiries respecting loans for extension work, we wish to deal with preliminary estimates of financial results. The inspectors have frequently compared these estimates of profits obtainable with the actual results of working the undertaking in question. As a result, unfavourable comments have been made and doubts thrown on the estimates forming the real subject of the inquiry in question. Commencing from the beginning, a town obtains an electric lighting provisional order, and one or two energetic councillors take up the matter of carrying out the powers of this order. They most likely approach some prominent consulting engineeer and ask him what they ought to do. They usually add that they are not authorised to spend any money on professional advice. The consulting engineer, if a Westminster man, will tell them that he will give them a preliminary report and estimate for a nominal fee of fifty guineas, or even less, which will include his travelling expenses when going to see the town, his report, and, perhaps, an interview with the electric lighting committee or whole council. He will spend one day in the town to get a general idea of the same, but the figures in his report are bound to be based on his experience obtained elsewhere. His estimate of revenue and expenditure for, perhaps, three or four years will be worked out on average figures, and in all the reports we remember seeing a definite price per unit sold is given for each year. The results are, perhaps, very favourable for the third and fourth years, showing a large margin of profit, which will induce the council to go on with the work. So far, so good; but is it fair to compare this preliminary report as to profits with the actual profit obtained? We state emphatically that it is not, and give our reasons as follows. In the first place, it may be that the preliminary report is considered and reconsidered until anything from six months to two years may elapse before the engineer gets instructions to issue specifications for the work. It thus may be three years before supply is started, and three years in the development of electrical engineering shows great alteration in standard practice. The engineer's experience may by then have proved to him that a lower charge per unit in the first instance is really more economical, because it encourages a more rapid development of the undertaking, and does not penalise the first users of electricity. It, of course, means a larger loss in the first year or two, but it is followed by a much wider use of electricity throughout the town. Again, another cause for the variation between estimate and obtained profit is quite outside control of the consulting engineer. He does not have the fixing of the rates, and they may be altered without even consulting him. We know of one case in Lancashire where the horse tramways were converted at a great expense for electric traction. The engineer pointed out that this expenditure was warranted by the lower working cost and probable increase in traffic which would ensue. He said that after the trams had been worked electrically for a year or so fares might be reduced. What happened was this. At the next election, when the conversion was still in progress, a large number of Labour members were elected. These obtained the control of the tramway committee, and their first act was to reduce all the fares by one-half without even consulting the eminent firm of engineers who had the conversion of the tramways in hand. As the electric cars were only running on one or two sections and the traffic was disorganised by the conversion, a heavy loss was incurred at once. The

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same lines are now working with an annual deficit, after paying capital charges, which could be obviated by a slight rise in the fares now fixed. There are other reasons for variations between estimates prepared often at two days' notice and the results from the working of what may be quite a different system in future years. We have said enough, however, to show that the Local Government Board inspectors are quite beside the mark in drawing conclusions derogatory to the accuracy of engineers' estimates in general from any comparison made with such preliminary reports.

FORTHCOMING EVENTS

FRIDAY, NOV. 17.

Electro-Harmonic Society.—At 8 p.m., concert (ladies' night) at the Holborn Restaurant.

Institution of Mechanical Engineers.—At 8 p.m., the seventh report to the Alloys Research Committee: "On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys," by Dr. H. C. H. Carpenter, Mr. R. A. Hadfield, and Mr. Percy Longmuir.

Motor Exhibition.—Olympia.

SATURDAY, NOV. 18.

Institution of Electrical Engineers.—At 10 a.m., students' visit to Chelsea generating station.

Junior Institution of Engineers.—At 2.30 p.m., visit to Messrs. Barclay, Perkins, and Co.'s Anchor Brewery, Park-street, Southwark Bridge.

Northampton Institute Engineering Society.—At 7.30 p.m., lecture on "A Comparison between Gas and Electricity in regard to their Use as Illuminants," by Mr. S. M. Hills.

TUESDAY, NOV. 21.

Tramways and Light Railways Association.—At 12 noon, visit to Motor Exhibition at Olympia.

Institution of Electrical Engineers (Birmingham Local Section).—At 8 p.m., address on "Some Problems in Electro and Electro-Thermal Chemistry," by Prof. R. Threlfall, F.R.S.

WEDNESDAY, NOV. 22.

Society of Arts.—At 8 p.m., lecture. "The Cinematograph and its Applications," by Mr. F. Martin-Duncan.

THURSDAY, NOV. 23.

Institution of Electrical Engineers.—At 8 p.m. (at the Institution of Civil Engineers), "The Applications of Electricity in the Royal Gun Factory, Woolwich Arsenal," by Colonel H. C. L. Holden, R.A., F.R.S.

Tramways and Light Railways Association.—At 8 p.m. (at Society of Arts), "Paving of Roadways," by Mr. W. L. Green.

FRIDAY, NOV. 24.

Physical Society.—At 5 p.m., "The Dielectric Strength of Air," by Mr. A. Russell: "On the Electrical Conductivity of Flames containing Salt Vapours for Rapidly Alternating Current," by Dr. H. A. Wilson; "On the Lateral Vibration of Loaded and Unloaded Bars," by Mr. J. Morrow.

Engineering Standards Committee.—At 11 a.m., conference of glow lamp makers at Institution of Civil Engineers.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., address by Mr. J. Swinburne, M.I.E.E.

Society of Arts.—Nov. 27, at 8 p.m., Cantor Lecture (I.), "The Measurement of High-Frequency Currents and Electric Waves," by Dr. J. A. Fleming. Nov. 29, at 8 p.m., "The British Association in South Africa," by Sir W. H. Preece, K.C.B.

Institution of Electrical Engineers (Manchester Section).—Nov. 28, at 7.30 p.m., "Theoretical Considerations of Feeder Systems," by Dr. W. G. Rhodes, M.I.E.E.; "Street Cable Systems," by Mr. G. J. Watson, M.I.E.E.

Institution of Electrical Engineers.—Dec. 8, at 8 p.m., dinner at Hotel Cecil.

PERSONAL.

Mr. James H. Shepherd has been appointed general manager of Dundee, Broughty Ferry, and District Tramways Co. Five years ago, following the introduction of the electric system into Dundee, he was appointed assistant superintendent of depôts, and for the last 3½ years he has performed the duties of depôt superintendent at the headquarters of the city tramway department.

The South Shields Town Council have appointed Mr. John Wilson to be general manager of the Corporation's new electric tramways at a salary of £250 per annum. Mr. Wilson has been general manager of the old South Shields tramways for 20 years.

The Erith Urban District Council have appointed Mr. A. S. Scott as junior clerk in the electricity department at a salary of 27s. 6d. per week.

EXHIBITION SLAVES.

The Touching Ballad of the Exhibitor's Representative.

[It is generally acknowledged that the late Electrical Exhibition was a huge success, but small reference has been made in the public Press to the share that the hardworked exhibitors' representatives had in this magnificent result.]

Now the Exhibition's ended, what a busy time and wet;
What a lot of solid grafters at Olympia I've met;
Not to mention pretty maidens, some there were in costume blue
Who at making lamps were perfect, and at making matches too.

But the way we slaved was cruel, tho' we did it all like men,
And if ever the occasion comes we'll do it all again.

Oh! the work was simply killing, down before the mid-day chime,
Read the letters from those fatheads at the Works from time to time;
Send them postcards, "Awful busy, very nearly made a sale,"
Meet your *vis-a-vis* at Lyons, hear his latest moral tale.

Yes, the way we slaved was cruel, though we did it all like men,
And if ever the occasion comes we'll do it all again.

In the afternoon came thousands, some were thirsty, hot, and tired,
Ah! the way we worked like niggers getting bottle necks unwired;
Drawing corks and pressing triggers, till it made the fingers ache;
Not to mention keeping gamesters with the guests, for friendship's sake.

Oh! the way we slaved was cruel, but we did it all like men,
And if ever the occasion comes we'll do it all again.

Then to wander through the building, meeting slaves at every bar,
Culling business information, business news from near and far,
Ask how garden chairs are selling at the stand of P.P.P.
While the man in charge goes frantic underneath the plantain tree.

Ah! the way we slaved was cruel, but we did it all like men,
And if ever the occasion comes we'll do it all again.

Then to take a country client for a feed, and when he's wined,
Drink-for-drink him, mixing frequent, till you'd got him nearly blind.
If the blighter had an order for to place, his doom was sealed;
If he would not place it sober, faith, he would when he was keeled!

Ah! the way we slaved was cruel, but we did it all like men,
And I'm sure that when occasion comes we'll do it all again.

For a month we bore it bravely, hour by hour and day by day,
For the honour of our firms until our souls near left their clay.
Now—with feeble pulse some linger, waiting Time's all-healing touch,
Some see snakes and frogs of crimson. Ah! they worked too blooming much.

Oh! the way we slaved was cruel, but we did it all like men,
And we're game to fill the breach next time and do it once again.

B. C. H. J.

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THE LONDON COUNTY COUNCIL POWER BILL.

It was decided on Tuesday last that the London County Council should be one of the many applicants for powers to distribute electrical energy on a large scale throughout Greater London. This matter has been referred to before in our columns, but as it has now entered the region of practical politics we reproduce the two reports bearing on it. The first of these, from the Highways Committee, is dated Oct. 23, and reads:

1. We desire to direct the attention of the Council to the very important issues which have been raised in connection with the introduction into Parliament, in the session of 1905, of several Bills dealing on a much larger scale than any brought forward hitherto with the supply of electrical energy in London and certain adjacent districts. The largest of these schemes, that promoted by the Administrative County of London and District Electric Power Company, contemplated the supply of energy, both in bulk and also to large retail consumers, over an area of upwards of 500 square miles. The basis of this scheme was that the company should by agreement, or failing this, by competition with the consent of the Board of Trade, eventually become suppliers of electrical energy in bulk to all the local authorities and companies supplying in London, and in a large area outside London, or else absorb the existing undertakings and carry on the whole service. In the event of the existing supplying authorities not being absorbed, they would "scrap" their generating stations and become retailers or distributors of the energy sold to them in bulk or wholesale by the Administrative Company. At the present time about half London is supplied with electrical energy by local authorities' undertakings, each confined to a single borough, and the other half is supplied by companies whose undertakings are, with a few minor exceptions, compulsorily purchasable by the borough councils in 1931.

This right of purchase by the borough councils which is a cardinal feature of the Electric Lighting Acts of 1882 and 1888, still exists, but its value and practicability have become seriously jeopardised by the character which the companies' undertakings have assumed.

Inasmuch as a single company's undertaking often extends through several boroughs, whilst there is only one generating station, many local authorities will, if present circumstances continue, only be able to buy mains and no station, while others will only be able to buy mains and a station far too large for the needs of a single borough. In some cases, moreover, the stations are outside areas of supply, and, it is contended, not purchasable at all.

We have frequently drawn attention to these difficulties when, on former occasions, schemes much more restricted in character and extent have been put forward. The scheme of the Administrative Company, however, raises these issues in a far more acute form. Had the Bill become law, an enormous monopoly would have been created in the supply of what is now one of the most important and vital factors in the commercial development of London and the neighbouring districts. The danger of such a state of affairs is such that we do not feel it necessary to enlarge upon it now. It will be sufficient to remind the Council that the electrical supply, in common with the water, gas, and tramways services, in most of the large cities in England is in the hands of the local authorities respectively concerned; it being clearly considered that a monopoly in services of this character, which are vital to the welfare of the community, should not be in private hands. It seems clear, however, from the fact that this scheme (although it largely ignored the statutory rights of existing undertakers and tended to the creation of a private monopoly) received the approval of committees of both Houses of Parliament, that those committees must have been convinced that electrical energy was not at the time supplied in a sufficiently attractive and cheap form to meet the needs of manufacturers and others in London and the immediate neighbourhood, and that to enable a satisfactory supply to be given a scheme or schemes on a much larger scale than any then authorised was necessary. A great feature of the case for the Administrative Company's Bill was that existing areas were too small to admit of the generation and distribution of energy on the most economical scale, and, consequently, at the lowest price.

While admitting the proposition that larger areas than several of those at present existing are necessary to secure these ends, we do not feel that it is necessary either to entirely disregard the statutory rights of existing undertakings or to place them in such a position as will make it impossible for them to carry out their service.

What is required at this juncture of the history of the electricity question is, in our opinion, that a complete view of the case should be stated by an authority capable of putting that case before Parliament. Up to the present all that has been attempted has been to deal with the problem separately from the company's standpoint and the borough council's standpoint, which together do not, however, make up the whole case so far as it concerns London. This, for the reasons set out in this report, can, we think, be most adequately done by the Council as the central municipal authority. We have accordingly carefully considered how the advantages aimed at can be gained otherwise than by the creation of a private monopoly, and we have arrived at the conclusion that, having regard to the extent of area necessary to secure economical supply, and to the importance of preserving as far as possible, the existing rights of local authorities and the principle of municipal ownership contemplated by the Acts of 1882 and 1888, the only possible alternative is for the Council to obtain such powers as will enable it to supply electrical energy in London and the neighbourhood, the Council being the only London municipal authority entrusted with an area large enough to allow of generation on the necessary economical scale. The fact that the Council already has a very large generating station to supply electrical power for the tramways of London is, in itself, largely in its favour by rendering possible a load of the most economical character. We would point out, too, that one important objection which was raised in the case of the Administrative Bill was the enormous powers that would be conferred on private individuals in respect of the breaking up of streets and the interference in other ways with public property. It seems obviously desirable that such extensive rights as would have been conferred in regard to public property should be in the hands of a public authority, and, moreover, as the Council is itself from time to time laying electric mains in all parts of London for tramway purposes, considerable convenience and economy of work would be gained were the two services in the Council's hands. In addition, there is the fact that the Council is already responsible for the conduct of very large services involving the consumption of such similar stores and the formation of such similar organisations as would be necessary for the supply of electrical energy. In view, therefore, of these considerations of economy, and also the importance of retaining in public hands the control of a service so essential to the development of London in the future, we believe that the Council will think it right to seek powers to enable it to supply electrical energy as proposed. The authority to be sought should, we think, include power (1) to supply energy in bulk throughout the whole of the area in question, and (2) to supply energy to large individual consumers, as, for instance, railway, canal, and tramways companies, or authorities where these undertakings extend over more than one area.

We have not at present gone fully into the details of a definite scheme for the supply of electrical energy, but, from reports which we have had before us, and having regard to the favourable position in which the Council stands in many respects, we are of opinion that it will be quite practicable to put forward a satisfactory scheme, bearing in mind the importance of providing cheap electrical energy for general use in London, and at the same time securing continuity of the policy of public control which was intended to be ensured by the purchase clauses of the Electric Lighting Acts of 1882 and 1888.

The Council on Oct. 24, 1905, authorised us, with the Parliamentary Committee, to confer with representatives of the London local authorities upon the whole question of the supply of electrical energy in London. It is proposed to hold this conference on Monday, Nov. 20, 1905, and we will then place our proposals, in the event of the Council adopting them, very fully before the local authorities. In the meantime, however, we have thought it right, having regard to the short time available for the issue of the necessary parliamentary notices as to the deposit of a Bill, etc., to place before the Council this outline of the policy which we recommend it to adopt. We have, as required by standing orders No. A 27 and A 161, informed the Finance and Parliamentary Committees of our intention to recommend the Council in this sense. It is, however, necessary for us to ask the Council to suspend the operation of standing order No. A 161, which requires that all proposals relating to applications to Parliament for powers shall be submitted to the Council not later than its first meeting in June of each year. We think that this is clearly a case of urgency, which comes within the class contemplated by standing order No. A 162, inasmuch as it was not until August that it was known that the Administrative Company's Bill would not pass. We have consulted the solicitor, in accordance with standing order No. A163 and he is of opinion that the Council has power to promote legislation in the direction indicated, provided that the provisions of the Borough Funds Act, 1872 as applied by the County Council's (Bills in Parliament) Act, 1903, are adopted. We recommend:

(*a*) That the operation of standing order No. A 161, relating to the time for the submission to the Council of schemes involving application to Parliament, be suspended, in order that the following recommendations may be considered.

(*b*) That authority be sought in the session of Parliament of 1906 (1) to enable the Council to supply electrical energy in London and certain surrounding districts on the lines indicated in the report of the Highways Committee, dated Oct. 23, 1905; (2) to confer upon the Council power to carry out any necessary works, including the erection of buildings, the laying of mains, etc., necessary to give effect to such powers; (3) to empower the Council to make arrangements with local authorities and others having power to supply electrical energy, and to enter into agreements to give effect thereto; and (4) to confer upon the Council any general powers which may be necessary to enable it effectively to supply electrical energy.

(*c*) That the costs and expenses of promoting the legislation referred to in the foregoing resolution be defrayed out of the county fund.

(Signed) FITZROY HEMPHILL, Vice-Chairman.

The second is from the Finance Committee advising that the matter should not be proceeded with. This is dated Nov. 8, and reads:

1. The Highways Committee are recommending the Council to promote a Bill in the next session of Parliament to enable the Council to supply electrical energy in London and certain surrounding districts, and it devolves upon us under standing order No. A 27 to report upon the financial bearings of the proposal. The authority to be sought includes power (1) to supply electrical energy in bulk throughout the whole of the area in question, and (2) to supply energy to large individual consumers, as, for instance, railway, canal, and tramways companies, or authorities where these undertakings extend over more than one local government area.

In considering this most important proposal we have found ourselves in a position of great difficulty owing to the absence of any financial data to guide us in advising the Council. Time has not permitted a definite scheme to be worked out by the Highways Committee, and their report to the Council only outlines in very general terms the proposals which they recommend the Council to place before Parliament.

We are strongly of opinion that in a matter of this magnitude,

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raising financial issues of the greatest importance, the Council should, before committing itself to the undertaking, have before it a definite and carefully-worked-out scheme.

In the absence of any such scheme we have given such consideration to the subject as time and the limited amount of information at our disposal have allowed. The two main questions on which the Council will naturally desire to have our advice are: (1) Are there reasonable grounds for thinking that the enterprise will be self-supporting? and (2) Can the large sum of capital required be raised without affecting the credit of the Council?

The first of these considerations is one of vital concern, for we cannot suppose that the Council would agree to invest some millions of public money in an undertaking of this kind without substantial reasons for the belief that it would be at least self supporting—in other words, that the profit on working would be sufficient to pay the interest on, and provide for the repayment of, the money borrowed. The credit of the ratepayer would in any case be pledged for the raising of the capital; but the Council will no doubt agree that beyond this no further assistance should be looked for from the rates. The Council will note that the report of the Highways Committee offers no guidance upon this matter beyond the general statement that in the Committee's opinion "it will be quite practicable to put forward a satisfactory scheme."

In these circumstances we have endeavoured to assist the Council to a conclusion from a consideration of the estimates and financial data placed by the power company before Parliament last session in support of their scheme, with which the Highways Committee's proposals are in a measure comparable. We desire to distinctly disclaim any acceptance of the company's estimates and calculations, but we think it may be useful to the Council to have some of these materials before it.

The power company proposed to supply a very large "industrial" and "non-industrial" area, of which no less than 75 per cent. was outside the county of London. Capital powers to the extent of £6,600 000 were sought by the Bill, and the initial capital expenditure to complete the first station of 60 000 kw., distributing mains, and subsidiary works was put down at £2,100,000, the total capital expenditure up to the completion of the undertaking being estimated at £6,600 000, including £100 000 for "preliminary" expenses. The company sought powers to supply existing undertakers (borough councils and companies) and large undertakers—*e.g.*, railways, docks, etc.—throughout their area, and also in the "industrial" area manufacturers and other power users *direct* with the consent of the existing authorised undertakers, provided that if that consent were unreasonably withheld an appeal could be made to the Board of Trade. The company estimated that they could generate electricity at the low price of ·154d. per unit, a figure which, adding general and other expenses, worked out to ·522d. per unit sold, and that with a sale of 133,500,000 units by the year 1910 at an average price of ·7d. there would be a balance, after providing for reserve, depreciation, and renewals, sufficient to pay 5½ per cent. on a capital of £2 000 000, and, further, that with a sale by the year 1916 of 600,000,000 units at ·55d. there would be a balance sufficient to pay

4½ per cent. on £1,000,000 debenture stock	£45,000
5 per cent. on £2,000,000 preference stock	100 000
8 per cent. on £3,000,000 ordinary stock	240 000
Total	£385,000

and to carry forward about £38,000.

These figures related to the company's entire area, of which, as above stated, the greater part was outside the county of London; the company gave no figures for the county of London separately.

It is, to say the least, doubtful whether the profit estimated by the company could have been obtained.

Whether the above estimates were well founded or not, it appears to us that they are deserving of the Council's attention, particularly in view of the fact that any practical scheme put forward by the Council will inevitably be compared with these figures.

The Highways Committee do not say what capital would be required, but we have assumed that a sum of about £3,000,000 would be required *in the first instance* for a large generating station with mains and subsidiary works. The expenditure of this money would be spread over five or six years, and it is obvious, therefore, that there must inevitably be a long period during which the capital would be unremunerative. The power company proposed to meet this difficulty by obtaining power to pay interest out of capital at the rate of 3 per cent. up to a maximum of £310 000. There is no precedent for a municipal body being given such a power, and we must assume, therefore, that the interest on the capital raised would have to be defrayed out of the rates year by year. We estimate that for interest payable on a sum of £3,000,000 during the construction of the works an aggregate sum of about £380,000 would have to be so provided. This is a consideration which we do not think the Council has sufficiently appreciated in the past. There are precedents for the postponement for a few years of the sinking fund provision, and we have therefore assumed that no charge under this head would fall upon the ratepayers of the earlier years.

The ultimate debt charges, assuming that the expenditure on land and buildings were spread over 60 years, and the cost of machinery, trunk mains, etc., over 25 years, may be taken roughly at about 6 per cent., which, on an initial outlay of £3,000,000, would represent an annual charge of £180,000 a year.

What the Council has to consider is the probability or otherwise of the undertaking showing a profit on working sufficient to produce this amount.

The power company calculated on a total output for their entire area of 133,500,000 units in five years' time, and on 600,000,000 units in 11 years' time, when the works would be completed.

We find that the output of the existing undertakers in London in 1903-4 was as follows:

Companies	85 933 026 units.
Borough councils	27 963 137 ,,
Total	113,896,163 ,,

On the basis of the power company's calculations it would be necessary for the Council to sell upwards of 200,000,000 units at an average of ·7d. per unit in order to realise a profit on working of £180 000 a year, even if the working expenses should prove to be not higher than those estimated by the company, and if the same provision is made for renewals and reserve.

It is difficult to compare the proposals foreshadowed by the Highways Committee with the power company's scheme for various reasons. In the first place, the proposed area of supply has not yet been determined by the Highways Committee, but we gather that it would include a large district outside the county of London. This is an important point, because the existing conditions of the electric supply in London, and the extent to which existing undertakers are providing therefor, appear to us to render it extremely probable that a scheme of supply limited to the county would not allow of a sufficient output for production at the lowest possible cost. On the other hand, there are obvious difficulties in the way of the Council obtaining powers of supply outside the county of London, and the wider area would largely increase the amount of capital to be provided, and add greatly to the Council's responsibilities, for whatever financial risks there may be in the undertaking would fall entirely on the ratepayers of the county of London.

It is not clear from the proposals outlined in the committee's report whether the Council would be able to supply power direct to individual manufacturers, or only, with certain exceptions, to supply through existing undertakers. The Council is aware that the power company sought powers, with the consent of the Board of Trade, to supply directly to the manufacturers, with the object, no doubt of securing thereby a lever to force the distributing undertakers either themselves to supply the manufacturer at or about the prices offered by the power company, or to accept a bulk supply from the power company. It appears to us that this matter has an important bearing on the probable amount of business for which the Council might look.

Again, the Highways Committee are not yet in a position to estimate the amount of support which the Council would be likely to receive from existing undertakers (companies and borough councils), and until some information on this point is forthcoming, it appears to us undesirable for the Council to commit itself.

Turning now to the other consideration which has occupied our attention, we feel it our duty to state to the Council that we view with apprehension the large addition to the Council's capital commitments which this undertaking would necessarily involve. As the Council must be aware the question of the extent of its commitments, particularly in their bearing on the amount of money which will have to be raised on loan during the next two or three years, has for some time past been a matter of growing concern to us. We desire to impress upon the Council the fact that, however good its credit may be, if it were to force larger loans on the market than the investing public could readily absorb, the Council would inevitably have to be content with a lower price for its issues of stock, and this would particularly be the case when the general conditions of the money market are not altogether favourable for such issues. The effect of such a course would speedily prove detrimental to the Council's credit, and in our opinion the Council should so limit its capital expenditure as to obviate the necessity for making undue demands upon the money market. The time has, in fact, arrived when the Council must, in our judgment, select from the objects of expenditure which it is being pressed to undertake those which are necessitated by its present statutory duties in order that its general financial position may not be prejudiced.

The Council is at the present time engaged in carrying out several great improvements and works involving a large amount of capital expenditure, and during the present year it has decided upon the immediate electrification of the whole of the northern system of its tramways, and this with various extensions and other reconstructions will necessitate a far larger capital expenditure on tramways during the next few years than in any past year. Again, the acquisition of a site for the new county hall has been approved, and provision for this, together with the building, will make a serious addition to its normal requirements on capital account. In these circumstances and apart altogether from the consideration of the risk which the proposed scheme involves, we think the Council should endeavour to find some solution of the problem which would not involve the raising by the Council of large sums of capital in the near future. The report of the Highways Committee does not discuss any alternative policy by which the evils which might result from the creation of a virtual monopoly with wide powers might be obviated, as, for example, the introduction in the power company's Bill of adequate safeguards in the form of a purchase clause, sliding scale of price, and dividend and other similar provisions. We merely refer to this aspect of the subject in order to point out that there are alternative methods of dealing with the difficult situation which has been created by the general recognition of the changed conditions under which electrical energy must in future be generated.

In conclusion, we desire to impress upon the Council the fact that the enterprise to which it is being asked to commit itself is one which, from its nature and from the possible developments of electrical science, is of a somewhat uncertain character, and that the Council is being asked to commit itself without any figures before it showing that the undertaking would be made self-supporting. We are, moreover, of opinion that the Council should be further guided in this matter by its financial position, and that it should not largely extend its financial engagements during the next few years beyond those already entered into.

(Signed) WELBY, Chairman.

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After a lengthy debate on Tuesday last, the amendment to refer the matter back to the Highways Committee was rejected by 79 votes to 36

Sir Francis Mowatt then moved that the following amendment be added to the recommendation: "Provided that, before the introduction into Parliament of any Bill, opportunity shall be afforded for full discussion in the Council of its provisions, especially as they affect the financial consequences of the scheme."

The amendment was carried, and upon a division the recommendation as amended was agreed to by 79 votes to 32.

OPENING ADDRESS TO THE DUBLIN SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

BY P. S. SHEARDOWN, MEMBER, CHAIRMAN FOR SESSION.

(Concluded from page 674).

Storage Batteries as an Adjunct to Central-Station Equipment. The writer (G. Gaettling) remarks that only a few years ago station engineers were strongly averse to the use of batteries as being unnecessary and complicated, but that now many engineers considered that a reliable service could not be given without them. In a table showing the increase in kilowatt-hour capacity of central-station batteries he notes that in 1894 two stations only had batteries, the total capacity being 938 kilowatt-hours. In 1904, 22 generating stations, 68 sub-stations, and 8 exciter batteries had been installed, with a total capacity in kilowatt-hours of 124,211; 95 per cent. of these storage batteries had been installed by one firm of makers. He claims that battery rooms should be located close to the switchboard room to save voltage loss and to keep the cable connections short; that it is unwise to erect batteries so that inspection cannot easily be made; that the floor of a battery room must be both acid proof and fire proof, and states that a flooring in vitrified brick on a layer of 6in. of concrete is most satisfactory, and that the bricks be grouted in with hot pitch. Cells should be installed in one tier, as a double-tier installation is difficult to inspect. Battery tanks should be placed on double insulators to prevent leakage. With regard to plates themselves, the positive consists of a rigid conducting support, holding in place soft lead formed into small buttons of coiled ribbon, with corrugated surfaces, these buttons extending slightly beyond the surface of the hard metal support or grid, as it is technically called. These plates have been found to stand very satisfactorily the excessive demands that the storage battery is called upon to meet. The development in the negative plate has kept pace with that of the positive plate. The negative plate now consists of a hard metal supporting grid, in which the various sections of active material are securely held in place by means of a thin covering of perforated sheet lead. The advantage of this plate over all other types lies in its strong mechanical construction, in its greatly increased life, and its ability to maintain its capacity throughout a long period of use. A still further development, and a most important one, is the substitution of thin wooden diaphragms between the plates as separators, in place of the glass tubes heretofore generally used. This new type of separator is superior, in that it effectively prevents any possibility of short-circuits forming between the plates, thus keeping the cells in uniform condition, so that the amount of work in operating the battery is reduced materially, and the proper relation of charge to discharge maintained more economically—all of these features combining to effect a very considerable increase in the life of the plates.

In the discussion surprise was shown by the English engineers that the value of the reversible booster seemed to be unknown in America—they did not appear to appreciate how much the life and upkeep of a battery depended on the life and cost of upkeep of the regulating cells; that in America they were still using the old end cell regulation, whereas in England they were gradually introducing a fixed number of cells and booster regulation. It was also shown that, whereas in America the system of maintenance by contract had been practically abandoned, in England it had become almost universal and worked out at about 7·5 per cent. per annum of the original cost, and for that amount those who guarantee the battery have to keep them up to 100 per cent. capacity; one advantage claimed for this maintenance system being that the guarantor insisted on certain tests and inspections being made which in actual practice tended to increase the life of the battery. The American life seemed to be that they placed so much importance to and faith in their storage batteries in the cases of emergency, that they did not like to run the risk of impairing their reliability by coupling to them a piece of rotary machinery which they claim might be an element of failure, and they stated that, owing to the fairly steady load that they had on their batteries, the regulating coils had not given them much trouble. The splendid results obtained with wooden separators were emphasised, the capacity of the batteries having been increased very much since these boards were installed. The boards affected only the negative plates, it having been proved that after a short time in use the negative plates gave only 80 per cent. of their guaranteed capacity, but that, after this board diaphragm had superseded glass separators, in three weeks' time they could get from 110 to 115 per cent., so the life of the negative plate is increased by at least two years.

Storage batteries are very largely used in the States in the sub-stations in electric railway service, and in J. B. Entz's paper on this subject the following points are brought out: That although the efficiency of a storage battery may not be high compared with other forms of electrical machinery, that the batteries deal satisfactorily with the portion of the load which is least economical for the generating or transmitting apparatus—that is to say, that the peak load which occurs occasionally, and with the light load experienced during the night, when with storage batteries steam plant may be entirely shut down. With regard to the efficiency, the writer states that with batteries used very considerably on peak work their output will amount to from 15 to 20 cent. of the total output of the station, and as the battery under average conditions will not be fully discharged, a certain portion being held in reserve to meet abnormal conditions, the efficiency of the battery will be high. Taking this at 85 per cent. as a minimum, he finds that the loss in the battery where their output is 20 per cent. of the total is 3 per cent. of the total output of the system, and that it is safe to assume that on account of the improved efficiency in transmission and the improved load factor on the rotaries that the efficiency of the sub-stations would be increased considerably more than this amount, and that any improved economy in generation of power at the main power-house will be net gain. As to the construction of a battery for such service, it is pretty well established that the positive plates should be of the Planté type and not of the pasted type, while the negative type are preferably of the pasted type. The characteristic trouble of negative plates has been loss of capacity due to shrinkage of the spongy finely-divided active material into a denser and less porous material. This has been practically true of Planté negative plates where the active material is relatively small in quantity, and has been reduced from the peroxide previously formed from the plate itself. A process has been discovered of manufacturing a negative active material which always retains its loose spongy porous condition, but as this has but little mechanical strength, means have to be provided in the plate for retaining it in position; such plates have proven eminently satisfactory in service, and extended tests show very great increased life and the maintenance of low resistance and low polarisation factors.

A very interesting paper was given by Mr. Alexander Dow on the direct-current distributing system of American cities. The general system of distribution in large American cities is a three-wire, direct-current, low-pressure system, the potential across the outers usually being in the neighbourhood of from 210 to 220 volts. As you are aware, this is quite different from the system usually employed in distribution in English and Continental systems, where, if alternating distribution is not installed and the direct-current system employed, the pressure across the outers is usually from 440 to 500 volts; and Mr. Dow gives evidence in favour of the low-pressure system originally installed, and still adhered to in large American cities—meaning cities of a population of 250,000 or upwards. Originally in America the current was produced as direct current, the stations being comparatively close together and feeding right into the network, each engine driving a pair of generators, as it is not customary there to depend upon the balancers or upon a storage battery for balancing the load on a three-wire system, although storage batteries are often used for auxiliary or reserve sources of current. With the increased demand for electrical power the system of generation has changed, and most of the large cities have one, or at most two, large generating stations situated outside the area of distribution and transmitting power in the form of three-phase high-pressure current to sub-stations. But at the sub-stations, by means of either rotary converters or motor-generators, the current is converted to direct current and supplied at low voltage to the original three-wire distributing network. It is generally claimed that by doubling the voltage on a three-wire system, as has been practically altogether done in England, you double the amount of power that can be sent through a network of given sized cables without any increase in the resistance losses; but the author argues that on their system it simply tends to the multiplication of sub-stations and a comparatively small increase in the amount of high-tension feeder cables required, and argues that the amount of generating machinery required with either system is the same, and that the increased expenditure in dividing up the converting machinery into a comparatively large number of units so as to feed at many

* Delivered on Nov. 9, 1905.

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different points into the network is not a very costly matter, as many of the sub-stations are only required to be run during the period of heavy load, and that, therefore, the increased wages is not an important matter. He also argues that by this means they can regulate the voltage in all parts of the distributing network with a minimum amount of variation, which means that they can use very much higher efficiency lamps than is possible where the high-voltage lamp is used on a large network fed into at points long distances apart. The custom in the States is for the supply and maintenance of the lamps to be included in the price charged for current, and that, therefore, it is a matter of great importance to them first of all to operate a lamp which requires a small consumption of energy; and, secondly, to have a lamp that will give a long life before breakage of the filament or loss of power makes it necessary to renew. Their standard lamp is 16 c.p. operating on 3·1 watts per candle. The author thought that by working with a high-efficiency lamp they had a saving in current of about 20 per cent., and rather pertinently remarked that the object of a lighting company should be to supply light, and not electrical power, at the cheapest possible rate to the consumer. With the 3·1-watt lamp referred to they were able to realise an average life of over 470 hours per lamp before the candle-power was reduced by blackening to 80 per cent. of the initial candle-power. Five per cent. of all the lamps manufactured for them are selected at random before being packed and tested for watts per candle at the rated voltage, and out of this 5 per cent. one-tenth are given a continuous life test, being run at marked marked voltage until the candle-power has fallen to 80 per cent. initial value. With regard to alternating current, although it has the advantage of requiring less cost for plant in the sub-stations, and a smaller amount of attendance than rotary converter apparatus, he claimed that with a mixed system of lighting and motors (the latter being largely used for lift service), the power factor would seldom be higher than ·9 and frequently lower than ·8, which would mean larger generating plant and larger mains, and naturally this low power factor means still greater difficulty in voltage regulations.

Steam-Turbines. — Several important papers were read on steam-turbines, which, in view of the great advances this type of prime mover has made of recent years, naturally commanded a good deal of attention. The first paper was by Mr. W. R. L. Emmett, who has been largely responsible for the development of the Curtis steam-turbine as manufactured by the General Electric Company. He first of all drew attention to the fact that a much smaller building was required where steam-turbines were installed than was the case with low-speed reciprocating steam-engines, mentioning that if the full advantage of the steam-turbine was to be realised, the station should be designed with this special feature in view. With regard to efficiency, he admitted that up to the present the best class of steam-engine had attained results under favourable conditions quite as good as had been obtained with the steam-turbine, with the following difference—that in the case of an ordinary reciprocating engine the greatest difficulty was attained at one given load, but that the efficiency fell off very rapidly either when unloaded or overloaded, which was a very important point, because, especially in the case of ordinary generating stations, it was very hard, indeed, to keep an engine loaded with a constant steady load, but in the case of the steam-turbine the variation in efficiency at half load and 25 or 30 per cent. overload was very nearly as good as at the load for which the turbine was designed to run with maximum efficiency. The energy available in expanding 1lb. of steam from a pressure of 150lb. to a vacuum of 29in. is 27 per cent. more than if expanded to a vacuum of 25in., yet the efficiency of the modern reciprocating engine is only improved by 1 per cent. if the vacuum it discharges into is increased from 25in. to 29in., because the best engines open the exhaust at a pressure of 7lb. to 8lb. absolute, and consequently lose a large proportion of the expansive force of steam below that point, the degree of vacuum below the point of exhaust only serving to diminish the back pressure and not employing an effective expansion to the vacuum point. The reason of this is that as steam expands to low pressure the volume increases in a rapidly increasing ratio, and this increase of volume is so great that it soon passes the limit of capacity for which cylinders can be profitably designed. There is thus a large proportion of the valuable energy due to the expansion of the steam which cannot be used in reciprocating engines, and which must be lost in the form of heat in exhaust steam. The steam-turbine possess the inherent advantage that it can be designed to work effectively to very high degrees of expansion in the steam; since the steam in the turbine is not confined to chambers where it must exert pressure, it is available for doing work as long as it possesses expansive force capable of imparting an effective velocity to the steam itself. Thus the steam-turbine operates in a larger field of theoretical possibility than does the steam-engine, and that it is not at present more efficient is simply because its development on a large scale has been confined to the past four years, and that it, therefore, has not had as much time and trouble spent on experimenting with it as has been done with the steam-engine, which has been so much longer in the field. The writer dealt on the fact that condensing plant capable of maintaining a high vacuum was of much more importance with steam-turbines than with reciprocating engines, but stated that, owing to the construction of the former, it was easier to prevent air leakage. He then drew attention to the great increase in efficiency which could be obtained with existing steam plant by arranging for them to exhaust into a low-pressure turbine, driving a generator working in parallel with the plant driven by the reciprocating engine and then allowing this turbine to exhaust into a high vacuum. He claims that the turbine designed for operating under these conditions would be an ideally simple affair, and its maintenance and care would add little or nothing to the cost of station operation, there being many large stations in which the introduction of such turbines with proper condensing facilities would increase the output as much as 30 per cent. without any increase of the fuel consumption or change in the boiler plant. The turbine should be arranged to receive steam at about 8lb. pressure absolute corresponding approximately to the pressure when the exhaust valve opened in the low-pressure cylinder of the engine. The engine would then handle all the power which it could develop with maximum efficiency, and its own output would be only slightly reduced, and the turbine would develop the power to which the engine was not well adapted. The cost of installing such turbine with complete condensing facilities would not exceed £12 per kilowatt of capacity added to the station. Another application of the steam-turbine which promises a considerable degree of economy is by its use utilising the waste heat from gas-engine installations.

The best gas-engines (according to the author) turn about 20 per cent. of the heat of the fuel into useful work, the remainder is lost either in the exhaust gases or in the heating of the water used to jacket the cylinders and other parts. It should be possible to pass the exhaust gases through the tubes of low-pressure boilers fed by hot water which had passed through the jackets of the engines. The boilers would deliver steam to simple low-pressure turbines with suitable condensers; in this manner 30 per cent. could easily be added to the power developed by the gas-engine without increasing the gas consumption.

Another paper (Francis Hodgkinson) of great interest dealt with steam-turbine performances, some valuable information dealing with actual tests made on Westinghouse-Parsons steam-turbines being given. The tests on a 750-kw. turbine showed that when running with a boiler pressure of 140lb. non-condensing, and with no superheat, the consumption per brake horse-power hour at full load was 28·26lb., but with the steam-turbine running on a 28in. vacuum, boiler pressure 150lb., superheated 100deg., the consumption was reduced to 12·38lb. On another 750-kw. turbine, boiler pressure 150lb., vacuum 26in., superheat 150deg., at full load the consumption was 13·18lb. per brake horse-power hour, but with similar conditions except that the vacuum was increased to 28in., the consumption was reduced to 11·79lb. In another 400-kw. turbine it was found that when operating with 150lb. boiler pressure, 28in. vacuum, and dry superheated steam, the consumption at little over full load was 13·89lb. per brake horse-power hour, but by superheating 100deg. this was reduced to 12·48lb. With regard to the efficiency over a wide range of load, this consumption of a 750-kw. turbine was given at ·479 per cent. of full load as 13·85lb. of steam per brake horse-power hour; at full load, 11·79lb. of steam; at 24 per cent. overloaded, 11·42lb. of steam; and at 41 per cent., 11·5lb. per brake horse-power hour.

In a paper on aluminium as an electric conductor the following points were brought out by H. W. Buck: That at the present its electric utility is practically confined to (A) 'bus bars in power stations; (B) high-tension overhead uninsulated conductors; (C) low-voltage feeders, usually insulated with weather-proof braid only. It is debarred from use in a number of cases on account of the practical impossibility of applying the ordinary methods of soldering. At the present relative cost of the two metals, aluminium is about 10 to 13 per cent. cheaper than copper of the same resistance. Aluminium, owing to its low conductivity, and necessarily greater diameter, makes it more expensive for use on cables where costly materials are used for insulation. Aluminium wire is not suitable for telephone work on account of its coefficient of expansion and its comparatively low tensile strength, which causes a greater sag at high temperatures than in copper wire, although it is stated that where it has been used the speaking through appears particularly good, which may possibly be due to the particular balance which exists in the aluminium wire between the resistance, inductance, and capacity, aluminium having somewhat less self-induction and more capacity than a copper wire of the same resistance. Aluminium is particularly well suited for 'bus-bar construction owing to the great saving in weight and the lower cost, but care should be taken when using aluminium for such purposes to provide for expansion and contraction. Aluminium also is very widely used for low-voltage direct-current feeders

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for railway work. The 53 per cent. reduction in weight as compared with copper requiring smaller poles, and the increased radiating surface of the aluminium feeder, allows a greater overload to be carried by it than with copper. The most prominent use of aluminium electrically is for overhead high-voltage transmission circuits. When first introduced considerable trouble was experienced with breakage resulting from flaws in the material and from crystallisation due to the wire swaying in the wind, but wires are now supplied stranded instead of solid, even down to small sizes, and the original trouble of breaking has disappeared. The writer of the paper had communicated with many users of aluminium wire so as to get their expression of its position as an overhead conductor as compared with copper, and his replies illustrate the following points: That the wire now furnished from the manufacturers is entirely reliable. The wire is not easily affected by ordinary atmospheric conditions, but where the air is badly contaminated with chemical fumes it is best to protect the wire with a weather-proof insulation, but in the case of a damp atmosphere near the seacoast the metal will protect itself by a thin improvised coat of oxide. Aluminium wire gathers much less salt than copper. It costs less to erect aluminium wire on account of its weight, but being softer it must be more gently handled than copper. The fundamental consideration which enters into the use of aluminium for overhead line work is that of wind pressure, and especially so in modern long span suspensions. The author has made experiments on a 950ft. span with supports 45ft. high. The highest actual wind velocity he had so far come across was 34 miles per hour.

A good many papers were read dealing with the single-phase motor for railway work, as there seems to be a strong influence at work in the States proclaiming the virtues of this type of machine, which a few years ago nobody had a good word for. A very interesting paper was read giving a description of Mr. Arnold's method of utilising single-phase synchronous motors for railway work in connection with air-compressor engines and air-storage tanks. It is, of course, well understood that if the difficulty of getting the synchronous single-phase motor up to speed, and also of overcoming the difficulty of obtaining a suitable starting torque, could be overcome, that this type of motor has many advantages due to its satisfactory operation on high-voltage lines, and also the simplicity of the generating and transmitting apparatus required with same. Mr. Arnold proposes to get over these difficulties and has made same extensive and interesting experiments on the matter, although his system is still only partially developed, but it certainly involves some novel and interesting features. For instance, the motor is constructed so that both the armature and field-magnet system, or, as he calls them, the rotor and stator, can both revolve—that is to say, the stator may be held stationary and the rotor revolve, or, *vice versâ*, the motor held stationary and the stator revolve. The rotor is geared to the axle of the car by means of a crank pin secured to a pinion, which also drives a compressor cylinder, while the stator is free to revolve round the rotor, and drives, by means of a crank pin, a second compressor cylinder. Both cylinders are piped to air reservoirs located under the car, or one cylinder may be used as a compressor and the other cylinder as an engine driven by compressed air from the former. When this car is standing in a station, the rotor, being rigidly geared to the car axle, is stationary, while the stator runs with full synchronous speed, and is thus transferring full energy through the crank to the compressor cylinder, while energy is being stored in the form of compressed air in the air reservoir. To stop the car, it is possible to increase the pressure behind the compressor piston attached to the rotor to such an extent that it overcomes the effort of the rotor to revolve, thus tending to cause the stator to revolve, while at the same time it holds the car at rest without the use of wheel brakes. To start the car by means of the controller which operates valves, the air cushions behind the piston of the rotor cylinder is removed. The air which is being compressed by the stator cylinder, supplemented by the storage air from the tanks, is now allowed to act on the back of the rotor piston; the rotor then begins to revolve, and as it accelerates the stator slows down by exactly the same amount that the rotor has increased its speed. As the rotor and car speed increase, the controller is gradually moved so that the inlet valves of the rotor cylinder give a small percentage of cut-off until the car speed corresponds to the full synchronous speed of the motor, at which time the stator comes to rest. To bring the car to rest, instead of applying mechanical brakes to the wheels in the ordinary manner, thereby dissipating the entire stored energy of the car in the form of heat, the energy is saved in the form of compressed air to assist in starting the car by setting the controller in such a position that the rotor cylinder compresses air and delivers it into the storage tanks. Any desired rate of retardation can be secured by throttling the delivery passages from the rotor cylinder. The inventor admits that the machine in its present form is somewhat complicated for commercial application, but by the development of suitable rotating air machinery the system is capable of great simplification, as by this means the large number of reciprocating parts with their complicated valves, etc., would disappear.

RESIGNATION OF THE WOOLWICH ELECTRICAL ENGINEER.

Mr. John B. Mitchell, electrical engineer for the borough of Woolwich, has sent in his resignation (under protest) of the appointment which he holds under the Council, and the same has been accepted by the General Purposes Committee, and was to come before the Council last night. Mr. Mitchell was appointed electrical engineer by the late Plumstead Vestry, and was transferred to the new authority when Woolwich was made a municipal borough. The present intention of the committee is to throw open the appointment to competition, and advertise for candidates. The salary at present attaching to the appointment of electrical engineer is £500, but it is more than likely that in order to get a "superior man" another £50 will be offered.

We have not had time to investigate this matter, but just as we are going to press our attention has been drawn to a leader in the *Kentish Independent*, entitled "Very Shabby," which deals with the subject as follows:

"Government by party—whether in political or municipal matters—is responsible for many shady transactions, but not often, in this locality at least, for anything so shabby as the treatment which has been meted out by the Labour Party to Mr. Mitchell, the electrical engineer to the borough of Woolwich, whose resignation, under protest, we report elsewhere. It is, of course, within the rights of any municipal authority to dismiss, or call for the resignation of, any of its officers, should the necessity, from any cause whatsoever, arise; but it should be done in the proper constitutional way. But what has happened in Mr. Mitchell's case is this. A note was dispatched by the town clerk, upon the instructions of the mayor, to Mr. Mitchell, asking him to meet the mayor, together with Councillors Grinling and Sheppard, in the mayor's parlour, on Sept. 8. Mr. Mitchell kept the appointment, when the mayor informed him that they had asked him to meet them to discuss the situation of the electricity department generally. His Worship went on to say that it might be thought by some people that he and his party were too impatient, but they themselves had come to the conclusion that they had been very patient, in fact, too patient, with regard to the working of the electricity department. At this juncture, we understand, the electrical engineer put the very pertinent question as to on what authority they called upon him to discuss at such a meeting any matter concerning the electrical undertaking. Matters had gone thus far when Councillor Grinling intervened by saying that the interview was but a friendly one, and that they had been requested by the Labour Party to ascertain if matters could not be remedied. This brought the reply from Mr. Mitchell that he had no desire to discuss matters with this unofficial deputation, and, further, he was under the impression that the electricity undertaking should be run on proper commercial lines, and for the good of the community as a whole, and not to suit any particular party, whatever they might call themselves. This, we think, was in the circumstances a very proper answer, though possibly it might not have been a politic one. This unpleasant interview, we are told, was brought to a close by a pretty plain intimation to Mr. Mitchell that he had better resign.

"We feel bound to ask, in the interests of the ratepaying public, what right had these gentlemen to arrange a private meeting without any mandate whatever from the Borough Council, and quite unbeknown to them—in order to force a resignation from a public officer. We do not doubt that in what they did they acted with the best intentions—from their point of view—but they made a great mistake. The proper course of action was to bring any complaint before the Electricity Committee, and through them before the Council. The fact is, as we have pointed out in these columns over and over again, the electrical undertakings of the borough are becoming a gigantic success, and more is expected of the electrical engineer than any one man can do, and the pace of expenditure has become much too fast with the information and time available for the preparation of engineering and other details. Besides this, the Electricity Committee is composed for the most part of men who know as much about electricity as Cæsar did of the telephone—absolutely nothing. And such a combination, instead of helping an official, only hinders him and renders him dissatisfied and desperate.

"We are sure the public will sympathise with Mr. Mitchell in the manifestly unfair treatment he has received at the hands of the party who dominate the Woolwich Borough Council in being made a convenient scapegoat. It is only another instance of the unsatisfactory results of the introduction of party politics into local government."

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TRADE NOTICES AND NOVELTIES.

New Accessories.

The accompanying illustrations (Figs. 1 and 2) show two useful tumbler switches, being new adaptations of Mr. A. P.

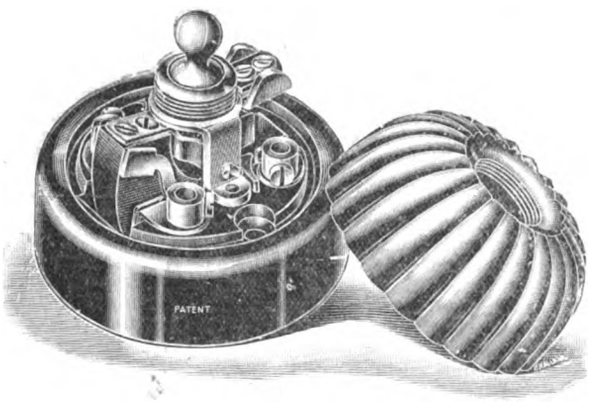


FIG. 1.

Lundberg's patent "Duplex" switch movement which was recently described in our columns. Referring to Fig. 1, the requirements met by this switch are as follows—viz., series-parallel with "off" position, whole or part circuit with "off" position, and reversing with "off" position. When one of the

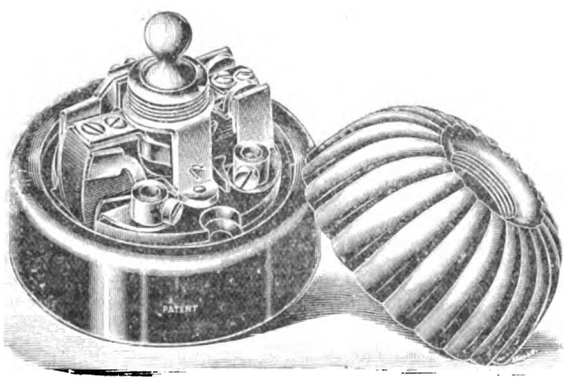


FIG. 2.

contact arms is in its "on" position it is locked there, the contact arm which is in its "off" is also locked, the same locking action taking place when the contact arms are in their opposite positions. The single spiral spring used allows equal tension on both contact arms, and produces no jar to the fingers of the operator. Moreover, the "off" position is very definite. Covers are made in a variety of patterns for this switch, which can also be supplied in flush and suspension types. The three-way switch (Fig. 2) with "Duplex" movement, is as distinctly noteworthy. It is, however, unnecessary to enumerate here the many novel applications and economies which can be effected through the use of these special tumbler switches. Suffice it to say they mark a great advance on the clumsy and expensive methods of adapting turn-type switches which have hitherto been employed to meet the same requirements. Fig. 3 illustrates the "Presto" tumbler switch. This is Mr. Lundberg's latest pattern of "Pivot"

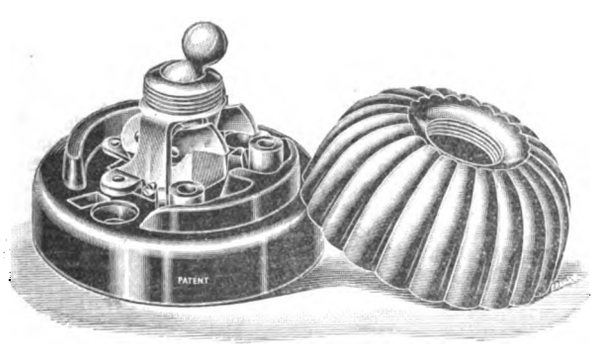


FIG. 3.

switch movement. Ebonite for insulation in the rocking bar is dispensed with; it is now made of metal and porcelain only. The application of the mousetrap type of spring to produce the "variable leverage" action and locked "on" position which are the features of the "Pivot" movement, is quite novel. This switch has all the advantages of the standard "Pivot" switch, but, so far, is made only in the single-way type. Our next illustration (Fig. 4) represents a two-way switch of the suspended pear "see-saw" type. This switch is of effective construction on a porcelain base, easily removable from the containing case to facilitate wiring up. It is provided with a division between the terminals and an insulated sliding bar. The "M. I. P." ceiling rose (Fig. 5) is another novelty. It can be adapted in at least 17 different

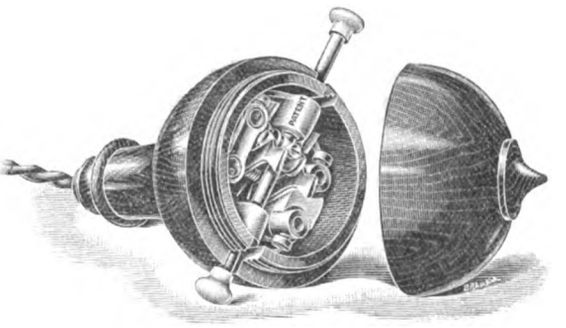


FIG. 4.

ways. The arrangement of the detachable plug and terminals allows of this versatility, whereas an ordinary ceiling rose has but a limited application. The thought may occur to the reader that Mr. Lundberg is certainly not less versatile as an inventor. He is always presenting some fresh novelty or economising device, and as his electrical accessories are invariably of substantial design and thoroughly well made, we never have the slightest hesitation in recommending them.

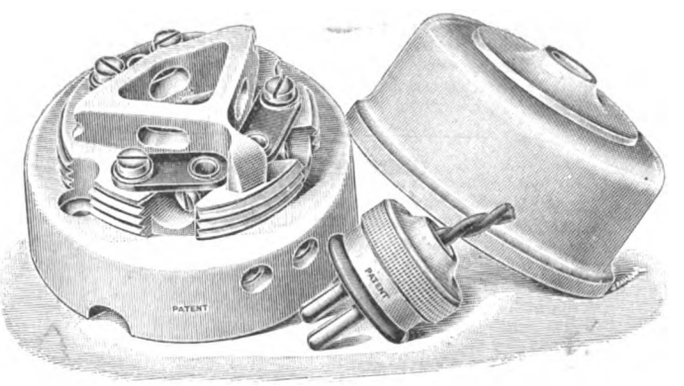
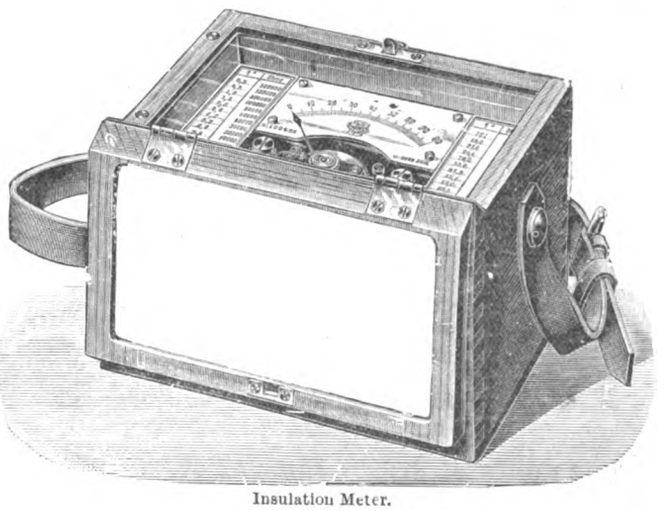


FIG. 5.

Insulation Meters.

Our illustration herewith shows one of several useful types of insulation meters, for installation work, supplied by the Union Electric Company, Limited, 151, Queen Victoria-street, E.C. This instrument comprises a permanent-magnet moving-coil galvanometer, series resistance, and dry cell battery enclosed in a portable case. It can be used in any position and is unaffected by external magnetic fields, means being also provided to enable it to be used for testing purposes at the supply pressure.



Insulation Meter.

Simplicity of operation and great accuracy are claimed as its leading features. Further particulars will be found in a list dealing with detectors, ohmmeters, and magneto-generators recently issued by the above firm.

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Cheaper "Osmi" Lamps.

It will be seen on referring to our advertisement columns, that the General Electric Co. are making a reduction in the prices for their "Osmi" lamps. The high efficiency of these lamps is well known, but hitherto the high prices charged for them have retarded their popularity. We are, therefore, pleased to note the reduction in question.

LEGAL INTELLIGENCE.

LAMBETH ELECTRIC LIGHT UNDERTAKING.

Metropolitan Borough Council of Lambeth v. the South London Electric Supply Corporation.

An action was decided in the King's Bench Division yesterday before Mr. Justice Bigham, in which the Borough of Lambeth Corporation sought for penalties for breach of agreement against the South London Electric Supply Corporation. Under this agreement the latter undertook to destroy in a refuse destructor in connection with the electric light station all the dust-bin refuse of the borough. This was one of the terms under which the Lambeth electric lighting order was originally transferred to the company. After the destructor had been at work for some time, it was closed down as a nuisance on the application of the plaintiffs. It was part of the original agreement that the destructor should be of such a design as was approved by the Vestry, and the company got this approval before constructing the same. They accordingly counterclaimed for the value of the destructor, which was rendered useless to them by the action of the plaintiffs. The case was fought out on a point of law, which turned on the fact that in advertising the transfer of the order, the Lambeth Vestry (now merged in the Corporation) had not disclosed the full details of their agreement. Without hearing technical evidence, his Lordship gave judgment for the defendant company on the claim. He also gave judgment in favour of the South London Electric Supply Corporation on the counterclaim, after the Corporation had agreed to forego damages. They, therefore, get their costs under both actions.

UNDERGROUND MAINS.

Mr. Justice Warrington, sitting in the Chancery Division on Friday last, disposed of the case of the Ingleton Electric Lighting and Power Co. *v.* the Ingleton Gas Co., in which the plaintiffs sought damages from the defendants for injury alleged to have been done to a cable by the defendants' workmen whilst engaged in relaying a gas-pipe. For the plaintiffs it had been stated that they were authorised by provisional order to supply electric light and power to the district of Ingleton, and they had statutory powers to put down mains and cables, subject to the authority of the Board of Trade, and this they had done. The defendants, it was said, had no statutory powers at all to open streets and lay mains, but they did so, and in the course of some of these works they so injured one of the cables belonging to the plaintiff company that the village of Ingleton was thrown into darkness one night, the supply of electric power very seriously incommoded for some time, and the actual fault was only found after some difficulty and at great expense. This was caused, it was contended, by the negligence of the defendants' servants.

After hearing evidence on both sides, his LORDSHIP, in giving judgment, said that as to the actual facts he preferred the evidence of the defendants' witnesses to that of the plaintiffs'. The former were the people who had done the work, and in his opinion they were more to be trusted. If the gas-pipe had been in the middle of the trench dug by the defendants, the edge of the trench would have been 14in. from the feeding cable which was injured. It came out in the evidence, however, that the pipe was not in the middle, and the edge of the trench was further still from the cable. The plaintiffs' theory was consistent with the injury having been caused during the opening of the trench in January, but they had not, in his opinion, discharged the onus which was on them of establishing that the injury was occasioned by the defendants' workmen, and he thought if he was to accept the description of what was done by the defendants he must come to the conclusion that the injury was not done by them. His Lordship did not think it was consistent with the facts that the injuries should have been occasioned by a pick used by their workmen. The strength of the plaintiffs' case was this: there was a hole admittedly occasioned by external agency, and by a blow of such an instrument as a pick. No explanation was offered as to how the injury could have been occasioned. The answer was that the plaintiffs had to satisfy the Court that the injury was done by the defendants, and it was not for the defendants to find the explanation of how the injury was done. Believing the evidence of the defendants, he had to come to the conclusion that the facts they proved were inconsistent with the idea that the injury was done by them. The plaintiffs, to his mind, had not established their case, and there would be judgment for the defendants, with costs.

THE MONTREAL STREET RAILWAY CO. v. THE CITY OF MONTREAL.

This was an appeal before the Judicial Committee of the Privy Council from a judgment of the Supreme Court of Canada of March 25, 1904, reversing a decision of the Court of King's Bench for Quebec and a judgment of Mr. Justice Davidson's.

The arguments were heard in July before a Board composed of Lord Davey, Lord James of Hereford, Lord Robertson, and Sir Andrew Scoble, when judgment was reserved.

Sir ANDREW SCOBLE, in now delivering their lordships' judgment, said the main question in the appeal was whether the city of Montreal was entitled, under its contract with the Montreal Street Railway Co., to claim percentages upon the gross earnings arising from the whole operation of its railway—whether within or without the limits of the city of Montreal—or whether such percentages were payable only in respect of such earnings as arose from the operation of its railway within the limits of the city. The contract was authorised by the city authorities by "By-law No. 210, concerning the establishment and operation of an electric passenger railway in the city of Montreal by the Montreal Street Railway Co.," which was accepted by the company on Dec. 28, 1892. The contract itself was executed by the parties on March 8, 1893. At the time of its execution the company had in operation a railway worked by horse traction situate in the city with short extensions into some of the adjacent municipalities. The article of the contract relating to the payment of percentages was Article 36, and was in these terms: "The company shall pay to the city annually, from Sept. 1, 1892, upon the total amount of its gross earnings arising from the whole operation of its said railway, either with cars propelled by electricity or with cars drawn by horses," certain specified percentages. The reason for including both methods of traction or propulsion by horses or by electricity, was stated to be that the change from horse power to electric power was necessarily to be gradual, and might, under Article 15 of the contract, possibly not be completed until Sept. 1, 1895. The law applicable to the construction of this contract was thus expressed in Article 1,018 of the Civil Code of Lower Canada: "All the clauses of a contract are interpreted the one by the other, giving to each the meaning derived from the entire Act." Regarded in that light, the contract was for the establishment and operation of an electric passenger railway in the city of Montreal. Article 1 provided that "the Montreal Street Railway Co. shall establish and operate, subject to the conditions hereinafter mentioned, lines of railway for the conveyance of passengers in the city by means of cars propelled by electricity in the streets hereinafter mentioned and in all other streets which may hereafter be determined by the Council of the city of Montreal." Article 12 provided that "the *tracé* of routes in the different streets of the city, as well as the establishment and transfer connections, shall be made and shall remain under the control of the City Council. Until further orders the cars shall run in the streets mentioned in the schedule of routes herein below indicated." That schedule was given in Article 46, and enumerated 19 routes, all of which were in the city, and many of which purported to run "from the eastern city limits" to "the western limits of the city of Montreal." As regarded the privileges conferred on the company with regard to the use of electric power in the streets, the right to open the streets, and so forth, the city could only deal with the streets within its jurisdiction, nor had it power to regulate times and fares beyond its own limits. Every outside municipality into whose area the company might desire to extend its operations had independent powers in those respects, and with them the company had to make separate arrangements. Indeed, the only reference in the contract to areas outside the limits of the city was contained in Article 44, which provided that "in the case of annexation by the city of any of the outside municipalities the company shall be obliged within three months after being ordered by the Council to extend their system through that new annexed portion of territory not already provided with electric cars, and to furnish a similar service as is furnished to the city." No such annexation, their lordships were informed, had taken place, but the insertion of that provision was a clear indication that the city considered that the territories of outside municipalities were not included in the scope of the contract. Looking at the contract as a whole, it appeared to their lordships that the lines of railway contemplated by it were, as defined in Article 1, "lines of railway for the conveyance of passengers in the city," and that the expressions "the said railway," "the said railway tracks," and "its said railway," wherever they occurred in the contract, must be taken to refer to the lines within the limits of the city. The percentages, therefore, claimable by the city were only upon the gross earnings arising from the whole operation of the lines within those limits. Some of the earnings of the company arose from traffic which began and ended within the limits of the city, but another, and possibly a greater, part was derived from traffic which originated in the city and terminated in the suburbs or originated in the suburbs and terminated in the city. For all traffic attributable to the operation of the railway in the city, wherever it originated or terminated, the company was accountable. The accounts of the whole earnings had, therefore, to be submitted and checked in order that the proper percentage payable to the city might be ascertained and verified. A second question discussed in the local courts was as to the method on which the accounts between the city and the company had been adjusted. From the nature of the case it was impossible to separate the earnings inside from those out the city with anything approaching mathematical accuracy, and accordingly the judge of first instance, by an order of Nov. 19, 1898, very properly referred it to two experts, one of whom was the treasurer of the city of Montreal, and the other the comptroller of the Canadian Pacific Railway Co., to examine into the method of calculation to be adopted in order to secure a just apportionment. Those gentlemen reported that "after considering divers other methods by which such apportionment might be arrived at," they were of opinion "that the system now pursued by the Montreal Street Railway Co. is the most practical one and in its operation just, but that if any change were to be made it would be to increase the earnings per car mile in favour of the outside districts." The learned judge adopted their report, and it was confirmed by the judgment of the majority of the Court of King's Bench. Their lordships saw no reason to dissent from that conclusion. They would humbly advise his Majesty that the appeal ought to be allowed and the judgment of the

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Supreme Court reversed, with costs, and that of the Court of King's Bench confirmed. The respondents must pay the costs of the appeal.

SOUTH LANCASHIRE ELECTRIC TRACTION CO.

In the Lancashire Chancery Court at Liverpool on Monday last the case of Krauss *v.* the South Lancashire Electric Traction and Power Co., which was a debenture holder's action, came on for further consideration before Vice-Chancellor Leigh Clare.

Mr. PRESTON, who represented the plaintiff, said the property subject to the debenture stock comprised the whole of the shares of the South Lancashire Tramways Co. and the South Lancashire Light Railway Co., a generating station for the supply of electricity, and certain small items. Mr. Arthur Stanley, M.P., purchased the property for £150,000, but out of this two prior encumbrances had to be provided for. The first was a charge in favour of Parr's Bank, in respect of which there was £37,500 now due, money borrowed in order to complete a portion of the tramways company system, and the second encumbrance was a claim by the Electric Conversion Syndicate, who had brought an action against the Company. If the action of that syndicate succeeded, it was possible there would be a claim taking priority to the debenture stock. The purchaser being a debenture holder of the company, it had been arranged that he should set off as part of the purchase money what would become due to him as dividend on his debentures, and provision was made for the judgment on costs and the remuneration of trustees.

The Vice-Chancellor made an order.

TRAMWAY EXTENSIONS.

In the Sheriff's Court on Friday last, Mr. Under-Sheriff Burchell had before him the case of Crutcher *v.* London County Council, in which Mr. George Crutcher, of Queen's-road, Peckham, S.E., claimed compensation in respect of three-quarters of the forecourt of his premises appropriated by the Council for tramway purposes.

Mr. Boydell Houghton announced that by consent of the two parties the jury had agreed upon a verdict of £300.

TRAMWAY COLLISION.

In Hamilton Sheriff Court on Tuesday, Sheriff Thomson closed the record and fixed proof in three actions against the Lanarkshire Tramway Co., at the instance of James Marshall, farmer, Airbles; Robert Hamilton, farmer, North Motherwell; and Ebenezer Inglis, gamekeeper, Logans, for damages arising out of a collision in the Motherwell-road on the evening of March 25 last. The amounts sued for are respectively, £5,000, £2,000, and £1,500. The defence is that parties were themselves liable for the accident by not keeping a proper lookout and crossing in front of a running tramway car. The cases, it was stated, are to be sent to the Court of Session for trial by jury.

COMPANIES' MEETINGS AND REPORTS

AMAZON TELEGRAPH.

The ordinary general meeting of this Company was held on Tuesday last.

Mr. GEORGE KEITH, who presided, said the past year had been a very successful one for the Company. The price of rubber had been abnormally high and commercial activity had increased. During the year their cables had worked well, and had carried more traffic, though they still suffered somewhat from landslips on the banks of the river. They were, however, gradually moving the cables into positions which would render them less liable to damage from this cause. The traffic receipts for the year amounted to £67,253, and, compared with those of the previous year, showed an increase of £26,702. This was partly due to an increased volume of business, and to increased rates. The total working expenses were £52,883, and showed an increase of £8,840; station expenses were £949 more, chiefly on account of the higher value of the currency; ship expenses were £1,082 less, owing to fewer repairs being required during the year. The cost of cable had been a very heavy item, owing to the large amount of restoration work carried out on the three remaining branches of the section. The Alemquer section was relaid in January last, at about a cost of 34 miles of cable, and about 100 miles were expended in restoring the two Macapa Chaves sections, the work of restoring these two cables being completed in July last. After meeting expenditure and providing for all charges, there remained a credit balance of £9,836, as compared with a deficit of £7,130 for the previous year. The directors had been able to readjust the finances of the Company and put them on a more permanent basis. Temporary loans were paid off by the issue of £100,000 of 6 per cent. debentures. Altogether, the position of the Company had greatly improved.

The report was adopted.

LANCASTER AND DISTRICT TRAMWAYS.

The report of this Company for the year ended Sept. 30 last, to be submitted at the meeting on the 18th inst., states that receipts from all sources show a decrease of £576. The result of the year's working is a profit of £662, and, after paying interest on loans, amounting to £642, there is a balance of £20 remaining to be carried forward. The number of miles run has been 84,856 as compared with 92,600, and the number of passengers carried 422,615, as compared with 450,803 last year, showing a decrease of 7,744 miles and 28,188 passengers. The receipts per mile have been 14·94d. as compared with 14·59d., and expenditure 13·15d., as compared with 12·94d. last year. Cost of provender and bedding per horse per week has been 8s. 10d. as compared with 8s. 7½d. last year.

WEST INDIA AND PANAMA TELEGRAPH.

The report for the half-year ended June 30 states that the amount to credit of revenue is £32,773, against £34 581 for the corresponding half-year of 1904. The expenses have been £23 230, against £23.437, leaving a balance of £9,543, to which is added £1,756 interest on investments and £494 brought forward, making a total of £11,793. It is proposed to pay 6s. per share on account of arrears of dividends to June 30, 1905, on the first preference shares, absorbing £10,368, leaving £1,423 to carry forward. This will leave the following dividends in arrear: on the first preference shares, £3,456; on the second preference shares, £14,007. The directors report that the British Guiana subsidy of £4,500 per annum, voted for 10 years from Jan. 1, 1892, in consideration of the Company's laying a new cable between that colony and Trinidad, and continued at that rate up to March 31 last, has from that date been reduced to £3,000 per annum.

WESTMINSTER ELECTRIC SUPPLY.

An extraordinary general meeting of the Westminster Electric Supply Corporation was held on Wednesday at the offices, Eccleston-place, S.W., when the resolution increasing the capital of the Company from £800,000 to £2,000,000, by the creation of 240,000 shares of £5 each, was unanimously confirmed.

ALLGEMEINE ELEKTRIZITAETS-GESELLSCHAFT (BERLIN).

In their annual report the directors of this Company announce a dividend of 10 per cent., as against 9 per cent. 12 months ago. A meeting will be held on Dec. 11 to sanction an increase in the capital of the Company from 86 to 100 million marks. The net profits for the past year have amounted to 10,354,000 marks, as against 8,566,000 marks in 1903-4.

APPOINTMENTS VACANT.

Switchboard Attendant, Southend Town Council electricity works. Salary, £1. 1s. per week.

Assistant Lecturer and Demonstrator in Electrical Engineering, Leeds University. Salary, £175 a year.

Laboratory and Workshop Assistant, Battersea Polytechnic, S.W. Commencing salary, 20s. a week. See advertisement in last issue.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office.

Wireman for electric light and power plant. Applications to Box 29, *Electrical Engineer* Office.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Junior Assistant Wages, 30s. per week. Applications to Engineer, Electricity Works, Canterbury, by Nov. 18. See advertisement in last issue.

Representatives for an electrical contracting firm. Applications to Box G 33, *Electrical Engineer* Office.

Junior Charge Engineer. Salary, 30s. per week, rising to 35s. Applications to the Borough Electrical Engineer, 335, High-street, Cheltenham. See advertisement in last issue.

Mechanical Draughtsman, Birmingham University. Salary, £250 per annum. Applications to the Secretary before Nov. 27. Full particulars in advertisement columns.

Switchboard Attendant. Wages, 25s. per week. Applications to Box B P 5, *Electrical Engineer* Office. See advertisement.

Improver. Wages, 10s. per week. Applications to Box 702, *Electrical Engineer* Office. See advertisement.

NEW COMPANIES REGISTERED.

Canadian Industrial Co, Limited.—Capital, £50,000. Object: to use water power for producing electricity, and for other purposes, to construct, equip, operate, and maintain electric, cable, or other tramways and telegraph or telephone systems, etc. Registered office: 58, Lombard-street, E.C.

British Buffalo Marine Motor Co., Limited.—Capital, £5,000. Object: to adopt an agreement with W. A. Cloud and H. J. Nichols, and to carry on the business of engineers and repairers of motors, parts, and accessories.

British Hosiery and Electrolytic Bleaching Co., Limited.—Capital, £60,000. Object: to acquire certain patents relating to the Vogelsang electrical bleaching process, now belonging to the Foreign Electrical Bleaching Patents, Limited, etc. Registered office: 6, Eastcheap, E.C.

Peru Copper Syndicate, Limited.—Capital, £5,050. Object: to acquire any copper or other mines and mining rights.

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Rubber Producers' Syndicate, Limited.—Capital, £7,000. Object: to carry on the business of planters and producers of and dealers in indiarubber, guttaperchs, balata, and other gums.

Jones and Leslie, Limited.—Capital, £2,000. Object: to acquire and carry on the business of electrical engineers carried on at 25 31 Eyre-street-hill, Hatton-garden, E.C., by T. L. Jones, as Jones and Leslie.

Cumberland Power Syndicate, Limited.—Capital, £5,000. Object: to adopt an agreement with J. Sturgeon, B. H. Thwaite, A. R. Chorley, and J. Paterson, and to carry on in Cumberland and elsewhere the business of an electric power and power gas supply company, etc. Registered office: 4, South-parade, Leeds.

Wemyss and District Tramways Co., Limited.—Capital, £55,000. Object: to acquire the rights under the Wemyss Tramways Order Confirmation Act, 1905, for the construction and working of electric tramways in the parishes of Kirkcaldy and Dysart, Wemyss, and Scoonie, and within the burghs of Buckhaven, Methil, Innerleven, and Leven, Fifeshire. Registered office: Royal Bank-buildings, High-street, Leven.

Bowers and Hargrave, Limited.—Capital, £1,500. Object: to carry on the business of dealers in incandescent, electric, and other fittings, etc.

Egyptian Contracts Co, Limited.—Capital, £10,000. Object: to acquire and work rights, concessions, and contracts in Egypt and the Soudan. Registered office: 62, London-wall, E.C.

Liens Registered.

Northampton Electric Light and Power Co, Limited.—Lien registered Nov. 6 for £300 4 per cent. debentures, part of a series not to exceed two-thirds of the subscribed and paid up capital. Amount previously issued, £33 200. No trustees. Charged on the undertaking, property, and uncalled capital.

Northallerton Electric Light and Power Co., Limited.—Lien registered Nov. 4 for £1 000 5 per cent. debenture, part of £5,000. Amount previously issued, £3,740. No trustees. Charged on all the property, present and future, including the uncalled capital.

Electrolytic Alkali Co, Limited (Middlewich).—Lien registered Oct. 31 for £200 4½ per cent. debentures, part of £50,000. Amount previously issued, £20 650. Charged on the undertaking and all the property for the time being, including the uncalled capital.

North Wales Power and Traction Co, Limited.—A charge dated Oct. 16, 1905, to secure £30,000 has been registered. Property charged—the company's undertaking and property, present and future, including uncalled capital, subject to £150,000 debenture stock. Holders—W. W. Pilkington and J. Beecham, both of St. Helens; J. Tomkinson, M.P., Willington Hall, Tarporley, Cheshire; D. McKechnie, Hillside, Cowley Hill, St. Helens; and E. Wagg, Southsea House, Threadneedle-street, E.C.

Scottish House-to-House Electricity Co, Limited.—A charge for £500, dated Oct. 24, 1905 (supplemental to a charge of March 31, 1904), has been registered. Holders—County of London Electric Supply Co., Moorgate-court, E.C. Property charged—the company's undertaking and property, present and future.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Cardiff.—The Asylums Committee require tenders for generating plant. Tenders by Nov. 27.

Torquay.—The Town Council invite tenders for generators, booster, traction battery, and switchboard. Tenders by Nov. 20. See advertisement in last issue.

London, W.—Messrs. Grice and Co., Addison Wharf, Warwick-road, Kensington, require a 10-ton electric derrick crane with 60ft. to 70 t. jib, continuous current.

Bermondsey.—Tenders for new plant, estimated to cost £5,390, will shortly be advertised for. An estimate is being prepared for condensing plant, for which tenders will be invited.

Ebbw Vale.—The Urban District Council invite tenders for free wiring and supply of incandescent lamps. Tenders by 12 noon on Nov. 25. Full particulars in advertisement columns.

Rawtenstall.—The Corporation invite tenders for the electric light wiring and fittings of the new free library. Tenders to Messrs. Lacey, Sillar, and Leigh, 78 King-street, Manchester, by Nov 20.

Omnibus Lighting.—A London motor omnibus company is open to receive proposals for the lighting of its vehicles by acetylene or electricity. Apply to Box 306, Willing's, 125, Strand, W.C.

Beckenham.—The Urban District Council invite tenders for two 250 kw direct-current railway generators, direct coupled to two high-speed, vertical enclosed type engines. Tenders by noon on Nov. 23.

Sao Luiz.—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 15. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Harrogate.—The Directors of the Frederick Hotels Co. invite specification and tenders for laying down electrical plant at the Hotel Majestic, Harrogate. Further particulars on application to the Secretary, 8, Bloomsbury-square, London, W.C.

Aston Manor (near Birmingham).—The Public Works Committee invite tenders for the maintenance of a portion of their tramway system for 12 months from Jan. 1 1906. Tenders to the Chairman of the Public Works Committee, Council House, Aston Manor, by noon on Nov. 24.

Whitchurch (near Cardiff).—The Asylums Committee of the Corporation invite tenders for the following plant, to be delivered and erected at the asylum: (Section 1) battery of accumulators, with booster; (2) engines and generators; (3) switchboard. Tenders to Mr. J. L. Wheatley, Town Hall, Cardiff, by Nov. 27.

Bray (Ireland).—The Urban District Council invite tenders for the supply and delivery of 220 yards $^{7}/_{16}$ concentric paper-insulated and lead-covered cable for a working pressure of 200 volts, and 10 10-ampere alternating-current induction voltmeters, 100 volts, 60 periods. Tenders to Mr. P. MacDonnel, clerk, by 10 a.m. on Nov. 21

Christiania.—The Norwegian Telegraph Department are calling for tenders for the supply of 3,000 kg. of bronze wire. Tenders from British firms should be lodged *by their agents* in Christiania by midday on Dec. 1. The conditions of tender can be seen by agents on application to the telegraph authorities at Christiania, Bergen, Stavanger, and Arendal. Apart from the usual Customs duties, a preference of from 10 to 15 per cent. is given to Norwegian manufacturers.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension to that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

RESULTS OF TENDERS.

Hereford.—The tender of Callender's Cable and Construction Co. for bitumen cables for Widemarsh-street auxiliary feeders, at £48. 1s. 8d., has been accepted.

Colchester.—The Town Council have accepted the tender of Mumford and Co., at £78, for a vertical Weir-pattern steam pump capable of delivering 3,500 gallons an hour, and the tender of Stanford and Co., at £37. 5s., for supply and erection of a steel water-tank, 12ft. by 3ft. by 3ft., and framework.

Erith.—The Urban District Council at their last meeting accepted tenders as under: Electric Construction Co., motors; C. Booth and Co., Liverpool, at £86. 10s., for the supply of hydraulic pit bogie, car-body lifting appliances, and one pair of traversing jacks. The British Westinghouse Co. are to supply some additional spare parts for the cars at an extra cost of approximately £50.

North-Eastern Railway.—The company have placed a contract with the British Thomson-Houston Co., of Rugby, the contractors for the electrification of the Tyneside branches, for 285 5-ampere direct-current and 600 7½-ampere alternating current lamps of a patent design. Note.—Each of the 5 ampere lamps, which will operate on circuits of 110 volts, are to burn no fewer than 150 hours, whilst the 7½-ampere alternating-current lamps are to burn 80 hours before any recarboning will be necessary.

Purifiers.—The Paterson Engineering Co., Amberley House, Norfolk-street, W.C., report recent orders, including a Paterson condensation water purifier of 70,000lb. hourly capacity, for the Cleveland and Durham County Electric Power Co. (through Willans and Robinson); also water softeners and heaters, etc., for Great Western Railway electric power station, Park Royal (through Aiton and Co.), the borough of Southwark electricity works, and (through J. G. White and Co.) for Buenos Ayres and Monte Video. They also report orders in hand for purifiers for power plants at the Cape Copper Co.'s works, South Wales; Poplar union workhouse; Felix Hotel, Felixstowe; Hollingworth and Co., Turkey Mill, Maidstone, etc.

Worcester.—The City Council have accepted the following tenders for coal for the electricity stations at Powick and Hylton-road: South Wales, etc., Coal Co., best large Welsh smokeless steam coal, 18s. 6d. per ton; through-and-through Welsh coal as now supplied, 15s 9d; best Welsh washed steam nuts, 16s. 3d; best large Staffordshire coal, 12s. 6d.; best Staffordshire nuts, 11s.; best washed Staffordshire nuts or beans, 9s. 3d.; best steam coal from the Cannock Chase or North Warwickshire district, 12s. 6d.; best bright slack, 7s. 6d.; Dynevor through-and-through coal, 15s. 6d.; ditto, Nantyglo-Merthyr, 15s. 3d. For Tybridge-street: Underwood and Co., best large Welsh smokeless steam coal, £1; through-and-through Welsh coal, 16s. 6d.; best large Staffordshire coal, 15s. 9d.; best Staffordshire nuts, 10s. 11d.; best washed Staffordshire nuts or beans, 9s.; best steam coal from the Cannock Chase or North Warwickshire district, 12s. 3d.; best bright slack, 7s. 4d.

Metropolitan Asylums Board.—The Board have received the following tenders for supply of engineers' tools, electric motor, etc., to the Western Hospital:

	£	s.	d.
H. Greene and Co., 22, Martin's-lane, E.C. (accepted)	189	9	4
Selig, Sonnenthal, and Co., 85, Queen Victoria-street, E.C.	192	19	0
G. Hatch Limited, 20 and 21, Queenhithe, Upper Thames-street, E.C.	206	4	3
J. Gibb and Co., 99, Fenchurch-street, E.C.	218	18	0
W. Newbold and Co., 107, Upper Thames-street, E.C.	227	17	6
British Electrical and Mechanical Co., 55, Barbican, E.C.	228	16	0
A. Schove, 9 and 11, Moor-lane, E.C.	232	18	0
Buck and Hickman, Whitechapel-road, E.	234	8	0
W. T. Skelding and Co., Dudley	234	11	11
Hobdell, Way, and Co., 63, Crutched-friars, E.C.	240	15	2
Britannia Engineering Co., Colchester	245	4	6
Easterbrook, Allcard, and Co., Sheffield	247	9	6
Dempster, Moore, and Co., Glasgow	249	11	6
J. Spencer and Co., Hollinwood, Lancs.	325	15	9
Tangye Tool and Electric Co., Birmingham	357	2	9
Low Moor Co., Bradford	406	3	7

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Government Contract.—Messrs. Newtons, Limited, of Taunton, report Government repeat orders for two 100-kw. and two 50 kw. steam-driven dynamo sets. The two 50-kw. sets are coupled together. The engines are being supplied by Browett, Lindley, and Co. We are informed that the repeat orders for these machines are of the well-known Mawdsley type made solely by this firm, and that they are the result of satisfactory records, both as regards high efficiency and low temperature rise, of former contracts. Note.—We understand this firm are making this type of machine in sizes from ½ h.p. to 500 h.p., instead of the well-known Taunton machines previously made by them, the new machine being more suited to the requirements of consulting and central-station engineers, and in their opinion a decided step in advance of modern dynamo design.

London County Council.—Tenders have been received as follows:

(1) Wiring and fitting Lee-green fire station.

Hooper, Neary, and Co., Trafalgar-road, Greenwich, S.E (accepted)	£141	10	0
J. Defries and Sons, 146-7, Houndsditch, E.C.	155	0	0
National Electric Construction Co., 34, Victoria-street, S.W.	157	0	0
Durrell and Co., 58 Fenchurch-street, E.C.	160	0	0
R. Dawson Limited, 8 Berners-street, W.	160	0	0
F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W.	164	10	0
O. Clark and Co., St. Mark's-road, North Kensington, W.	170	0	0
J. O Grant and Taylor, 63, Queen Victoria-street, E.C.	175	0	0
W. H. Johnson, 200, Upper Kennington-lane, S.E.	183	15	0
Barlow and Young, 8, London-street, Fenchurch-street, E.C.	240	0	0

(2) 34 single-deck steel cars still required for the Aldwych-to-Islington tramways:

Tenders for 34 single-deck car bodies.

Brush Electrical Engineering Co., Loughborough	£14 773	0	0
United Electric Car Co., Preston	14,790	0	0
Metropolitan Amalgamated Railway Carriage and Wagon Co., Birmingham	16 252	0	0
Hurst, Nelson, and Co., Motherwell	19,550	0	0

Tenders for 34 car trucks.

Brush Electrical Engineering Co.	3,774	0	0
Hurst, Nelson, and Co.	3,978	0	0
Mountain and Gibson, Bury	4,046	0	0
United Electric Car Co.	4,420	0	0
Peckham Manufacturing Co., U.S.A.	4,930	0	0
Metropolitan Amalgamated Railway Carriage and Wagon Co.	4,862	0	0

Tenders for the electrical equipment and assembly of 34 single-deck cars.

British Westinghouse Electric and Manufacturing Co., London	9,996	0	0
Witting, Eborall, and Co.	10,693	0	0
British Thomson-Houston Co., Rugby (alternative)	11,084	0	0
Brush Electrical Engineering Co.	11,696	0	0
British Thomson-Houston (not to specification)	10,948	0	0

Or alternatively—

Tenders for 34 single-deck cars complete.

British Thomson-Houston Co.	28 947	0	0
Ditto (alternative)	29 280	10	0
Ditto ditto	29 635	10	0
Dick, Kerr, and Co., London	29 325	0	0
Ditto (alternative)	29 818	0	0
Brush Electrical Engineering Co.	30 243	0	0
British Westinghouse Electric and Manufacturing Co.	34 170	0	0
Hurst, Nelson, and Co.	33,694	0	0
British Thomson-Houston Co. (not to specification)	28,806	10	0

Note.—On Tuesday the committee reported as follows: "It will be seen that the lowest combined tender is £399 more than the sum of the three lowest separate tenders, all of which appeared to be satisfactory. The amounts of the lowest tenders appeared to us to be somewhat large, and we, therefore, placed ourselves in communication with the Brush Electrical Engineering Co. and the British Westinghouse Electric and Manufacturing Co., the firms submitting the lowest tender for each of the three separate items, with a view to ascertaining whether they would not be prepared to make some reduction in the amount of their tenders. As a result the Brush Electrical Engineering Co. has expressed its willingness to reduce its tenders for car bodies to £14,280, but the company cannot see its way to reduce the amount for the trucks. The British Westinghouse Electric and Manufacturing Co. states that it can make no reduction in its tender for electrical equipments, but is willing to supply both the trucks and equipments and to erect the cars for an inclusive sum of £13,481. We are, therefore, of opinion that the Brush Electrical Engineering Co.'s revised tender for car bodies and the British Westinghouse Electric and Manufacturing Co.'s combined tender for trucks and equipments should be accepted." The committee submitted recommendations in accordance with these proposals. This was agreed to.

Tramways over the Bridges.—Sir Benjamin Baker recommends the widening of Blackfriars Bridge by 30ft. on the western side, and he further states that new foundations will have to be provided to sustain the increased weight. The Bridge House Estates Committee of the City Corporation approve the proposal, and have given orders for the issue of the usual parliamentary notices, provided that the London County Council assents fully to the conditions laid down in the last report of the Bridge House Estates Committee. It is estimated that the work of widening Blackfriars Bridge will occupy nearly two years.

BUSINESS NOTES.

TRACTION.

Coombe.—Steps are being taken to expedite the reconstruction of the tramway track in the district.

Weston-super-Mare.—The Council have refused permission to the electric tramways company to lay a double track along the sea-front.

York.—The City Council, we are informed, are considering a scheme for the acquirement of the local tramway service and its conversion to electric traction.

Swansea.—A correspondent complains in the local Press of the noise caused by the tramcars, and urges the adoption of an improved system of watering roads.

Liverpool.—Another accident occurred last week at the Hall-road Station—a baggage car while being shunted ran into the dead end and caused injuries to two persons.

Dundee.—In a report prepared by the manager of the tramways the suggestion is made for touching the Tay Bridge and West Stations and the Tay Ferries with the tramway system.

Yarmouth.—To meet the demands made upon them by increasing traffic, the Tramways Committee have placed an order with the Brush Electrical Engineering Co. for two additional cars.

Swanage.—The promoters of the proposed light railway from Bournemouth to Swanage have, it is stated, decided to proceed with their scheme, which is estimated to cost £200,000.

Deptford.—The Borough Council are to petition to the Board of Trade against an increase in the rate of speed of London County Council cars along some of the streets in the borough.

Crewe.—The London and North-Western Railway Co. are fitting Crewe Station with signal boxes which, it is said, contain the finest electrical equipment of any signal cabins in the world.

Glasgow.—The Tramways Committee of the Town Council at a meeting on Tuesday approved of the general manager's report, recommending that the existing car routes in the city be not interfered with.

Stalybridge.—The Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Board have made an offer of £350 to the Stalybridge Corporation in full settlement of their claim for the reinstatement of roads.

Walsall.—The Tramways Committee have given instructions for an instrument for testing the armatures and insulators to be purchased at an estimated cost of £25, and for the destination curtains to be renewed when necessary.

Cheshire.—The Board of Trade have decided to confirm the order granted by the Light Railway Commissioners, authorising the construction of the Tarporley and Mouldsworth light railway subject to certain modifications in the routes.

Italy.—According to the *Neue Freie Presse*, a direct electric railway is projected between Genoa and Milan, and a committee in furtherance of the scheme has been formed under the auspices of the Banca Commerciale Italiana and of the Genoese municipal authorities.

Taunton.—The electric tramway service was resumed last Wednesday after a stoppage of about two months, during which time the track has been relaid. This formerly consisted of tar macadam, which was found to be unsatisfactory, and granite setts have been substituted.

Paddington.—The proposal made by the Borough Council that they were prepared to consider favourably the London County Council's projected electric tramway from the Marble Arch along Edgware-road to Cricklewood, providing the County Council bore the cost of street widenings, has been rejected.

Guildford.—It is stated that there is a good prospect of the Guildford and Woking light railways being commenced early next year. A new company is being formed, it is understood, to take over the powers acquired by the West Surrey Light Railway Co., and it is stated that most of the capital is already assured.

Dunfermline.—The District Committee have decided to accept £7 instead of £10 per mile wayleave to be granted to the West Fife tramways. Notice of motion was given at a Council meeting to the effect that a *plébiscite* be taken of the ratepayers as to whether they would have municipal or private company tramcars.

Durham.—The British Electric Traction Co. have obtained leave of the Board of Trade for an extension of six months. The clerk of the County Council lodged a formal objection to the extension, and the Board of Trade has stated that they would be unwilling to entertain any further application unless progress shall have been made with the works.

Lincoln.—Successful trial trips were made last Saturday on the new electric trams from the Bracebridge terminus to the Great Northern Railway crossing. A Local Government Board inspection of the system has yet to be completed, but it is hoped this will shortly be effected to the satisfaction of that body, and that soon the cars will be brought into use.

Derby.—The Tramways Committee reported at the last meeting of the Council that the receipts of the Corporation tramways for the five weeks ended Oct. 28, 1905, were £3,570. 4s. 7d., being an increase of £300. 5s. 11d., as compared with the corresponding period last year. This committee had decided to contribute to the Highways Committee the sum of £75 per annum towards the cost of watering the tramway lines.

Southend.—It was reported at a meeting of the Council that consideration of the proposed extension of the tramways system along High-street and Marine-parade would come up for consideration at a later date, together with the suggestion for a through service of cars

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between Southchurch and Leigh, *via* Prittlewell, London-road, and the Middleton respectively, and also in connection with the beach section.

Greenwich.—At the last meeting of the Borough Council a report was accepted of the Highways Committee recommending that the assistant secretary of the Board of Trade be informed that the Council was not in favour of the speed of the trams exceeding a maximum of 10 miles per hour so far as the lines within the borough were concerned. It was proposed by the Board of Trade to increase the speed to 12 miles in several instances.

Falkirk.—The Falkirk and District Tramways Co. intimate that they intend to make application, by means of a provisional order, for power to extend their tramway system from Falkirk to Laurieston and from Falkirk to Grangemouth. The matter was discussed at a meeting of the Eastern District Committee of the Stirling Council, and it was ultimately agreed to appoint a committee with powers to deal with the matter and to safeguard the interests of the County Council.

Ayr.—A breakdown, which caused considerable interruption of traffic on the Corporation tramway service, occurred last week. For the third time within a short period the overhead system at the end of High-street as it enters New Bridge-street partly came down, causing a somewhat dangerous situation from the live wires. At the part that gave way the supporting wires have a long stretch, and have not the middle supports that the rest of the line has, hence the liability to give way.

Earlsheaton.—The inability of the Soothill Nether District Council to carry out their order for the construction of a tramway is causing great inconvenience to the inhabitants of this district. The Council endeavoured to transfer their powers to the Wakefield District Light Railway Co., but that company are indisposed to extend their present line. No progress has been made by the Council in their effort to dispose of the powers of the order. Negotiations are still on, but so far as can be learned they are not likely to lead to anything.

Whitworth.—It was reported at a District Council meeting held last week that if Whitworth would construct, equip, and maintain the tramway track in their district, the Rochdale Corporation would be prepared to run cars over such tramway at a cost of 6d. per car mile, with an additional 10 per cent. cost. The experts who were present at the meeting agreed that the sum of £10,000 per mile, or £40,000 in all, would have to be spent in order to satisfy Rochdale's requirements. It was decided to discuss the question in committee.

Notts.—The dangerous tram terminus at Trent Bridge is likely to be soon remedied, for we learn that instructions have now been given by the Tramways Committee for the terminus to be constructed close to the foot pavement, and the work is to be placed in hand directly the necessary cross-overs have been delivered by the makers. Looking well ahead, too, the committee have decided that when the London-road scheme is completed the terminus shall be laid close to the opposite pavement, thus leaving the centre of the road absolutely open.

North-Eastern Railway.—An action seeking for the recovery of damages for the loss of an animal caused by the animal being electrocuted was sustained in the North Shields County Court. The animal was conveyed in a truck, and while being unloaded knocked over a movable truck placed to prevent cattle from straying on to the electric line. The animal, however, walked through the gap on to the live rail and was killed. The contention of the company that in providing a movable fence they had done all that could be expected of them was not sustained.

Colchester.—The Board of Trade do not approve the plans showing the rail and sub-structure proposed to be used in the construction of the tramway along Military and Old Heath roads. It was resolved at a meeting of the Council to defer to the next meeting consideration of the tramways manager's report as to the use of tickets in lieu of boxes, and introduction of intermediate stages. Sanction has been given for the borrowing by the Corporation of £7,334. The Tramways Committee have resolved not to permit police officers in uniform to travel on the tramways without payment.

Poole.—At the final meeting of the Urban District Council prior to its amalgamation with the Urban District Council of Branksome, a report was submitted by the Tramways Committee recommending that the clerk write pointing out that the Council were still of opinion that their present by-law as to picking up and setting down passengers ought to be maintained, that through tickets from the Square to the Albert-road ought to be issued on all cars, and that the workmen in Poole and Branktome ought to be allowed to travel any 1d. stage for ½d. in the same manner as the workmen in Bournemouth.

Heywood.—Arrangements have been made by the Council with the Bury Tramways Committee whereby the latter will supply power for working the Heywood electric tram system at 1·2d. per unit in addition to the charge of 4½d. per car mile run as previously arranged. The work of reconstruction is proceeding steadily, but not so satisfactorily as could be desired. There has been some delay with the overhead equipment owing to a difficulty in obtaining the brackets, but this work is now proceeding. At the electricity works the boiler is in its position, and it is expected that the engine and other machinery will be delivered in about a fortnight.

Erith.—The Tramways Committee of the Erith Urban District Council have recommended that the attention of the London County be called to the fact that a double line of tramway from the terminus of the Council's tramways at Abbey Wood to a junction with the Bexley tramways in High-street, Plumstead, is authorised to be constructed by the Council under the Erith Tramways and Improvement Act, 1903, subject to the consent of the London County Council and the metropolitan borough of Woolwich, and that the Council is prepared to immediately construct the tramway, and asks for the consent of the London County Council to such construction.

Lowestoft.—The tramways manager reports that the number of passengers carried on the cars during the year amounted to 2,338,323, the receipts from which were £10,325 as against £10,597 for 2,372,681 passengers carried in 1904. At a meeting of the Council the question of constructing a double track from Bevan-street to the Hempland was considered and further adjourned. It has been agreed that the rateable value of the tramways undertaking shall be reduced from £943 to £350. Correspondence was read at the last Council meeting with reference to the proposed sale of the tramways and electric lighting undertaking to a private company, but the matter was allowed to drop.

Weymouth.—At a recent meeting of the Weymouth District Trades and Labour Council, held on Thursday, Nov. 2, the following resolution was carried: 'That no steps be taken to decide the question of tramways for the town of Weymouth until the question be submitted to the ratepayers of the town in some suitable hall in Weymouth." Our readers will remember that Prof. Kennedy reported fully on that scheme. At the last Council meeting this report was discussed at length and a motion was proposed in favour of scheme D, which is the biggest of the four alternative schemes submitted, which includes a line as far as Portland to cost £80,000. It was decided to refer the matter to the whole Council and committee.

Musselburgh.—It was stated at a meeting of the Town Council that the tramway company proposed to apply to the Board of Trade next month for a provisional order to extend the present system of electric trams from the Levenhall terminus along by the seashore through Prestonpans and on to Port-Seton, and the support of the Town Council, as the local authority, was requested. Some discussion ensued, in the course of which the opinion was expressed that the company should pay wayleave, and also that they ought to widen the roadway so far as it lay within the bounds of Musselburgh. Ultimately it was agreed that a special meeting of the Council be called on an early date to give consideration to the matter.

Newcastle.—A strike is threatened on the Corporation tramway system in consequence of a proposed change by which the men will work five days a week instead of six. The notice issued states that owing to alterations for winter traffic, and the reliefs for holidays being complete, the traffic department is over-staffed. In order to spread loss of employment over a larger number of men, it will be unavoidable in many cases to give more than five days work a week, which will be given in rotation. The effect will be to reduce the wages of motormen from 30s. to 25s. a week, and other grades in proportion. Close upon 1,000 men are affected, and a mass meeting is to be held to-day to consider the advisability of striking on Saturday.

Sunderland.—The secretary of the Sunderland District Electric Tramways announces that the greater part of the company's system is now in working order. The first section of about 11 miles, from Grangetown to Houghton-le-Spring (including the two branches to Penshaw Station and Fence Houses Station), having been examined and passed by the Board of Trade, was opened for traffic on June 10 last, and a further section from Houghton to Hetton of nearly two miles was opened on Oct. 20. With an average of only 10 cars (one-third of the total number) the total traffic receipts from the above dates to the end of last month amounted to £6,957. At the present time a service of 18 cars is in operation, and that number will be increased in due course. The Durham Collieries Electric Power Co., from whom this company is to take its power, are provisionally working a generating plant under agreement, but that company's complete installation should be working by at latest the end of January next, when the full service of trams can be running.

Cardiganshire.—At the meeting of the County Council the question of the proposed light railway between Lampeter and Aberayron was brought forward. Six months ago the County Council had undertaken to advance by way of loan the sum of £20,000, provided that the district councils and the other local authorities interested undertook to provide £10,000. That resolution was made operative for six months only, and that period having elapsed it was necessary to renew the undertaking. It was reported that the engineer of a firm of London contractors—Messrs. Jackson and Co.—had gone over the route and considered the prospects of financial success of that line, and his conclusions agreed with those of Mr. Yockney, the promoters' engineer, and the result was that the company were now prepared to construct the line. All the local authorities had contributed as desired, with the exception of the Lampeter Rural District Council, but this was due to a formality, which would be complied with on the following day. The Light Railway Commissioners had given the County Council to understand that the Treasury grant would be forthcoming. The question of renewing the undertaking was referred to the Finance Committee.

Torquay.—About 250 yards of the first portion of the tramway track in Newton-road, near Torre railway station, is now complete, and it is hoped, with fine weather, to rapidly finish the remaining open portions. The cutting at present extends nearly down to Castle-circus, and on this section the rails are laid practically the whole distance. The cutting of Fleet-street section is now approaching the town hall for one of the tracks, and rails are laid from the Strand to beyond Swan-street. It is anticipated that in a few days the laying of wood paving will be started on this section. It is roughly estimated that there is now an outlay of about £300 a week in the wages of the men. At the last Council meeting the town clerk reported upon the conference between the Council and the representatives of the Dolter Company, which was of a satisfactory nature. In brief, the company waive the question of the feeder cable, and extend the time to March 31 for the Corporation to supply the current. In consideration of the Council allowing them to lay the tramways on the Torbay-road, the company agree to pave the whole of the roadway in question. The report on the conference was adopted by the Council. The recom-

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mendation that the application of the company be agreed to, and that the necessary agreement be drawn up, was carried.

Huddersfield.—It was reported at the annual meeting of the Borough Council that the total number of units of electricity generated at the tramways power station during the municipal year amounted to 2,892,991, which was an increase of 113,726 over the corresponding period last year. The average generation cost per unit was ·246d. as against ·249d., and the average works cost per unit, including maintenance and materials used, was ·273d. as compared with ·271d. for last year. The present rolling-stock consists of 70 cars, comprising 11 bogie and 59 four-wheeled or truck cars, and two electrically-equipped coal trucks. The present number of covered cars is 27, but the work for equipping six additional cars is in progress at the Great Northern-street depôt. During the year the cars and their equipments have been thoroughly maintained, and a number of them have been speeded up, which has enabled the services to be greatly accelerated. The system of coal haulage has made satisfactory progress, and three firms are now having coal conveyed direct by trucks from the Hillhouse coal-shoots into their mills. The overhead equipment and cables have given satisfactory results, and the monthly tests that are taken show them to be in good condition. The present service of cars is 43 on ordinary days and 56 on Saturdays. The total traffic receipts from Nov. 1, 1904, to Sept. 30, 1905, amounted to £63,222. 12s., an increase of £2,421. 7s. 7d. over the corresponding period last year. An experiment is being tried with the object of establishing a system of through cars between several termini on the Huddersfield Corporation tramway system. Should this prove successful, it is believed that a great acceleration in the service will follow.

West Ham.—The report of the tramways manager relative to the first year's working of the system of electric traction, inaugurated in February, 1904, shows that the gross revenue for the year ended March 31 amounted to £56,199, or an average per car mile of 10·9d. The estimated profit due from the North Metropolitan Tramways Co. in respect of the horse cars worked by them on behalf of the Council is £5,500. The total expenditure amounted to £37,852, or an average per car mile of 7·3d.; to this, however, is added the sum of £1,080 as being the cost of maintenance of the horse cars, and the balance carried to net revenue account amounted to £22 817, to which must be added £392 as bank interest. Interest on capital and contributions to sinking fund absorb respectively £9,020 and £4,326 of this amount, whilst £3 093 has been appropriated to the reserve or renewals fund, and £7 000 transferred to the borough fund to the relief of rates. The tramways manager, Mr. Blain, reports that from the inauguration of the system the traffic has been most satisfactory and encouraging. The number of passengers carried over a mileage of 1,240,774 miles amounted to 15 773 592, and the total receipts from this source reached the sum of £55,063, or an average per car mile of 10·68d. The total length of track (double and single) which is owned and worked electrically is 23 miles, and the total number of units required during the year amounted to 1 511,866. The working expenses reached 67 per cent. of the receipts, and the traffic revenue per car mile averaged 10·68d. There has been a marked immunity from delays to traffic breakdowns or serious accidents proceeding from causes under the control of the department, though the narrowness of many of the streets through which the tramways pass and the heavy vehicular traffic were responsible for occasional irregularities. In April, 1904, the Tramways Committee increased the rate of pay for both motormen and conductors to 7d. per hour, the former from 6½d. per hour and the latter from 6d.

London County Council.—The Highways Committee have recommended to the Council an estimate of £803,600 for the conversion of the present horse tramways into an electrically-equipped system, at present running along the following routes: (*a*) Theobalds-road terminus to London Docks; (*b*) Norton Folgate to Stamford Hill; (*c*) Aldgate terminus to Poplar; (*d*) Moorgate-street terminus to junction with Old-street; (*e*) Holborn terminus to junction with Theobalds-road; and (*f*) along Old-street between Great Eastern-street and Shoreditch. It is hoped to complete the reconstruction of this section of the tramways by Christmas, 1906. The system to be adopted is the underground traction, and details have been approved by the Board of Trade. In order that the reconstruction and equipment of the first section of the lines may be proceeded with as little delay as possible, the committee recommend that tenders be obtained for the track work and rolling-stock, cables, ducts, plant, etc., at an estimated price of £665,600. The Finance Committee submitted a report at the meeting on Tuesday last on the proposal of the Highways Committee to obtain parliamentary sanction to acquire property for the making of a station under Wellington-street in connection with the underground tramways under Aldwych. They point out that the total expenditure sanctioned for the subway was £317,000, but they understood that some saving is expected on the original estimate for construction. It is estimated that a further sum of £37,000 will be needed for the acquisition of property and the necessary works now contemplated, and this will increase by about £1,920 a year the charges against the tramway revenue for interest on and repayment of debt. It appears to the committee a large sum of money to expend for this purpose. The Highways Committee report that the total tramway traffic receipts from April 1 to Nov. 4, 1905, were £375,112 from lines worked by electrical traction, and £99,505 from lines worked by horse traction, or a total of £469 617. The receipts for the corresponding period in 1904 under the same heads were £321,937, £81,093, and £403,030 respectively. These figures are not exactly comparable owing to the purchase of undertakings, the extension of lines, and the conversion of routes from horse to electric traction.

Croydon.—The Council have considered and adopted the following report of the Tramways Committee: "The committee received a certificate from the borough road surveyor stating that tramway No. 20, authorised by the Croydon and District Electric Tramways Act, 1902, has been duly constructed and equipped. The town clerk reported that the draft lease of the said tramway was, on the 18th September last, sent to the British Electric Traction Company, Limited, for perusal, and that the draft lease not having been approved by the company, an application was made to the arbitrator appointed under the Croydon and District Electric Tramways Act, 1902, for an appointment to settle and determine the form of the lease between the parties. The arbitrator sat and heard the parties on the 26th October, when, after a number of questions had been raised on behalf of the company, the arbitration was adjourned until the afternoon of Thursday, the 9th November inst. In consequence of the position taken up on behalf of the company at such hearing, the committee are advised and now recommend the Council to pass the following resolution—viz.: 'That the town clerk do inform the British Electric Traction Company, Limited (as the fact is), that the tramway referred to in the Croydon and District Electric Tramways Act, 1902, as tramway No. 20 has now been constructed and equipped in accordance with the provisions of that Act. And the Corporation do offer and require the British Electric Traction Company, Limited, to accept such lease as in the said Act mentioned of the right of user of the said tramway No. 20, and of demanding and taking tolls and charges in respect thereof for a term of 21 years from the 16th day of November, 1905, determinable by the Corporation as in the said Act mentioned. And that such offer and requirement be signed by the town clerk and served upon the said company accordingly. And that the town clerk do also inform the said company that as from the said 16th day of November, 1905, the said tramway No. 20 will be at the disposal of the said company, and that in the event of the said lease not having been previously granted the said company will be entitled as from that day to the right of user of the said tramway and taking tolls and charges in respect thereof in the same manner and subject to the same conditions and stipulations as if such lease had been actually granted.'"

LIGHTING AND GENERAL.

Derby.—It is proposed to light the market hall by electricity.

Wembley.—There is a movement to introduce Post Office telephones into the district.

Southgate.—The Urban District Council contemplate the erection of a dust destructor.

South Bank.—The Urban District Council have decided to apply for the extension of the electric lighting order.

Thornhill.—The proposal to apply for an electric lighting provisional order has been deferred for the present.

Kirkcaldy.—Mr. Oliver Melville has been instructed to provide a 6½-h.p. motor for the high school at a cost of £40. 4s.

Alloa.—The supplementary agreement with the British Electric Plant Co. has been signed, and came into force on the 15th inst.

Uffculme (Devon).—We understand Messrs. Fox and Co. contemplate putting an electrical installation into their woollen factory.

Willans and Robinson.—Prior to the payment of interest, the debenture registers and transfers will be closed until Nov. 30 inclusive.

Sowerby Bridge (Yorks).—The work in connection with the Urban District Council's electricity supply undertaking is now in progress.

Hereford.—The output of current for the quarter ending Sept. 29, 1905, was 28 885 units, against 20,758 units in the corresponding quarter of 1904.

Southport.—On Friday the mayor opened a large electrical exhibition which is being held under the auspices of the Corporation, and which will close to-night.

Romford.—An application is to be made for an extension of time relative to the electric lighting order transferred to the Empire Electric Lighting and Power Co. in 1903.

Morecambe Tramways Co.—The annual report recommends a dividend of 4 per cent., as compared with 3½ per cent. last year. Receipts from fares are slightly higher.

New Issues.—W. T. Henley's Telegraph Works Co. are issuing £150,000 of 4½ per cent. first mortgage debenture stock, forming part of a total authorised issue of £300,000.

Chester-le-Street.—The Rural District Council have rescinded a former resolution refusing consent to the County of Durham Electric Power Supply Co. to the carrying of overhead mains.

Preesall (near Preston, Lancs.).—The United Alkali Co. are, we understand, substituting electric motors for steam driving throughout their works. They have their own generating plant.

Calverley (Yorks).—We note that the Yorkshire Power Co. are making arrangements to supply the urban district of Calverley, near Leeds, with electricity. Installation work should follow.

Ramsgate.—An electrical and trades exhibition is being held, and will remain open until Nov. 28, at the Royal Victoria Pavilion, under the auspices of the Ramsgate and District Electric Supply Co.

Partnership.—Particulars of an opening for an electrical engineer with some capital and experience as junior partner in Glasgow branch of a high-class firm of electrical engineers appear in another column.

Hexham-on-Tyne.—It seems that the Hexham and District Electric Supply Co. have got under weigh with their scheme, and are now putting down a plant for the supply of electricity in the urban district.

Fire.—It is reported that a four-storey building, occupied by Dunlop Rubber Co., was destroyed by fire at Birmingham early on Friday morning, heavy fog preventing discovery until the flames had obtained a good hold.

Trowbridge.—We understand that the difficulties of the Urban District Council with the Western Electric Distributing Corporation

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relative to the costs of transfer of the order have been referred to Mr. G. Pearson, of Bristol.

Yarmouth.—In consequence of an application by the Education Committee for the electric light to be installed at the new school at Southtown, the Council have offered to fix and keep in repair 50 25-c.p lamps for £3 3s. per lamp per annum.

British Aluminium Co.—The directors have decided to pay an interim dividend for the half-year ended June 30 at the rate of 6 per cent. on the "A" preference shares and 7 per cent. on the 7 per cent preference shares payable 2nd proximo.

Ashton.—The application of the Great Central Railway Co. for a supply of current for lighting the new station at Guidebridge and power for the repairing shop has been referred to the Works and Management Sub-Committee, with power to act.

Olympia Exhibition.—We have received from Messrs. A. Reyrolle and Co., Hebburn-on-Tyne, an elegant souvenir descriptive of their motors, and we are informed that they will be pleased to forward a copy to any of our readers who may apply for the same.

Stepney.—The Council are taking up a loan of £3,770 for the provision of storage tanks, water-softening plant, etc., at the electric lighting station. The Council will support the Poplar Council's action with regard to the wiring of consumers' premises.

Sussex Telephones.—The National Telephone Co. are laying pipes underground for the necessary cables to supply subscribers in Southwick, and the work will be continued to and throughout Shoreham. Work has also been started at Henfield and Burgess Hill.

Dumbarton.—A petition of the Electric Supply Corporation, Salisbury House, London-wall, E.C., for consent to the erection of an electric generating station, a car-shed, offices, and sheds, and also for diverting the mill lade, is before the Dean of Guild Court.

Brandon.—An application from the County of Durham Electrical Power Distribution Co. for consent to an application for a provisional order for the supply of electrical energy in the Council's district will come before the next meeting of the Urban District Council.

Barnstaple.—Messrs. Edmundson's have decided to open a branch at Barnstaple, and have secured a shop, showroom, etc. The branch will be worked in connection with Ilfracombe, where Mr. Alan Jenkins is the manager. The local manager at Barnstaple will be Mr. F. Williams, who has been engaged with the firm at Ilfracombe.

Agencies.—Mr. R. Salem, of 71, Bishopsgate-street Within, E.C., has been appointed sole representative for London and the South and South-East of England for William Sanders, Wednesbury.—The Rhodes Electrical Manufacturing Company have appointed Messrs. R. A. Fullerton and Co., of 116, Hope-street, Glasgow, as their sole agents for Scotland.

Swansea.—The Swansea, Mumbles, and Morriston telephone exchanges are being interconnected, but, we are informed, intercommunication will be strictly local to each place, and will not extend from one place to another, and will not extend to the numerous other exchanges in the extensive system of the National Co. in the Swansea area.

Newport.—The proposed reductions in the charges for electricity and electric light have been approved by the Town Council, who expect an increase in the number of consumers to compensate for the estimated loss of £1 000 following from the new departure. Various suggestions for the lighting of York-road and Kensington-avenue are under consideration.

Frimley.—An application of the Camberley Electric Supply Co. for consent to an application to the Board of Trade for an electric lighting provisional order will shortly come before a committee of the Urban District Council. The company propose to charge on the maximum demand system at 7d. to 3d. per unit, making an average cost of 4½. to 5½. per unit.

Hammersmith.—At the inquest into the death of an employé at the electricity station a verdict of accidental death was returned. It was found that the workman had neglected to use the rubber gloves provided for him, and that he died from the effects of a shock received in removing an ammeter from a switchboard while standing with one leg on the chair and the other on the mat.

Chelmsford.—The Corporation have accepted a tender for lighting the public streets from the Chelmsford Electric Lighting Co. as follows: for each arc lamp (21 of 1,000 c.p. each), £25. 5s. per annum; for each incandescent lamp (231 of 70 c.p. each, except at corners where they are to be of 150 c.p. each), £3. 3s. The fines now charged for lamps unlighted to be doubled.

Hull.—A few weeks ago we referred to the municipal telephone system as a paying concern. Recent accounts show a profit after paying all interest on loan, sinking fund charges, and plant kept up out of revenue. So far the system has not cost the ratepayers a single penny, and it is stated that the subscribers in Hull are saving over £10 000 this year in reduced charges alone.

Stafford.—An application from the Postmaster-General for permission to erect an overground telegraph line along the main road, from the junction with the Tean Uttoxeter-road, at Fole, to Rocester, *via* Hollington, thence from Rocester through Benstone and Ellastone to the junction with the boundary of the Mayfield Rural District Council at Middle Mayfield, has been agreed to.

Macclesfield.—The estimated capital outlay on the electricity scheme as prepared by Mr. Woodward, which has been approved, includes the following: buildings, £3 700; generating plant, £8 000; mains, £3 700; consumers' connections, £600—total, £16 000. The plans of Mr. Bradburn, architect, of the building and the chimney to be erected on the Bowling Green yard site, have also been approved.

London Gazette.—The partnership between Joseph Grain, jun., and Percy Hopper, carrying on business as electrical accessory dealers and sundriesmen at 92, Northumberland-street, Newcastle-on-Tyne, has been dissolved by mutual consent. Notices appear of applications to the Board of Trade by the Wisbech Corporation for extension of time and by the Frome Urban District Council for transfer of their provisional orders.

London County Council.—At the meeting on Tuesday tenders were received for the supply, delivery, and erection of self-discharging steel coal trucks for use at the Greenwich generating station. It was agreed to lend the Poplar Borough Council £2 497 for electric lighting purposes. The Finance Committee submitted a report in which they argued against the Council undertaking the work of a bulk supply of electricity. We deal with the result in another column.

Colchester.—The last report of the engineer gives the following figures: output of electricity for lighting during September, 1905, 42,376 units, against 39 304 the corresponding week of 1904, and 28 705 in 1903; for traction, 35 675, against 36,405 in 1904; used in generating station, 4 057; number of consumers at end of September, 778, against 551 in 1904 and 347 in 1903; total number of 8-c.p. lamps connected, 34 530 against 27,159 in 1904. Four electric lamps are to be erected, and a Nernst lamp substituted for a gas lamp.

Erith.—An extension to Northumberland Heath is to be made at a cost of £295. In answer to an offer from the borough of Woolwich to supply electricity in bulk, the Council have replied that they do not at present require a supply of electricity in bulk, and that they will communicate with the Woolwich Borough Council if such a supply is required at any future time. The question of revising the present scale of charges for the supply of current for heating and power purposes has been referred to the resident electrical engineer to report.

St. Albans.—Consent has been given to the Postmaster-General to lay a line of underground telegraph wires from the post office to the city boundary on St. Stephen's-hill, and negotiations are going on with a view to an alternative route being decided upon in the place of a proposed line of overground wires from the post office along to the city boundary in the Sandridge-road, which would involve the erection of a number of poles. The electric lighting agreement with the St. Albans District Electric Supply Co. has been approved by the Board of Trade.

Lowestoft.—The resident engineer's last report states that during the month six new consumers have been connected to the mains, representing 221 8 c.p. lamps. There are now connected to the mains 658 consumers, representing 33,416 8 c.p. lamps. During the year 105 new consumers have been connected, representing 5 800 8-c.p. lamps. The engineer is about to report upon the cost of lighting Christ Church clock by electricity. The charges for current for tramway purposes for the year ending Sept. 30, 1906, have been fixed at 2d. per unit, with the proviso that at the end of the year the charge shall be again considered.

Morley.—The borough electrical engineer, Mr. J. E. Ellis, in his last report states that the output of electricity during the month ending Sept. 30 was 11,727 units, against 12,004 the corresponding month last year, the decrease in the output being 277. The actual units sold to consumers by meter was 7,8?9, against 6 313 the same month of last year, showing an increase of 1,496. There were 123 lamps connected during the month, and the total number of lamps connected to date was 13,124. During the month one ½-h.p. motor had been coupled to the mains, which was working very successfully, which brought the total motors connected to the mains up to six, equal to 27½ h.p.

Scunthorpe.—An inquiry has been held into the application of the Urban District Council for sanction to borrow £4,500 for electric lighting purposes. The Council are already engaged in a scheme of electrical pumping for their new waterworks, and are anxious to combine an electric lighting plant, and also to keep out any private company who might seek powers for supplying electrical energy. The contract for the work has been provisionally accepted by the British Westinghouse Electric and Manufacturing Co. Mr. Cobban, the engineer for the scheme, said it was expected that a profit of £41. 6s. 7d. would be made on the first year's working. It was also intended to light the principal streets with 16 c.p. lamps.

Cannock.—The Shropshire Electric Power Co. are prepared to enter into an agreement to supply to the Council electricity as they require at a rate of 2½ d. per unit, or if taken in continuous demand at a rate not exceeding ¾ d. per unit. Sanction to a loan of £3 000 will be applied for so as to purchase the necessary accumulators and mains and carry out the works enabling the Council to distribute this within the Cannock area, exclusive of Bridgtown. The Council can supply at 4½ d. per unit. The 3d. per unit charged to the Council includes the redemption fund and cost of maintenance and distribution. On sanction being obtained, an agreement will be prepared with the Shropshire Electric Power Co. for the supplying of electricity on the terms named.

Mill Installation.—The distinction of possessing one of the oldest electrical installations in the West Riding of Yorkshire falls to Messrs. W. Fison and Co., whose Greenholme Mills at Burley-in-Wharfedale were equipped as long since as 1889, at a cost of about £3 500. Additions have been made to the plant from time to time, and it now comprises one horizontal slow-speed engine of 100 h.p., and two similar engines of 30 h.p., coupled through counter shafting and belts to seven dynamos, ranging in capacity from 40 kw. to 20 kw. The latter were supplied by Messrs. Crompton and Co. and the Phœnix Dynamo Co., and are direct-current machines used in conjunction with accumulators. This plant supplies current at 110 volts pressure to an installation of 1,500 16-c.p. and 32-c.p. incandescent lamps and three 10 h.p. motors. The maximum load obtained is 93 kw., while the units generated per annum total about 60 000. Naturally, the plant is now somewhat antiquated, hence the intention of the above firm to replace it with an entirely new and up-to-date equipment in the near future.

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Walsall.—The last report of the Electricity Committee was as follows: "The total number of consumers supplied on Oct. 31 last was 435. During the past month the total units generated at the station were 157 390. The total output from the main generators was 152,383 units. The total units from the transformers were 120,025 (estimated). The machinery was run for 735 hours. The wages paid amounted to £132. The electrical engineer has been requested to report on the application of the Shropshire, Worcestershire, and Staffordshire Electric Power Co. for the approval of the Corporation to the company promoting a Bill for conferring powers upon them (*inter alia*) to furnish the Corporation with electricity in bulk, and with the consent of the Corporation to supply manufacturers with current for trade purposes."

Hammersmith.—The loan of £13,700 for boilers and fittings, steam-piping, and auxiliary apparatus in connection with the extension of the electric lighting installation will now be taken up, and application is to be made for £15,570 for work executed since the last loan was applied for (February, 1904), and for work in course of execution or shortly to be executed, as follows: mains and sub-stations, £7 898. 12s. 8d.; laying services to consumers' premises, £3 569 4s. 9d.; erection of buildings, £4,103. The last report of the Electricity and Lighting Committee shows that the premises of 19 additional consumers, representing a maximum of 805 8-c.p. lamps, have been connected to the mains, that nine consumers have been disconnected, and that the present number of consumers taking current from the mains is 1,715. The Council will support the London County Council's Wiring Bill. A high-tension main is to be laid at a cost of £94.

Curtis Turbines.—The British Thomson-Houston Co., Rugby, report that the sales to date of Curtis turbo-generators amount to a total of 24,000 kw., of which 11,750 kw. have been delivered and put in service in various stations in the United Kingdom. The principal orders show a total of ten 1,500 kw. sets, four 1,000-kw. sets, and four 750-kw. sets. The Curtis turbine rights in America are owned by the General Electric Co., of Schenectady N.Y., who have received orders to date for 472 machines, aggregating 454,886 kw., of which 282 machines, aggregating 237,775 kw., have been delivered and are in use or in course of erection. Four sets of 8,000 kw. are under construction, and it is interesting to note that these will be the largest steam turbo generators in the world. The list of orders also includes 30 5,000-kw. sets, 11 3,000-kw. sets 31 2,000 kw. sets, 31 1,500 kw. sets, of which 15 5,000-kw. sets, 7 3,000-kw. sets, 16 2,000-kw. sets, and 23 1,500-kw. sets have been delivered.

Rubber in Ceylon.—A correspondent writes to the *Globe* that this year's seed crop of Hevea brasiliensis in Ceylon has been a bumper crop, and that on one estate over six million seeds were harvested and sold this year. At 200 trees per acre, this will plant 30,000 acres. The writer continues as follows: "From the first few plants in Ceylon all the millions of trees in India, Burma, Assam, Malay States, Straits Settlements, Borneo, Java, Fiji, Samoa, Madagascar, Gold Coast, etc., have been obtained. Ceylon is the most enterprising planting country in the world." We admit the last sentence, and have always admired the pluck the Ceylon planter has repeatedly shown under adverse circumstances, but with regard to the other statement, the writer appears to have forgotten the seedlings introduced into India from the Amazon by Mr. Wickham, acting as special commissioner to the Indian Government for this purpose.

Huddersfield.—The annual statement of the electricity department for the year ending Dec. 31, 1904, shows a surplus balance of £3 875; £2,110 was taken from the depreciation fund to enable the department to repay to the borough fund the amount of £5 985 which had been provided to meet deficiencies during the first three years' working of the undertaking. The capital expended upon the department at the end of last year was £175 972. There has been repaid and contributed to sinking fund for repayment of capital the sum of £39 530, leaving a balance of capital to be repaid of £137,442. An additional amount of £9,743 is included in the depreciation and contingencies account. During the present year there have been 197 additional consumers connected, with 12 768 8-c.p. lamps. This brings the total consumers to 2,196, with 150,401 lamps connected. Owing to the increased output, the conditions of working are steadily improving. In 1894 the capital expended equalled £3 per 8-c.p. lamp connected; it was at the end of last year only £1. 5s. 1d. In July the price for energy for lighting purposes was reduced from 4½d. to 4d. per unit. This will represent a loss in revenue of about £2,400 per annum, in addition to the loss of about £800 due to the reduction of meter rents. During the year the mains have been extended to Golcar, and from Milnsbridge to Longwood, interconnecting the Crosland Moor district with the Longwood district. Mains have also been extended considerably to various parts of the borough where a supply has been required.

Birmingham.—At the new electric generating station of the Corporation, now in course of erection in Summer-lane, the chairman of the Electric Supply Committee (Mr. Councillor Ellaway), accompanied by the committee, last week proceeded to the top of the chimney stack, where he laid the last brick and completed the chimney. The chimney has been designed to deal with the flue gases produced by boilers having a capacity of about 20,000 h.p., and is the first of two similar chimneys that will be required for the ultimate capacity of the generating station. The chimney has been built by Messrs. W. Sapcote and Sons, the first brick having been laid on Dec. 14, 1904. It has therefore taken 11 months to complete; the work, however, was delayed some 3½ months on account of bad weather. The leading dimensions of the chimney are as follows: height from the base, 249ft. (225ft. from floor level); internal diameter, 15ft.; external diameter at bottom, 24ft.; external diameter at top, 17ft. 4in.; total weight of chimney, 2,750 tons; approximate number of bricks used, 500,000. As far as capacity is concerned, this chimney is the largest that has been built in Birmingham, and it is pleasing to note that the whole of the work in connection with it has been carried out without any hitch whatever, and has proved to be highly satisfactory in every respect. It is anticipated that the chimney will very shortly be put to work, as four of the boilers are now completed. It is proposed to raise steam in them for the first time in the course of the next six weeks.

Buxton.—At last week's inquiry into an application of the Urban District Council for sanction to borrow £4,000 for purposes of electric lighting, Mr. J. W. Leeming, electrical engineer, submitted the following report: "In 1901 the Council applied for a loan of £35,000—£16 520 for immediate expenditure, the remaining £8 480 would be required at an early date—but sanction was only granted for the £16 520, the remainder to be applied for when necessary. Of the £4,000 now being applied for, £1,000 is down for capital overspent—viz., £90 in excess of original loan charged to subsequent loan, £669 on buildings, £661 on machinery, £837 on mains, totalling £2,259—and £1,261 of the item set against machine tools, contingencies, sundries, etc., has not been spent, this making a balance of £997 overspent. The only item for immediate expenditure is £900 for a gas-engine plant for charging the batteries, as at certain periods of the year this very soon gets exhausted, which necessitates running up steam and using the boilers and machinery only partially loaded, and therefore very uneconomical running. The extra cost of charging the battery under the present conditions comes out at about £180, and the estimated cost with the gas-engine works out at about £95, showing a saving of about £87, and after deducting the interest, etc., on capital expenditure of the gas plant—viz., £66. 5s.—it shows a net saving of £30. 15s. per annum. This does not account for dark days, storms, etc., when I find it necessary to rush up steam as quickly as possible, which, of course, puts undue strain on the boilers, and on many occasions, before I could get steam enough to start, the voltage on the town had completely gone. This would all be avoided with a gas-engine, as it would be ready and running in a very short time, and save all the coal, labour, and time, and severe wear and tear on the boilers. The remaining £3,100 is for meters, service cables, extensions to distributors, and sundries that are estimated requirements during the next three years or so."

Gravesend.—The engineer's report on the quarter ending Sept. 30, 1905, contains the following figures: units supplied to tramway company, 118 912; corresponding quarter, 1904, 122,273; units supplied to private consumers, 35 621 (corresponding quarter, 1904, 28 792); units supplied for public lighting, 18 898 (corresponding quarter, 1904, 17 499); units used on works, 25 485 (corresponding quarter, 1904, 24 694); units unaccounted for, 18 116 (corresponding quarter, 1904 20,038); units generated, 218,032 (corresponding quarter, 1904, 213 296). It has been decided that the G-type lantern supplied by the Reason Manufacturing Co., as fixed opposite the Coach and Horses, Parrock-street, should be adopted as a standard. The engineer has recommended the erection of a 300 kw. steam generator, designed more especially to deal with the tramway load but capable of handling economically either lighting or traction loads. The two propositions available were: (*a*) a vertical cross compound condensing set, fitted with Corliss valves and running about 100 r.p.m.; (*b*) a Belliss vertical triple-expansion condensing set with piston valves and automatic expansion governor running about 350 r.p.m. Both schemes included pipework, condensers, separator, purifier, air-circulating, water, and lift pumps, additional switchboard, and connections. The cost of scheme (*a*) would be approximately £6,840, and that of scheme (*b*) would be approximately £5 410. The Electricity Committee considered that scheme (*a*) was slightly more economical in operation than scheme (*b*), but not sufficiently so to justify the additional capital expenditure involved. It had a further disadvantage in that rather more than double the floor space would be required, floor space which at some no very distant date would be very valuable. On the whole, scheme (*b*) was most suited to the requirements of the Council and the one the engineer recommended them to adopt. The adoption of scheme (*b*) as suggested would enable the existing lighting load to be doubled. It has been decided that the whole of the building scheme be carried out, that the plant mentioned in scheme (*b*) be purchased, and that immediate application be made for sanction to borrow £7,000 for this purpose.

PROVISIONAL PATENTS, 1905.

Nov. 6.

22628. Improvements in rails for track purposes. Horace Louis Petit Boot, Electricity Works, Tunbridge Wells, Kent.

22631. Improvements in sliding contact pieces for Wheatstone's bridges and potentiometers, and in the arrangement of wire for the same. Franke Herbert Parker, 72 Greenvale-road, Eltham, Kent.

22635. Improvements in electric glow lamps. John Ellis, Keynsham, Sandown, Isle of Wight.

22636. Clock for connecting and disconnecting the electric current in an automatic way. Max Neumann, 12, Bahnhofstrasse, Bremen, Germany.

22654. An improved method of and apparatus for equalising the output of main dynamo-electric generators supplying energy to a fluctuating external load. Arthur Pemberton Wood and the Lancashire Dynamo and Motor Company, Limited, 34, Castle-street, Liverpool.

22660. Improvements in the method of and apparatus for producing electricity by means of steam. Henry Ernest Fry, 24, John-street, Bedford-row, London.

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22673. **Improvements in electrical storage batteries.** Alfred Elmore Knight, 11, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Nov. 16, 1904, being date of application in United States.) (Complete specification.)

22710. **Improvements in or connected with the manufacture of electric cables.** Darwin Bates and Arthur Hugo Schültz, 15, Water-street, Liverpool.

22721. **An improved electric candle lamp.** Charles Clare Regnart, 29, Anson-road, Cricklewood, London.

22723. **Improved means for regulating the speed of electric motorcars.** Louis Kriéger and Compagnie Parisienne des Voitures Electriques (Procédés Krieger), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 1, 1904, being date of application in France.) (Complete specification.)

22724. **Improved means for regulating the speed of electric motorcars.** Louis Kriéger and Compagnie Parisienne des Voitures Electriques (Procédés Krieger), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 3, 1904, being date of application in France.) (Complete specification.)

22733. **Improvements in electric safety fuses.** Ernest Francis Moy, Percy Henry Bastie, and Ernest F. Moy, Limited, Greenland-place, Camden Town, London.

22740. **Improvements in and relating to the electrolytic deposition of metals.** Sherard Osborn Cowper-Coles, 70, Chancery-lane, London.

22741. **Improvements in or relating to indicators for ships, electric signal and similar lamps.** Thomas Harrison and Anthony Strong Frazer, 70, Chancery-lane, London. (Complete specification.)

Nov. 7.

22763. **Improvements in apparatus for moving electrically the points on electric tramways and railways.** Joseph Patrick Tierney and John Malone, 44, Booterstown-avenue, Booterstown, co. Dublin.

22767. **An improvement in or in connection with electric wiring.** Edward Arthur Hall, Gough-chambers, Savile-street, Hull.

22802. **Improvements in or relating to high-tension magneto-ignition systems.** George Herbert Smith, 306, High Holborn, London. (Albert Paul Louis Boulanger, France.)

22819. **Improvements in communicating signals telegraphically.** Frederick Howe Hadfield, Clun House, Surrey-street, Strand, London.

22820. **Improvements in omnibus electrical signalling circuits, particularly applicable in telephony.** Charles Mark Jacobs, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22841. **Improvements in and relating to electric traction.** Michaelangelo Cattori, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22856. **Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 8.

22874. **Improvements in printing telegraphs.** Leo Kamm, 27, Powell-street, Goswell-road, London.

22889. **Improvements in electrical contact breakers.** Reginald Masters Smith, 1, Broad-street-buildings, Liverpool-street, London.

22899. **Improvements in and relating to dynamo-electric machines.** Karl Krafft, 94, Avenue de la République, Paris.

22939. **Improvements relating to electric control apparatus.** Daniel Bacon, 7, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22946. **Improvements in or relating to self-lubricating brushes for dynamos or the like.** Louis Boudreaux, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Nov. 11, 1904, being date of application in France.) (Complete specification.)

22952. **Improvements in alternating electric currents and in methods of controlling the same.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

22954. **Improvements in contact breakers for the electric ignition gear of internal-combustion engines and the like.** George Charles Reed, 70, Chancery-lane, London.

Nov. 9.

22970. **Improvements in dynamo-electric machinery.** Walter Leo Hildburgh, 18, Southampton-buildings, Chancery-lane, London.

22971. **Improvements in current collectors for dynamo-electric machines.** Walter Leo Hildburgh, 18, Southampton-buildings, Chancery-lane, London.

23005. **Improvements in electric fusible cut-outs.** Herbert Henry Berry, Uplands House, Chase Ridings, Enfield, Middlesex.

23016. **Improvements in magnets, magnetic drilling posts or braces, and the like.** Andrew Stewart, 10, Livingstone-mansions, Queen's Club-gardens, West Kensington, London.

23035. **Improvements in arc lamps.** Adolfo Hess, 47, Lincoln's-inn-fields, London. (Complete specification.)

Nov. 10.

23058. **Improvements in magneto machines for use in connection with ignition systems of electrically-fired internal-combustion engines.** The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

23075. **A new or improved electromagnetic power hammer, drop stamp, or press.** Thomas Henry Large, 154, St. Vincent-street, Glasgow. (Complete specification.)

23077. **Improvements in process of electric welding.** Laurence Sylvan Lachman, 28, New Bridge-street, London. (Date applied for under Patents Act, 1901, Nov. 17, 1904, being date of application in United States.) (Complete specification.)

23085. **Improvements in and relating to systems of connections for telephone offices with separated plug service and group calling.** Deutsche Telephonwerke R. Stock und Co., G. m. b. H., Thanet House, Temple Bar, London. (Date applied for under Patents Act, 1901, Nov. 10, 1904, being date of application in Germany.) (Complete specification).

23087. **Improved manufacture of incandescence bodies for electric lights.** Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 15, 1904, being date of application in Germany.) (Complete specification.)

23088. **Improved manufacture of glow lamps with incandescence bodies of tungsten, molybdenum, or similar metals.** Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 15, 1904, being date of application in Germany.) (Complete specification.)

23099. **New and improved means of communication for telephony and telegraphy without wires.** Charles Brindley Mills and Edwin James Humby, 40, Chancery-lane, London.

23130. **Improvements in electrical cables.** Willoughby Statham Smith, 24, Southampton-buildings, Chancery-lane, London.

23132. **Improvements in magneto-electric ignition apparatus for internal-combustion engines.** Frederick Richard Simms and Robert Bosch, 4, South-street, Finsbury, London. (Complete specification.)

23138. **Improvements in the electrolytic refining of copper.** The Metals Corporation, Limited, and Sherard Cowper-Coles, 70, Chancery-lane, London.

Nov. 11.

23153. **Electric current transformer.** Harry Chapman, 34, Meerabrook-road, Sheffield.

23172. **Improvements in or relating to electro-mechanical systems for the propulsion of automobiles.** Henri Pieper, 24, Temple-row, Birmingham. (Date applied for under Patents Act, 1901, Sept. 29, 1905, being date of application in Belgium.) (Complete specification.)

23197. **Improvements in and relating to appliances for the movement and control of distant levers and switches by electricity.** William Schofield, 25, Woodend-street, Springhead, Lees, near Oldham. (Complete specification.)

23211. **Improved system for producing electric vibrations of different phase.** William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

23231. **A new or improved electrical fog signalling apparatus for railways and the like.** George Greetham, 9, Regent-street, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 30.

1904.

24788. **Electric arc lamps.** Whitney. (Date applied for under International Convention, Nov. 16, 1903.)

25764. **Electric motor controllers.** British Thomson-Houston Company, Limited. (General Electric Company.)

26295. **Electric control systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

27211. **Protection of electric distribution systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

27352. **Electric controlling apparatus.** Otis Elevator Company, Limited. (Otis Elevator Company.)

27444. **Electric switches.** Eckstein and Krause.

28787. **Electrical switches.** Stern and Greene.

29107. **Telephones for diving and like purposes.** Davis and Graham.

1905.

1670. **Alternating electric current motors.** British Thomson-Houston Company, Limited. (General Electric Company.)

2310A. **Electric switches for controlling brake apparatus or systems.** Fairweather. (National Electric Company.) (Date applied for under Rule 5, Patents Rules, 1905, Feb. 6, 1905.)

4097. **Electromagnetic devices.** Pape and Bender.

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2586. Safety cut-out devices for electric circuits. British Thomson-Houston Company, Limited. (General Electric Company.)

5981. Alternating-current electric motors. British Thomson-Houston Company, Limited. (General Electric Company.)

8158. Electric motor starters. Horton. (Date applied for under International Convention, Nov. 2, 1904.)

8511. Means for "tuning" Hertzian-wave receivers to particular transmitters. Hülsmeyer.

11336. Means for supporting and enclosing telephone and other electrical apparatus. Kingsbury. (Western Electric Company.)

11337. Safety apparatus for use in connection with telephones and other electrical apparatus. Kingsbury. (Western Electric Company.)

13964A. Electric lighting or other installations. Corkhill. (Date applied for under Rule 5, Patents Rules, 1905. July 6, 1905.)

14211. Starting apparatus with controller drum for induction motors. (Siemens-Schuckertwerke G. m. b. H.) (Date applied for under International Convention, Aug. 3, 1904.)

15257. Storage battery electrodes. Gardiner and Stringfield.

15298. Multiple telegraphy. Jones.

15299. Multiple telegraphy. Jones.

16080. Interrupters for making and breaking electric circuits Davis.

16773. Revolving field magnets for dynamo-electric machines. Siemens Bros. and Co., Limited. (Siemens Schuckertwerke G. m. b. H.)

17433. Fittings and accessories pertaining to electrical incandescence lamps and the like. Lambert.

17873. Signalling by electromagnetic waves. Briggs. (Secret document under Section 44, Patents, etc., Act, 1883.)

17974. Joints for electric cables. Siemens Bros. and Co., Limited, and Neale.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price. £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6½ 7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2¼ 2⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	93-97
—— 4½ per cent. 2nd Debenture Stock	100 ..	78-81
Callender's Cable, Debentures	100 ..	109-111
—— Ordinary	5 ..	11-12 xd
—— 5 per cent. Pref.	5 ..	5⅛-5¼
Crompton and Co.	3 ..	1½-1⅝
—— 5 per cent. Debentures	100 ..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1⅜-1⅝
—— "A" Shares, 01-017,139	5 ..	2-2½
—— 5 per cent. Debentures	100 ..	92 97
—— 4 per cent. Deb. Stock, Red.	100 ..	85 90
Electric Construction, Nos. 1 to 112,100	9 ..	⅝-¾
—— 7 per cent. Cumulative Pref.	2 ..	1⅝ 1⅞
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref...	10 ..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	12 13
—— 4½ per cent. Preference	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	32-34
—— 5 per cent. Bonds	100 ..	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	12¼-12⅜
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10⅜-10⅝
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11½-12½
—— 4½ per cent. Debenture Stock, Red	100 ..	107-109
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	102 105 xd
Brompton and Kensington, Ordinary	5 ..	9-10
—— 7 per cent. Preference	5 ..	9¼ 9⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9-9½
—— Nos. 60,001-80,000	5 ..	9 9⅛
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13¼
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	105-108
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	7-7⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5 ..	4⅜-5
—— ditto (1903) 40,001-80,000	5 ..	4⅜-5
Chelsea Electricity Supply	5 ..	6 6⅛
—— 4½ per cent. Debentures	100 ..	110-112
City of London, Ordinary	10 ..	11⅜-12¼
—— 6 per cent. Cumulative Pref.	10 ..	13¼-14¼
—— 5 per cent. Debenture Stock	100 ..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	104-106
County of London Electric Supply, Ordinary	10 ..	9⅜-10⅛
—— 6 per cent. Cum. Pref.	10 ..	12⅜-12⅞
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	102-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	6-6¼ xd
—— 4½ per cent. First Mort. Deb.	100 ..	108-110 xd
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	101-104
Havana Electricity, 1-15,000	10 ..	9-10
Hove Electric Lighting, Ord., 1-13,000	5 ..	8¼-8⅜
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103 xd
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	15/16-1 1/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11¼-12¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1⅝-2¼
—— 6 per cent. Pref.	5 ..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 100,001-300,000	5 ..	10 10¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 4½ per cent. Cum. Pref.	5 ..	5⅜ 5⅞
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	99-102
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0 9	5 ..	8-8¼
—— do., 57,0 0-75,000	5 ..	8-8½
—— 5 per cent. Pref., 1-57,00	5 ..	6¼ 6⅜
—— do., 57,0 0-75,0.0	5 ..	6¼-6⅜
Notting Hill Electric Lighting	10 ..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6⅜ 6¼
—— 4 per cent. Debenture Stock	100 ..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	2 2¼
—— 4 per cent. Debenture Stock	100 ..	76-80
South London, Ordinary	5 ..	3¼ 4
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16-15/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-108
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13¼ 14¼
—— 7 per cent. Pref.	5 ..	⅛-¼
—— 3½ per cent. Deb.	100 ..	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4¼-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5¼
Westminster, Ordinary	5 ..	12⅜-12⅝
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6¼
Electric Tramways.—		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5 ..	5⅝-6⅛
—— Ord.	5 ..	8⅛-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	105-107
Barcelona Tramways, Ord., 1-20,000	10 ..	13⅜-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9-10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101
—— 4½ per cent. Red Deb. Stock	100 ..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3¾-4¼ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	124-127 xd
—— Ord. Pref.	100 ..	113-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	106-109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-123
—— 4½ per cent. 2nd Deb. Stock	100 ..	98-100 xd
Buenos Ayres and Belgrano Trams	5 ..	3⅜-3¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	106-108
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	98-100
Calcutta Tramways, 1-102,268	5 ..	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-108
Cape Electric Tramways, Nos. 1-480,000	1 ..	1-1¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	3¼ 4¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14¼
—— 6 per cent. Cum. Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 ..	2¼-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	£1,000 ..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum. Pref.	10 ..	9⅜-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100 ..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100 ..	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,152 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 ..	92-94
—— 4 per cent. Pref.	100 ..	101-103
—— " deferred	100 ..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	105-103 xd
—— 5 per cent. Pref. Stock '91	100	119-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	114-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10⅛
—— Ordinary, 1-50,000	10	3⅛-4⅛
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99-100⅛
Waterloo and City, Ordinary	100	87-89

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111-112⅛
—— Deferred Stock	100	107-108
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1⅛-1⅜ xd
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 11	1,173	1,155	+ 17	− 1,548h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 11	178	185	− 7	—	8	8	,, 15	14,328	3,316,380	353,945	1	9·71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 12	952	976	− 24	− 720	23·53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 11	375	331	+ 44	+ 1,382	2	2	,, 31	17,133	4,709,738	266,525	·85	14·5	8,866	—
Blackburn Corporation	,, 8	907	826	+ 81	—	24	24	,, 25	48,875	8,661,720	986,953	1·35	11·89	2,035	7·44
Blackpool Corporation	,, 2	340	350	− 10	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 11	167	186	− 19	− 1,031	16½	16½	Dec. 31	31,846	2,325,677	579,264	3·28	13·19	—	7·27
Bolton Corporation	,, 12	1,825	1,744	+ 81	—	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 8	1,404	1,086	+ 318	—	16·82	16·82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 11	4,004	3,864	+ 140	—	96	77	,, 31	230,085	47,108,000	5,033,392	1·172	10·927	2,396	—
Brighton Corporation	,, 12	817	837	− 20	+ 455	9	9	,, 31	50,339	11,321,160	1,152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 10	4,643	4,634	+ 9	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 11	1,021	1,003	+ 13	—	10·60	10·60	March 31	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 12	276	317	− 41	− 1,331	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9·21	2,068	6·76
Cardiff Corporation	,, 4	1,950	1,838	+ 91	+ 232	26†	—	,, 31	112,209	24,134,363	2,770,049	1·12	9·72	3,782	9·44
Carlisle Tramways Company	,, 11	164	192	− 23	− 176	8·5	8·5	Dec. 31	10,713	2,935,003	359,736	—	7·14	—	5·18
Central London Railway	,, 11	7,112	7,002	+ 110	− 1,038	6	6	,, 31	347,538	44,875,547	1,281,214	1·86	65·10	57,931	35·80
City and South London Railway	,, 12	3,061	2,841	+ 220	+ 149	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L. Company	,, 9	408	425	− 17	+ 658	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Oct. 21	2·5	198	+ 7	—	4½	4½	,, 31	11,250	2,853,200	284,343	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Nov. 10	77	95	− 18	− 314	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars	,, 10	3,624	3,750	− 25	—	47	46	,, 31	267,489	50,050,949	7,077,372	1 21	9 07	5,691	5 55
Dublin S. District, Electric	,, 10	747	795	− 48											
Dundee City Tramways	,, 1	921	817	+ 107	—	23	23	May 15	44,695	11,641,525	933 005	·90	11·49	1,943	7 13
East Ham Corporation	,, 11	705	618	+ 85	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 11	14,976	14,314	+ 652	+ 17,775h	144¾	143	May 31	756,480	195,767,519	17,945,535	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 11	1,289	1,261	+ 27	—	35	35	,, 31	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 11	2,112	2,154	− 41	+ 503	27	26	,, 31	112,651	27,102,921	2,910,693	1	9·29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 8	101	121	− 20	− 816	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Oct. 18	185	208	− 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Nov. 11	5,377	5,402	− 25	—	89	89	March 25	298,233	64,223,676	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 11	1,188	1,816	+ 71	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 4	10,331	10,143	+ 188	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 12	1,352	1,409	− 57	− 1,329h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 4	11,242	10,498	+ 744	+53,175	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 11	150	48	+ 2	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 9	92	113	− 21	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 11	12,218	11,788	+ 430	+16,708	149*	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6 99
Metropolitan District Railway	,, 12	7,953	7,226	+ 727	+ 1,057	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 12	17,476	17,141	+ 335	+ 874	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 11	120	114	+ 5	+ 405	—	2¾	,, 31	6,159	1,972,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 11	3,700	3,639	+ 61	+ 3,648	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 12	1,587	1,323	+ 258	+14,597	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 11	1,431	1,554	− 123	+ 939	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Oct. 26	545	623	− 78	− 398	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	Nov. 11	747	381	+ 366	+18,321	6½	4½	,, 31	14,881	2,837,110	336,547	1 24	9·24	1,102	7·92
Rotherham Corporation	,, 9	5 4	497	+ 57	—	9½	7½	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 13	4,169	3,966	+ 203	—	70½	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 12	4,849	4,573	+ 276	+ 7,346	65¾	52½	,, 25	240,565	63,952,283	6,043,899	·903	9·543	3,653	6·477
Southampton Corporation	,, 8	897	910	− 12	− 450	—	18	,, 31	49,365	9,294,771	1,108,359	1·27	11 02	—	7·83
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 10	736	456	+ 280	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 5	1,187	1,117	+ 70	+ 1,152	20	20	,, 31	64,858	15,364,463	1,495,685	1 004	10 36	—	6·37
Swindon Corporation	,, 8	167	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D C.	,, 11	671	658	+ 13	+ 682	11·85	10 5	,, 31	38,768	7,412 881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 9	1,804	1,047	+ 757	+21,331	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 8	736	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

The Electrical Engineers (R.E.) Volunteers.—The annual regimental dinner of the Electrical Engineers' Section will be held on Saturday next, Nov. 25, at 7 p.m., in the Café Monico, Piccadilly-circus, W.

Simplon Tunnel.—We gather from the *Proceedings* of the Swiss Federal Council that it has been definitely decided to work the interior of the tunnel from the commencement electrically. The opening has been fixed for May 1, 1906.

North-Eastern Railway.—It is anticipated that the new high-level bridge connecting Newcastle-on-Tyne and Gateshead will be completed in the course of next year, and by carrying the main traffic, will leave the old bridge free for local service and enable electrification of the southern line to be proceeded with.

Royal Meteorological Society.—The council of this society have awarded the Symonds gold medal to Lieutenant-General Sir Richard Strachey, R.E., G.C.S.I., F.R.S., in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented tt the annual general meeting of the society on Jan. 17, 1906.

Newcastle Local Section.—The members assembled last Thursday on the occasion of the sixth annual dinner of the local section of the Institution of Electrical Engineers. Dr. W. M. Thornton, chairman of the Newcastle Section, presided, and he was supported by the mayor of Newcastle (Alderman J. Baxter Ellis), Sir Isambard Owen, the Hon. G. L. Parsons, Mr. Gerald Stoney, Mr. Ernest Hatton (manager, Newcastle tramways), and a number of gentlemen prominently connected with the electrical industry in the district.

North-East Coast Institution of Engineers and Shipbuilders.—The first general meeting of the twenty-second session will be held in Newcastle-on-Tyne (in the lecture hall of the Literary and Philosophical Society) this evening. After the formal business has been transacted, a reception will be held by the president (Lord Armstrong) and Lady Armstrong, to be followed by the reading of a paper by Mr. C. Schofield on "Pneumatic Tools as applied to Ship Construction, and their advantages to Shipbuilders and Engineers." The institution dinner will be held on Friday, Dec. 1.

Manchester Local Section (I.E.E.).—The inaugural meeting of the present session took place on the 17th inst. at the Grand Hotel. Mr. S. L. Pearce, the chairman, delivered his presidential address (which we deal with elsewhere), for which Mr. T. L. Miller moved a vote of thanks, and incidentally told a tale about the recently improved conditions in the Lower Regions owing to the influx of electrical engineers and scientists. Mr. C. D. Taite seconded the vote, and backed up the proposed Manchester electrical exhibition. A smoking concert concluded the proceedings.

Labour and Wages.—A conference took place at Newcastle on Monday between the North-East Coast engineering employers and a deputation from the Amalgamated Society of Engineers, the United Machine Workers' Association, and the Steam-Engine Makers' Association. The subject of discussion at the conference was an application for an advance of 5 per cent. on piece and 2s. per week on time wages. Ultimately the engineers and steam-engine makers agreed to accept a compromise of an advance of 1s. per week on time and 2½ per cent. on piece rates, to take effect from the first full pay in February. An agreement was not come to with the machine workers, the point at issue being whether the advance should apply to men who are receiving under 25s. per week.

Streams of Sweden and Electricity.—The United States Consul at Gothenburg, commenting upon the rapid progress being made in utilising the streams of Sweden having a fall of water sufficient to generate electricity, and the organisation of companies with this object in view, says that the company Sydsvenska Elektriska Aktiebolaget, of Halmstad, is being incorporated and registered for the purpose of buying real estate and waterfalls and erecting plants for the production, distribution, and use of electric power, etc., with a minimum capital stock of about £195,000, and a maximum of about £558,000. A plan to utilise the water power of the River Lagan has been worked out. So far the trouble too often has been to find a profitable use for the electrical energy after it has been produced.

Fire Prevention.—Any improvement in the facilities for dealing with fire in the Metropolis is to be welcomed, and we are therefore glad to learn that the Metropolitan Water Board have decided that the restrictions which have hitherto prevented an extended use of the London Hydraulic Power Company's supply of high-pressure water for fire extinction will be withdrawn. In future it will be possible for anyone to have hydraulic pressure apparatus fitted, subject to the domestic water used being passed through a meter. The injector hydrant combines in one jet the force and volume of both the hydraulic power and domestic supplies. In some districts in London served by the Hydraulic Power Company, under the *régime* of the old water companies injector hydrants have been in use for many years, but in the City and in other important districts it has been hitherto impossible to connect them directly to the water-mains. Such connections are necessary in order to obtain their full efficiency.

London Power Supply.—A conference of the metropolitan borough councils (convened by the London County Council) was held on Monday at the County Hall, Spring-gardens, for the purpose of considering the proposed Electricity Supply Bill of the London County Council. Mr. Evan Spicer presided. The proceedings were conducted in private, and lasted over two hours, but we were informed that the following resolution was agreed to by 14 votes to 6: "That this conference of borough councils approves of the introduction by the London County Council of a Bill enabling it to supply electricity in bulk, subject to the interests of the borough councils' existing undertakings being safeguarded and to the details of the measure proving to be otherwise satisfactory." Those borough councils voting for the resolution were Battersea, Bermondsey, Bethnal Green, Camberwell, Fulham, Greenwich, Hackney, Islington, Lewisham, St. Marylebone, St. Pancras, Shoreditch, Southwark, and Woolwich. The six voting against were Hammersmith, Hampstead, Kensington, Paddington, Wandsworth, and Westminster. With the exception of Poplar and Chelsea, the whole of the 28 councils were represented. We understand that the promoters are satisfied with the result of the conference, and that the terms of the London County Council Bill will be published shortly.

Use of Incandescent Lamps.—The electricity department and the electrical engineer (Mr. R. L. Acland) of the Chesterfield Corporation are to be congratulated upon having prepared an illustrated card giving some practical hints to users of incandescent lamps as to how these can best be used. The instructions may appear simple, but upon their observance really depends the life of a lamp and the economy or waste in current. Users are reminded to regularly clean all their lamps with a damp

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cloth, holding them by the glass and not by the cap, and when downstairs lamps get dull they should be removed upstairs, and replaced by lamps from above which have not been burning so long. Lamps should not be burned till they are black in the face from old age, as more light is to be obtained from a new 8-c.p. lamp than from a blackened 16-c.p., with only half the expenditure of current. The instruction card does not fail to remind users that current costs more than lamps, and that, although the Corporation sell the light, the price is fixed by the lamps used and how they are used. The advice is given in the form used on a well-known occasion by Mr. "Punch," and householders by bearing in mind the "dont's" are likely to find themselves in pocket. The card is suitable for hanging on a wall, and may be obtained on application to Mr. R. L. Acland, the borough electrical engineer.

The Influence of Electromagnetic Fields on Spark Spectra.—Experiments were made by Mr. John E. Purvis with a view to discovering the influence of very strong electromagnetic fields on the spark spectra of ruthenium, rhodium, and palladium, and the conclusions arrived at are enumerated in the *Proceedings* of the Chemical Society. The instrument used in carrying on the experiments was a 21ft. concave grating spectroscope. The spark passed between electrodes of the metals which were firmly held between the poles of a magnet. The strength of the field between the poles of the magnet was 40,000 units with a current of 21 amperes. The nature of the vibrations was analysed by a calcite prism. The general result of Mr. Purvis's observations showed that: (1) Most of the lines are divided into triplets, and that there is a periodic or rhythmic change in the directions of the vibrations of the constituents of the triplets. (2) Some lines become quadruplets, and within certain definite regions of the spectrum their constituents also change the directions of their vibrations. (3) Other lines become doublets (only a few of the lines are not affected when vibrating in the magnetic field). (4) The inner member of the triplets is usually the strongest, but this is not always the case. The two outer members of a triplet may be stronger than the inner one, and all three are sometimes equally strong. (5) The strongest spectral lines are not the most widely separated when vibrating in the field. Weak lines are usually more widely separated than strong ones. (6) The decrease in the width of the triplets does not proceed *pari passu* from the less refrangible to the more refrangible end of the spectrum.

Platinum.—It is not unlikely that, with Russia's attention being first directed to affairs in the Far East and then towards the pacification of her internal disorders, many of her industries must be adversely affected by reason of neglect and unsettled conditions, and of these the fate of the platinum industry in Russia is viewed with most concern by electricians. Any large diminution in the production of platinum in Russia cannot but accentuate the difficulties arising out of the present inadequate supply, and we must turn our attention to the output returns of other countries to see whether the signs are more promising. The world's total supply of platinum for the year 1904 amounted to about 300 kg., or 9,626 troy ounces, from South America, and 6,000 kg., or 192,500 troy ounces, from Russia. No supply of platinum from Australia was available. A slight product of both platinum and palladium from the Sudbury copper mines was placed upon the market, but it was not found profitable to extract all the platinum and palladium which these ores could furnish. Increased interest in the occurrence of platinum in hydraulic mines and dredges of the Fraser River is due principally to the fact that the natural alloy of iron and nickel previously found in Josephine County, Ore., and in Del Norte County, Cal., has also been found in commercial quantities in the Fraser River at Lillooet. An interesting and new occurrence of platinum in places in Sumatra has been noted by Prof. L. S. Hundeshagen. In a recent report on the production of platinum and allied metals in 1904, Dr. David T. Day, of the United States Geological Survey, points out that the output of platinum in that country had increased from 110oz. in 1903 to 200oz. in 1904, and the increase is interesting as showing the future possibilities.

Books Received.—"Die Entwicklungsmöglichkeiten des Induktionsmotors für Einphasen-Wechselstrom," by Dr. R. von Koch (Julius Springer, Berlin. 2s. 8d.). The author of this work has enlarged certain portions of an essay on the possibilities of development of the single-phase induction motor, which he prepared in order to obtain a degree at the Imperial Technical High School, Berlin. He deals first with the Thomson synchronous motor, and, after examining the various motor parts, compares the different types of induction motors. The book, which contains 49 illustrations and diagrams, should prove of service not only to advanced students, but to a much wider area.—The Société Belge d'Electriciens have sent us their *Bulletin* for November, whose articles are concerned chiefly with the exhibits at the recent Liége exposition. It contains an article on the motor invented by Zénobe Gramme in 1869, and announces that in the next issue of the *Bulletin* will appear an account of the movement inaugurated at Liége last month in the memory of Gramme. Descriptions are given of several generating sets displayed at the exhibition, together with an article on "The Telegraphs at Liége Exhibition," by M. J. Pierart.—We have received a copy of the *Proceedings* of the meeting of the Société des Ingénieurs Civils de France held on the 10th inst.—Messrs. Blackie and Sons have sent us "Elementary Physics" (by Mr. J. N. Brown. 2s.), which is intended primarily for students undergoing a third year's school course in physics. The October issue of the *Proceedings* of the American Institute of Electrical Engineers contains a paper on "Some Experiences with Lightning Protective Apparatus" by Mr. J. C. Smith (which we note separately), and a "Note on Lightning Arresters on Italian High-Tension Transmission Lines."—In the *Journal* of the Franklin Institute for November appears, among other articles, a paper dealing with the "Electrolysis of Water" by Mr. J. W. Richards.

Cape Town.—We have been favoured with a copy of the minute of the mayor (Mr. H. Liberman) for the mayoral year ending Sept. 14, 1905, in which is reviewed the work of the Corporation. The Council have had under consideration the question of generating electricity by water from Table Mountain, but it is evident that the possibility of so doing is very remote. It was discussed in the Council as far back as January of this year, and then submitted to electrical and water engineers. The engineers reported that with stations at Woodhead tunnel, Stinkwater gorge, and Molteno reservoir, a total of about 11,830 h.p. could be developed, which could be utilised in 24 or a less number of hours. Anything less than 15 hours, however, would be out of the question, owing to the abnormal capital outlay involved. They also pointed out that a 14-hour scheme would mean a loss of £1,191 to the electrical department, while on a 24-hour scheme, when water is available, a saving of £613 would be effected. But the engineers were unable to recommend the installation of a plant for use during the 24 hours, inasmuch as a constant flow of water could not be guaranteed, and, together with various other difficulties, would necessitate

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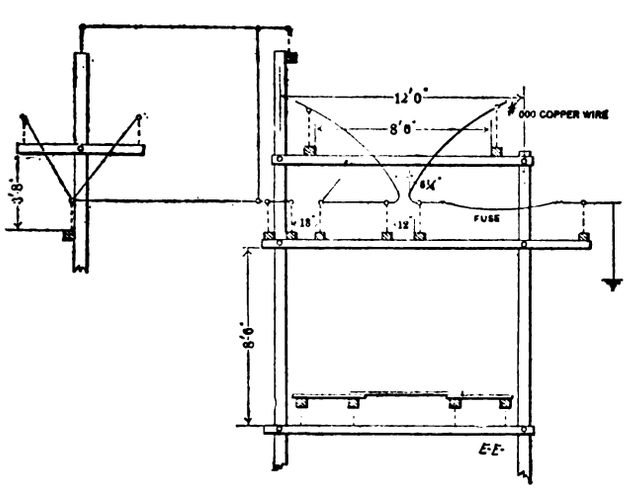
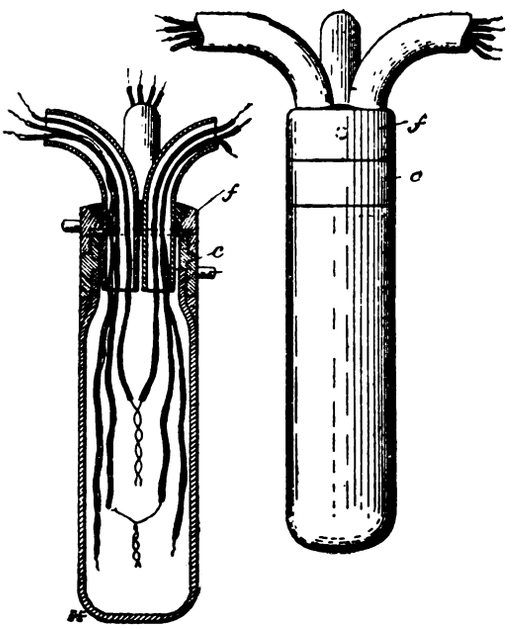
a larger capital outlay, and result in a larger annual expenditure than estimated. Under the circumstances it is not surprising to find the Council shelving the matter. The electric lighting of public streets has been extended in several directions, and the scale of charges for current was reduced to between 1s. and 1s. 6d. per unit for night current, the day units being divided by two, and then charged as night. An increased total consumption of 9·9 per cent. during the year is recorded. The cost of production of current during the first five months of the year shows a decrease as compared with the preceding year, and it is estimated that about £8,800 will be saved under this heading at the end of the year. The Council have shown much activity in dealing with the tramway arrangements, and they have insisted upon the owners of the system, the Metropolitan Tramways Company, Limited, fulfilling their obligations in respect to road maintenance and extensions. The result is that the system is in a good state of upkeep, and should the Council eventually decide to take over its working, they will find in the tramways a valuable asset. On the whole, the volume before us gives ample evidence of the Council's energy and progress.

Lightning Protection.—The October issue of the *Proceedings* of the American Institute of Electrical Engineers (vol. xxv.) contains a paper by Mr. Julian C. Smith, in which is described the apparatus installed by the Shawinigan Water and Power Company for protecting the lines running from their generating station at Shawinigan Falls to the sub-station at Joliette, a distance of 45 miles, and to the terminal station at Montreal, a distance of 85 miles. At each end of the Montreal line was a bank of Westinghouse lightning arresters of low equivalent type, and a bank of static interrupters. The number of gaps in these arresters was decided upon after a series of tests had been made to determine the lowest practicable breakdown voltage. These arresters were set to discharge at about 65,000 volts. In 1904, a bank of General Electric arresters was placed on the 50,000-volt line in the Joliette sub-station. This bank was also adjusted to discharge at about 65,000 volts. In 1904, three banks of horn arresters were installed on the Montreal line. These arresters consist of bent copper rods. The horns are spaced 6·25in. apart at the gap, this distance corresponding to a breakdown voltage of 90,000, and details of the horn lightning arrester may be seen in



the illustration. The company's experience during the past year shows that this scheme works very satisfactorily. In the opinion of Mr. Smith the horns are a valuable addition to the standard equipment, and since their installation there have been no arcs in the station, nor has any damage been caused to the apparatus. No interruption has been caused directly by lightning. On the other hand, each time the horn discharged a more or less severe short-circuit occurred, in no case, however, being severe enough to dislocate the system or to disturb the synchronous apparatus at the stations.

Cable Terminals.—A patent has been granted in the United States for a moisture-proof terminal covering for lead-armoured cables, by means of which, it is claimed, the disadvantages attached to the "wiping" process will be obviated. A description of the invention is given in the *Western Electrician*, and consists of a sleeve of lead or other suitable material forming a case covering for the splices and joints. This covering is completely closed at one end, while the other is "sweated" to a collar of brass (as shown



in the illustration, *e*), provided with a screw thread on its outer extremity to fit the internally screw-threaded lower end of cap, *f*, of brass or other metal. The cap is provided with an internal annular ledge and an extended rim above the ledge, creating, with a lead gasket resting upon the ledge, a shallow cup on the top of the complete casing. The gasket is provided with a series of holes for the reception of any number of lead-armoured cables that it may be desired to use, hot solder being poured around the cables in the shallow cup formed, preferably until the solder rises to a line a little above the top of the cap. By the use of this device it will be seen that to reach the terminal wires to make splices or tests, all that is necessary is to unscrew the brass collar from the cap, when the hollow casing may be removed and the wires exposed.

Railway Signalling.—Experiments have been carried on in America with space telegraphy and the ultra-violet light as applied to railway signalling, which have resulted in the invention of two devices for perfecting the system. One of the serious drawbacks of space telegraphy is the presence of a great number of wires adjacent to the railroad tracks which interfere with the transmission or reception of electric waves unless the aerial be at sufficient height to clear the wires, and to overcome this difficulty Mr. Isidor Kitsee describes in the *Western Electrician* a device which he has recently patented. The apparatus contemplates the use of a pole on the roof of the car, which, like the ordinary trolley pole, may be raised or lowered at will, but which can be operated automatically. In the roadbed are mounted projecting contacts which engage a lever arm at the bottom of the car. This lever arm, upon engaging the contact, is pushed over, and closes an electric circuit on the car which

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is supplied by a battery. The energisation of this circuit attracts the armature of an electromagnet therein, and releases a spring-driven ratchet wheel, one half of the periphery of which is of conducting material and the other half of a non-conducting material. As the wheel revolves, the tip of the armature glides over the conducting surface, closing a second circuit which includes a small motor driving a drum. The drum winds up the rope and draws down the trolley to clear the obstruction. When the wheel has completed its half revolution and the drum is turned sufficiently to draw down the pole, the projecting arm at the bottom of the car is again moved over by a contact on the other side of the obstruction, momentarily closing the first-mentioned circuit and again raising the armature pawl of the spring-driven wheel. This causes the armature to follow the insulated portion of the wheel, and come to rest in the first insulated notch on the periphery. The motor circuit is thus opened, and a weight on the lower end of the pole draws the latter up to the vertical position. The device is then in the original position, and the circuits are ready to perform the operation again at the next obstruction. Mr. Karl Scholz's experiments with the ultra-violet rays have proved that these rays have the property of reducing the electrical resistance of a spark-gap between two induction-coil electrodes, and the principle has been embodied by him in an ingenious train-signalling apparatus recently patented. Mr. Scholtz's idea is to provide on every train, on the front of the locomotive and the rear of the last coach, a receiving set for utilising the ultra-violet rays. The sender consists of an arc lamp connected to a dynamo on the train. This lamp is provided with a reflector which sends out a beam of light through a rock-crystal lens, which allows the violet rays to pass. The beam of violet light is capable of being projected 300m. or more. The receiving device consists of a spark-gap, which is normally too far open to admit of a discharge, but which, upon being struck by the beam of violet light from another train, will have its resistance reduced sufficiently to allow of a discharge taking place, whereby a relay is operated. The relay closes circuits for operating the air-brakes of the train, and for ringing a signal bell to attract the attention of the engineer. The receiver is fitted with a device for collecting the rays, so that the latter have an effective area of several square feet. At curves an automatic device turns the lamp so that the beam of light is always pointed at a portion of the track the desired distance ahead.

Gas v. Electricity.—Much has recently been heard as to the relative merits of these two forces, both as regards their application to domestic and industrial purposes; and the displacement of electric lamps in some parts of the city of London, together with the installation of gas lamps in Broad-street Station, are urged by partisans of the older rival as indicating its superiority over electricity. Mr. S. M. Hills in a lecture which he delivered to the members of the newly-formed Northampton Institute Engineering Society last Friday night made a comparison between gas and electricity in regard to their use as illuminants, and in the light of recent events some of his conclusions may prove of interest. The ideal illumination, he said, was that obtained by the diffusion of sunlight at the surface of a white cloud, and the nearest approach to this he considers is obtained by distributing a number of lights round a room. Thus, a room illuminated by one 16-c.p. lamp will not be so well lit as if 16 1-c.p. lamps were distributed about it. It is obvious, therefore, that the distribution of light in small elements is much more easily accomplished in the case of electrical illumination than in the case of gas, where an expensive and complicated system of pipes would be requisite. In drawing comparisons between the spectra of the sun, gas, and electric light, Mr. Hills was able to show that the latter possessed greater penetrative power, and was more like that of sunlight than was gas. Hence, in the state of the atmosphere when it is overcharged with water vapour, electricity, especially that supplied to flame arcs, far surpasses any arrangement of gas burners, or even an immense gas torch. A great consideration which weighs in favour of electricity as an illuminant is that there is practically no danger of fire by the use of current, and the speed and safety with which current can be transmitted makes it possible for spots inaccessible to gas to be illuminated. Nearly all electric fittings provide that the light is cast downward without the intervention of anything to bar the passage of a single ray, and the light can be raised or lowered from and to the place where illumination is desired without the danger of fire, inconvenience of heat, or evolution of fumes. In comparing costs, Mr. Hills based his conclusions upon personal observations and upon information supplied by reputable authorities, and arrived at the following figures worked out at city prices for gas and 1½d. per unit for electricity: double burner, ordinary low-pressure gas, 129 c.p., 11·1d., average total cost per candle-power per annum; single burner, high-pressure gas, 150 c.p., 9·0d.; double burner, high-pressure gas, 244 c.p., 11·7d.; old lantern arc lamp, 639 c.p., 8·0d.; flame arc lamp, 5·0d. The electric cost includes maintenance and interest charges, gas cost is solely for gas and mantles. In regard to the use of electricity for heating purposes, the advantages which attend it in its use as illuminant are likewise apparent. Electric heating is yet in its infancy, but further developments will greatly reduce the cost of energy for this purpose. By the use of this apparatus, however, there is a great saving in space, an absence of fumes, and freedom from vitiated air or other waste products. This is an important matter as far as purity of the atmosphere is concerned. As regards vitiating the air of a room with products of combustion, the electric heater is absolutely free from reproach, and the disagreeable effects produced by the use of a gas stove are entirely avoided. There are great possibilities of development in the electric apparatus used for this purpose, and its wider application may be looked forward to.

Newcastle Tram Strike. — Another of those unfortunate disputes between tramway employés and their masters occurred in Newcastle-on-Tyne, when 525 men in the employ of the Corporation tramways ceased work on Saturday last. The case of the dispute was a notice issued by the general manager, Mr. Ernest Hatton, to the effect that owing to the alterations rendered necessary in the winter months, and to the fact that the reliefs for the holidays were complete, the department was overstaffed with traffic employés, and that after Nov. 18 the number of days worked would be 11 per fortnight. This notice was met by the men with a suggestion that more cars should be run with a quicker service, but they gave to the management their notices that they would cease work at midnight on Friday. The Tramways Committee of the Corporation met and resolved that, if the men would withdraw their notices, they were prepared to appoint a sub-committee to meet an equal number of representatives of the men to consider the question in dispute. It was resolved further that, if the men should refuse, a sub-committee, with the general manager, should be empowered to act as they should deem best during the dispute. A mass meeting of the men was held early on

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Saturday morning, when it was resolved that they should decline to withdraw their notices until the new regulation was withdrawn. The men held another meeting last Sunday night and the following resolution was passed: "That we request the Tramway Sub-Committee to revert to the *status quo ante* and start *de novo*. Provided the committees agree to this, we will resume work on Monday morning, all grievances to be considered by a special committee and the Tramways Committee and an equal number of the tramway employés. All questions remaining unsettled to be submitted to referees." The vice-chairman of the committee (Mr. J. H. Rodgers) and other members of the committee accepted this, and the dispute was settled. It is a remarkable occurrence, though one peculiarly common to municipal management, that, in face of the tramways manager's assertion that his traffic department was overstaffed, the committee should consent to what virtually means a concession to the employés' demand. As is well known, the Newcastle tramway undertaking, whatever other excellent features it may embody, has not been a financial success, and the committee have had to cut down their expenditure in several directions in order to make ends meet. This year, however, it appears that there is a profit of about £20,000, and the employés, instigated by the paid agitator, are already clamouring for a portion. Several of the city councillors, including some of the Tramways Committee, have encouraged the men in their resistance, and it is in a large measure through their instrumentality that one of the agitators was able to exclaim that they had gained a "glorious victory" in which their "conditions were not cut down by one iota." It is needless to point out that such action on the part of sub-committee (if confirmed by the Tramways Committee) in sacrificing their general manager and submitting to the aggressive and uncompromising claims of the men cannot fail to relax the discipline of the service which Mr. Hatton's advent has done so much to restore. A private company would not be afraid to use their powers in so arranging their service as would be compatible with financial success and public convenience, and all the intimidations of salaried agitators would have had no effect in altering their decision to work on other than commercial and economic principles. We are afraid, however, that in the present case sentiment is likely to replace judgment and rectitude, and must suppose that the overburdened ratepayer and companies who pay heavy rates in support of enterprises which directly compete with their own for public favour will derive a morsel of consolation from the fact that the pet panaceas of municipal socialists benefit at least some portion of the community.

Institution of Electrical Engineers (Glasgow Local Section).—The above section of the Institution held its first monthly meeting for this session on the 14th inst. The chairman, Mr. J. M. M Munro, presided, and delivered his inaugural address, his subject being "Electricity in Civic Service." At the outset, the speaker dealt at considerable length with arguments for and against municipal trading. Then, taking Glasgow as typical of a progressive modern city, he described the beginnings, progress, and problems of its various electrical undertakings. He referred to the application of electricity to the city's fire alarms and clocks, and described the developments which had taken place in the apparatus. Going on to speak of the Corporation's two greater electrical undertakings—the lighting and the tramways departments—Mr. Munro traced the rise of these two concerns from their inception up to the present time. The electricity department's output had increased from 408,000 units in 1893 to 44,000,000 in 1905. The tramways department had 700 cars and 150 miles of track. The number of passengers carried for the year ending May, 1905, was nearly 200 millions. The total capital expenditure was abou £2. 15s. per inhabitant of Glasgow. Notwithstanding the triumphs of electric tramway traction, many of its problems still remained for solution. It was still impossible in Glasgow to recover much of the energy spent in stopping for helping to start a car. Mechanical appliances had been devised for this, but good electrical ones were now on the market. Congestion of traffic would compel them to have overhead or underground routes. The annual consumption of coal used for the generation of electricity was in Glasgow 82,623 tons. In 1915 he believed this total would have risen to 200,000 tons. These and other figures given raised several questions of policy primarily applicable to large cities: Ought the production of electricity in bulk for all purposes to be the work of one department distinct from the distributing and tramway departments? Ought such a great coal-burning undertaking to have its works outside the city? Ought great cities to acquire their own coalfields, as they have mostly acquired their mountain lochs and water-gathering areas? With regard to the first question, he would answer negatively in the case of smaller towns, but in larger cities he thought that in these specialising days it was better to put each department under management which could bestow all its attention upon one great branch. Some figures bearing upon this point were then given and discussed in detail. He did not think the removal of the generating stations beyond the city boundary would be in many cases financially advantageous. The profit margins of coalmasters, the cheaper sites, and the cost of carriage of coal and ashes were more than counterbalanced by the interest and depreciation which would be payable on cables, and the 5 to 10 per cent. loss in the long main feeders and the cost of reconversion of all instead of only the greater part of the energy. If transmission of compressed producer gas at high pressure were found to be as economical as electrical transmission of power, they might yet have the gas department responsible for the supply of fuel to the power station when gas-engines were used. Figures relating to the efficiency of gas transmission were quoted, and suggestions made regarding the generating of gas under high pressure. As to the use of water power, the city water supply could only yield 18 theoretical horse-power per foot of effective head. The Falls of Clyde might serve Lanark, but could be of little use to Glasgow. With regard to the utilisation of power from refuse destructors, while it might be wise to use their heat for the generation of electrical energy in small towns, the site and the arrangements of the city power station could only be affected disadvantageously by their modification to the requirements of refuse destruction. Yet the refuse of Glasgow might be capable of yielding over 5,000 b.h.p. for 18 hours per day and six days per week. With regard to street-lighting, much had been said of the displacement of arc lamps in Queen Victoria street, London, in favour of gas. Mr. Munro had found a pocket time-table unreadable 15 yards from the new gas lamp-posts, while at Blackfriars Bridge with flame arc lamps he was able to read the same size of printed matter 100 yards from the electric arc lamp. The displaced arc lamps, however, had been in lanterns of a singularly inefficient and hopelessly antiquated pattern. Some considerations affecting rational policy as regards district power supply and interurban electric traction were then dealt with. On the motion of Dr. Magnus Maclean, seconded by Mr. F. A. Newington, of Edinburgh, it was agreed to ask Mr. Munro's permission to print the address. There was a good attendance, and the session promises to be one of the best which the section has had.

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LONDON POWER BILLS.—I.

The Additional Electric Supply Company's (London) Scheme.

Amongst the numerous applications which are being made to Parliament for bulk supply to London, not the least interesting is that of the above company. The engineers for this scheme are Messrs. Kincaid, Waller, Manville, and Dawson, and Messrs. Harper Bros. Through the courtesy of Mr. Phillip Dawson, who is personally responsible for many of the leading ideas in the scheme, we are now able to give the following *résumé* to show in what respect this company's proposals differ from those of most power companies.

In the first place, the Additional Electric Supply Company (London) seek for powers to supply in bulk existing electric light undertakers, tramway undertakers, and railway companies. They do not ask for rights to supply the ordinary power consumer direct. This is a radical difference from the usual power company programme, which should remove the ground of much opposition from existing undertakers. The aim of the company is to supply in bulk to these existing company and municipal undertakers in a way which seems likely to have advantages for both the buyer and seller of the bulk supply. Thus it is suggested that the present undertakers should continue to use their existing plant for meeting peak loads only, and that during other times they should take a steady 24-hour load from the company. Of course this load would not be represented by an absolutely constant demand, but the load factor would be very much higher than is possible when a lighting peak has to be met. The proposed company would also serve railways and tramways, which undertakings are too large and cover too wide areas to be served commercially by existing undertakers. For instance, Mr. Dawson estimates that if the L. B. and S. C. Railway Company were to electrify all their suburban lines they would need about 60 million units per annum. With other railway companies requiring electric energy in amounts of a similar order, it will be seen that the supply of these from one undertaking involves plant of enormous magnitude.

The company propose to erect in the first instance a large power station on the River Ouse, six miles north of St. Neots, or 40 miles from London. In this station turbo-generators with a normal output of 60,000 kw., or 90,000 kw. on overload, will be installed. The actual size of the generators will be determined after powers to carry out the work have been obtained; they will, of course, be as large as can be manufactured with a certainty of successful running. In view of the fact that the General Electric Company of America are now building turbo-generators of 12,000 kw. capacity for the Chicago Edison Company, experience as to the working of such large units will soon be obtainable.

The reason why the neighbourhood of St. Neots was chosen may be summed up as follows: The River Ouse provides ample condensing water. There are numerous coalpits within from 45 to 80 miles radius from which an exceedingly cheap supply of small coal can be drawn. Lastly, but by no means least, the proposed station is close to the Great Northern Railway Company, and this company owns a strip of land adjoining their line along which wayleaves to London can be obtained, and it is proposed to carry a number of overhead wires along this strip of land, which is about one chain wide. The wires will run from the power station up to Enfield, and the voltage will be fixed at something between 20,000 and 30,000 volts. At one or two points along the line this strip of land is not continuous, and at these the company seek powers to acquire compulsorily the land needed to give them a continuous route for their overhead wires through private property. Mr. Dawson assured us that he had examined all the railway lines running out of London, and that the Great Northern Company alone had such a strip of land at their disposal. From Enfield it is proposed to continue the transmission lines underground, using the same voltage, but still railways will be followed where possible. Thus it is proposed by the company to obtain powers for wayleaves over all the railway lines in London, and also along the Regent's Canal and the River Lea Navigation. They only seek powers to break up streets in order to get mains to the works of the present authorised undertakers.

With the plant above mentioned and a 35 per cent. load factor, about 230 million units would be produced each year. The proposed system of supply might lead quite well to a higher power factor than this, and it would certainly lead to extreme economy in production. The power company being relieved from the supply of lighting peak loads could reduce the cross-section of transmission mains for a given output per annum. Again, with the proposed arrangement the present undertakers would use their existing plant for peak load only, and could shut down their stations for at least 16 hours per day even in mid-winter. Under these conditions, therefore, the Additional Electric Supply Company would be able to sell at a rate which should tempt the existing undertakers and attract to them the large private power users. The actual prices to be promised when the Bill comes before Parliament will be disclosed at a later date. The proposed expenditure on the first station and mains is £2,000,000.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.*

BY JOHN GAVEY, C.B., PRESIDENT.

(Concluded from page 700.)

CONSTRUCTION.

No marked changes have taken place in the methods of overhead construction beyond the general tendency towards the wholesale substitution of hard-drawn copper for iron wire for overhead conductors. The magnetic inertia due to the metal itself which affects high-speed results so largely when iron wires are used is, of course, absent in the case of copper. Although the first cost is higher, the scrap value of the copper when renewed is considerable, and there is the further point that when the time arrives for converting overhead telegraph circuits to telephone uses, the appropriated conductors will at once be available. In other respects there have been, of course, various improvements in details, which, however, do not need special mention.

In underground telegraphs, something approaching a revolution is in progress. It is a curious and instructive fact that the majority of the early inventors who designed or imagined methods of telegraphy contemplated the use of underground wires insulated by various ingenious methods, which, however, would scarcely have proved efficacious in practice. Further, in this country two of the great telegraph companies started with the idea of laying telegraphs underground, and very long lengths of guttapercha wire were laid in wooden casing, some of which is re-covered from time to time, and is even now found to be in excellent condition. Various reasons led to the abandonment of underground work in favour of overhead lines, and little was done in later years in the direction of providing a comprehensive underground system until the great work in Germany was initiated in the seventies. Owing, however, to the high cost of guttapercha, and to its great specific inductive capacity, the extended use of this material did not commend itself to the English Government, except, of course, in large towns, where underground work was imperative, for owing to the slow speed attainable on ordinary guttapercha underground wires, and the vast mass of Press matter that had to be transmitted by the Post Office, there was little temptation to indulge in a heavy expenditure with the object of replacing overhead wires by underground work, even though the overhead wires were occasionally subject to serious interruptions which no human skill or engineering foresight could guard against. The introduction of the modern multiple cable insulated by dry paper and enclosed in lead sheath has gone a long way in the direction of overcoming both these difficulties—viz., the financial

* Delivered at the meeting on Nov. 9

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difficulty of cost and the electrical difficulty of high static capacity.

Incidentally, it may be of interest to refer to the genesis of the modern air-space dry-core cable, for details of which I am indebted to Mr. Kingsbury. It is, of course, well known that many attempts were made years ago to obtain a cheap substitute for guttapercha-insulated wires, and these attempts generally took the direction of wires covered with cotton or other fibrous material enclosed in a pipe or tube, which was filled with a permanent insulator, either solid or liquid, such as paraffin wax or oil. At a later period paper was substituted for cotton, and it was proved that wires so insulated had a lower static capacity than those covered with cotton. It was at first assumed that this was due to the character of the paper used, but it was soon realised that the actual reason was that with the paper the insulating compound could not be forced into the tube so as to absolutely fill all the interstices, and that numerous air spaces existed throughout its length. From this to the use of the present form of cable was but a step. In cables of this type relatively large conductors weighing from 100lb. to 200lb. per mile can be provided with a static capacity of 0·1 microfarad per mile, and where a large number of wires have to be provided, at a total expenditure not very unduly in excess of that necessary for overhead wires. As soon as this type of cable became available for use, the Post Office took the initial step in the construction of a line containing 76 wires enclosed in a 3in. iron pipe from London to Birmingham, a distance of 117 miles. The line was commenced in 1897, was completed in 1899, and brought into use after preliminary experiments had been carried out with a view of determining its adaptability for the purposes of the Post Office. It was, of course, foreseen that the wires in close proximity would be subject to a certain amount of mutual disturbance, and it was doubtful to what extent this disturbance would interfere with the various methods of telegraphy in use. To provide for the worst possible case, therefore, the wires were twisted up in pairs like those required for telephone circuits, and the length of the lay of the neighbouring pairs was varied, so as to provide as far as possible for working metallic loops where necessary, either for telegraph or telephone purposes, with the minimum amount of mutual interference. The experiments proved that it was possible to work duplex on neighbouring single wires of a pair, when earthed at each end, without interference when the speed was limited to that possible with manual transmission. Quadruplex working was subject to some slight interference, but under these conditions Wheatstone working was not possible at a higher speed than 50 to 60 words per minute. The general result, however, was admirable from every point of view, and the steadiness of working and the freedom from interference by atmospheric or other causes was so great that the Portmaster-General subsequently decided to extend the London-Birmingham line to Glasgow. The question of the type of cable to be carried forward then came up for consideration. From London to Birmingham there were 38 pairs of wires. In the interval many types of paper-insulated cables had been devised with a view to obtain a form suitable for use with earthed circuits, and, therefore, to a great extent free from mutual induction, either static or electromagnetic, the ultimate outcome of which was the design of a conductor insulated with paper, each insulated conductor lapped with copper foil, and the whole of the wires cabled and sheathed with lead.

It was finally determined to continue the London-Birmingham section northwards by the laying of a cable containing 37 pairs of the ordinary paper-insulated wires as a core surrounded by 29 copper screened single-wire conductors, this decision being arrived at after it had been proved conclusively that where quadruplex or high-speed circuits were required it was possible to obtain satisfactory working with the quadruplex or Wheatstone on a metallic loop, and to superimpose thereon a key duplex. Where quadruplex is, therefore, in use on a long circuit, six channels are obtained on two wires, or a Wheatstone duplex and a key duplex can be worked on each loop. Again, it has been proved that between London and Glasgow, by the use of a repeater at Preston or Warrington, a speed of 200 words per minute can be obtained on these wires with Wheatstone apparatus, so that it will be observed that a great step has been made by the substitution of a moderately economical system of underground work, susceptible of working at high rates of speed, for the old costly and slow methods which the use of guttapercha involved where land telegraphy was concerned. The main underground line from London to Glasgow will be completed by March or April, 1906, and other important sections of main line, notably a section from London to Chatham, are in hand.

Here, perhaps, I may fitly state that the Post Office and the general public owe a debt of gratitude to our British manufacturers of electrical plant for the energetic and able manner in which they meet all requirements, however onerous, made upon them. They spare neither time, trouble, nor expense in an endeavour to meet the most difficult specifications, and it is not too much to say that without their assistance this record of modern progress could not have been realised. I render this tribute all the more willingly because it has lately become the fashion for irresponsible writers in the public Press to decry the British manufacturer as old-fashioned, not up to date, and not ready to meet modern requirements. I can truthfully say I have nowhere met reputable firms exhibiting this spirit.

Telephones.

Not the least remarkable of the modern developments of electrical engineering is the extraordinary growth of the telephone service throughout the whole of the world. Subsequent to the year 1860, when Reis invented his musical telephone, it was thought by the majority of electricians that no further approach towards the attainment of articulate speech could be made. The possibilities attending the use of loose contacts, at that time the most dreaded enemy of the electrical engineer, had not been foreseen, and the conclusion was generally arrived at that it would be impossible to devise a transmitter free from the defect of causing actual breaks in continuity so as to admit of the delicate curves necessary for the transmission of articulate speech being reproduced electrically. Bell's invention in 1876 was received almost in a spirit of incredulity, and when in the following year it was brought to this country, it was looked upon as a marvellous development. Although as a receiver the instrument was even then practically perfect, its powers as a transmitter were weak, but the invention of the microphonic transmitters in 1877, by Edison in America and Hughes in England, speedily led to the development of the telephone on commercial lines. Kingsbury has told us in his paper read before the Institution in January, 1895, how in 1878 the first telephone exchange was started in London, the old telegraph Umschalter switch having been utilised for the purpose. For many years the service was necessarily imperfect, gauged by modern standards, as for a long period open wires carried overhouse had to be resorted to, and single-wire circuits were practically a matter of necessity at large exchanges, the result being that cross-talk could not be eliminated, and comparatively inefficient transmitters were used in order to reduce the amount of this disturbance. The invention and development of the modern paper-insulated air-space cable, with its low electrostatic capacity, led to the general adoption of the one main factor in satisfactory telephone working—viz., the use of well-insulated metallic circuits so constructed as to be free from cross-talk. This opened the door to the use of the very best types of telephone transmitter, and paved the way for the successive improvements in exchange plant that are so marked a feature in modern systems, and that have led to the extraordinary increase in telephone statistics that has taken place in the last 10 years.

As the result of successive inventions, a steady and rapid improvement in the indoor plant available for exchange work has taken place, and so far as modern telephone switch is concerned, these improvements have been wholly in the direction of reducing the amount of talk on the part of the operator that was necessary under the old conditions. This has been brought about by the provision of a complete system of automatic signalling, whereby she is kept abreast of her work, so that, with the exception of asking for the number of the subscriber who is wanted, there should in all ordinary cases be no need for conversation

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between the subscriber and the operator, this being accompanied by a corresponding increase in the speed of working. In fact, one system goes so far as to render it unnecessary even to ask for the number of the subscriber required, that information being printed by the caller on a Morse slip. This tendency to reduce the operators to a species of intelligent automaton naturally suggests the possibility of the entire elimination of the operator, and the introduction of suitable automatic apparatus at the exchange. Several very ingenious methods of attaining this end have been devised, and one system has achieved a certain measure of success in America, several exchanges of some magnitude having been equipped with apparatus of this type. Two or three small automatic switches have been installed in Europe, but no European telephone administration has yet faced the problem of establishing an extensive automatic system for the use of towns in which large exchanges are required. To review the reasons for the hesitation so far displayed by the more important of the telephone authorities would be to introduce controversial matter, which would be out of place. The subject is, however, not exhausted, for it is being carefully studied at the present time in America, and there appears to be some possibility of development in the not distant future that may lead to important modifications in present methods.

One word may here be added as to the magnitude of the plant required for modern exchange working. There appears to be an occasional tendency to look upon telegraphs and telephones as a little apart from serious engineering undertakings, because in the actual transmission of telegraphic signals or telephonic speech minute currents measured in milliamperes and microamperes generally suffice. The movement of electric railway trains and street cars or electric cranes, of electric gun-training machinery, and other similar mechanical work, impresses the imagination far more vividly than does the still small voice that is heard in a telephone, but when modern telephone practice is considered it will be found that in the complexity of the system, the amount of electrical energy used for the purpose of signalling, and the extent of the works undertaken, a telephone system regarded from the engineering standpoint is in no degree behind any other electrical enterprise. As an illustration, it may be stated that in carrying out the preliminary arrangements for serving about one-third of the metropolitan area the Post Office has already excavated 564¼ miles of trench, it has laid 1,251 miles of duct, it has provided 162,216 miles of wire, and the weight of copper buried in the London streets amounts to 2,200 tons; and this apart from the work carried out by the National Telephone Company in the same districts. The secondary cells used for signalling and common battery speaking at the Central Exchange have a capacity of 5,500 ampere-hours, and the number of glow lamps in use on the existing Central Exchange for signalling purposes is 25,000. It may be added, however, in illustration of the growth of the system, that the first contracts for the Post Office system in London were entered into on Feb. 24, 1900, and the first exchange was opened on Feb. 24, 1902, with 169 subscribers, the ultimate capacity being 14,000 subscribers. Its growth was so rapid that within two years of its being opened it became necessary to commence the installation of a second exchange which is being constructed within the same building and which will shortly be opened with a further capacity of 20,000 subscribers, a corresponding enlargement of the general appliances in the building being involved.

Perhaps the most remarkable development that has taken place in the whole world is that which in the last few years has arisen in America. In the early portion of my address I referred to certain statistics furnished by the American Bureau of the census. The growth in the number of telephones provided by the American telegraph and telephone companies (commonly known as the Bell Companies) in the United States of America, as shown by the curve on the screen, is absolutely startling. I visited America in 1898, at which date the company had about 400,000 stations open. I have just returned from another visit, and find that they have 1,950,000 stations at work, an increase of 1,450,000 in seven years, and they are still progressing at the same pace. Domestic and other reasons appear to foster the use of the telephone. The number of private houses provided with these modern appliances bears a very high ratio to the number of business premises in which they are installed. All the large hotels have telephones in every room, a central switch connected to the main exchange being located in the hall. Large shops have installations varying from 250 to 1,000 telephones, these in some cases being scattered along the counters so that customers can telephone from their houses direct to the shop assistant whom they know to be acquainted with their wants or fancies.

The most important adjunct to the local exchange system is the trunk line or long-distance service, as it is variously called. In 1896 the Post Office acquired, by purchase, such of the trunk lines as had been erected by the National Telephone Company, and not only did it at once erect such additional wires as were necessary to provide a comprehensive service covering the whole country, but it has been engaged year by year in erecting additional trunks. Such is the favour with which the trunk service generally is regarded, that it is difficult to keep pace with the demand for additional wires. The annual growth is represented by the following figures:

Year ending March 31.	Circuits.	Miles of wire in actual use.
1896	165	17,500
1897	804	47,855
1898	877	55,721
1899	953	63,109
1900	1,039	69,713
1901	1,116	76,831
1902	1,165	83,302
1903	1,309	93,473
1904	1,418	102 799
1905	1,604	112,744

The determination of the distance over which telephonic speech is possible on various types of telephone circuit is a question of the greatest theoretical and practical interest, and it is one that has received much careful consideration. The theoretical investigations of Clerk Maxwell, Kelvin, Oliver Heaviside, G. A. Campbell, Pupin, and others have done much to elucidate the problem under consideration, and we are now, I think, fairly well acquainted with the various factors that govern and limit the range of possible speech, and the methods by which these limits can, under favourable conditions, be extended; such, for example, as the partial neutralisation of the effects of static capacity by the addition of self-induction. In connection with the transmission of telegraphic signals through long cables, it will be borne in mind that Lord Kelvin, in the year 1854, enunciated the K.R. law, and at first attempts were made to apply this law to telephonic work. Now, the simple K.R. law applies with some degree of accuracy to telephonic cables in cases in which wires of approximately the same gauge are concerned, but it fails in cases in which the electrical constants R, K, and L vary materially, and it is quite inapplicable as part of a general law to open lines where self-induction is a marked factor or where the conductivity of the wires varies materially. As illustrating this, the observations made by the able staff of the Bell Companies in America show to what extent the K.R. law fails (see Table A).

It was quite evident that the K.R. law failed owing to no account being taken of the important factor L, and on comparing a large number of results obtained over Post Office lines of different character the following rough empirical formulæ were designed to meet ordinary cases. As will be seen further on, these were found to give fairly concordant results within certain limits.

Aerial lines of 100lb. copper and upwards:

$$M = 210\sqrt{\frac{l}{K.R.\ 1{\cdot}75}}.$$

For unloaded paper cables

$$M = 85\sqrt{\frac{l}{K.R.}}$$

where M = limits in miles.

Before dealing with the more recent formulæ now in use for determining the limiting distances of speech, it may be well, perhaps, to refer briefly to the theoretical conditions

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TABLE A.—TABLE OF EQUIVALENT CIRCUITS

Type of circuit.	Loop resistance per mile. Ohms.	w/w capacity. Microfarads.	Long-distance standard of commercial talk. Length equal to 1,200 miles No. 8 B.W.G. open wire. Miles.	Long-distance standard of commercial talk. K.R.	Local service standard of commercial talk. Length equal to 750 miles No. 8 B.W.G. open wire. Miles.	Local service standard of commercial talk. K.R.
100lb. copper aerial	17·73	·007825	388	20,884	253	8,880
176lb. ,, ,,	10 26	·008218	560	26,443	360	10,927
425lb. ,, ,,	4·08	·008978	1,200	51,027	750	20,604
American standard cable	88·00	·051	41·8	7,842	26	3,034
Boston-Lynn cable	41·80	·042	73·2	9,407	45·5	3,635
London-Birmingham cable	11·00	·063	115·0	9,165	71·5	3,543

TABLE B.—TABLE OF EQUIVALENTS BASED ON ATTENUATION AND EMPIRICAL FORMULÆ RESPECTIVELY TESTS MADE WITH THE STANDARD APPARATUS DESCRIBED IN THE SCHEDULE TO THE AGREEMENT DATED 1905, BETWEEN THE POST OFFICE AND THE NATIONAL TELEPHONE COMPANY.

Type of line.	Constants per mile of loop. R. Ohms.	K. M.F.	L. Henries.	No. of miles of various types of conductors giving equal transmission to one mile 20lb. cable. (Calculated from Pupin's and Campbell's formulæ.)	Limiting distance based on speech limit of 43 miles standard cable. (Calculated from preceding column)	Limiting distance based on empirical formulæ.	Limiting distance based on speech limit of 43 miles standard cable. Observed experimental values.
Underground A.S.P.C. Cable—				Miles.	Miles.		
10lb. cable	175·64	0·07	0·001	0·61	26	25	26
20lb. ,,	86	0·055	0·001	1·0	43	43	43
40lb. ,,	42	0·056	0·001	1·47	63	66	63
70lb. ,,	25	0·063	0·001	1.83	79	72	—
100lb. ,,	17	0·058	0 001	2·45	105	91	—
150lb. ,,	11·7	0·065	0·001	2·95	127	113	127
200lb. ,,	8·75	0·07	0·001	3·5	151	150	—
Submarine Cable—							
160lb. Cu. and 300lb. G.P. per knot	12·9	0·12	0·00165	2·3	99	97	88
G.P. Quad—							
40lb. Cu. per mile	43	0·128	0·001	0·95	41	36	39
Aerial Wires—							
180lb. Cu. open	18	0·00808	0·0039	8·45	363	357	—
150lb. ,,	11·9	0·00839	0·00376	11·7	503	490	473 Means of several trials.
200lb. ,,	9	0·00862	0·00366	14·7	632	613	626
300lb. ,,	6	0·00893	0·003545	21	903	844	903
400lb. ,,	4·5	0·00919	0·00344	26·1	1,122	1,056	1,075
600lb. ,,	2·97	0 00958	0 00331	36·8	1,582	1,443	1,582
800lb. ,,	2·25	0·00987	0·00322	45·8	1,969	1,804	Not determined owing to disturbance.

which affect the transmission of telephonic impulse. The ordinary electrical conditions in a circuit which may modify or effect an impulse *in transitu* are the following: (A) resistance; (B) electrostatic capacity; (C) self-induction; (D) insulation; (E) abrupt and numerous alterations in the circuit which may cause reflection; (F) interference from extraneous cause — *i.e.*, static or magnetic induction, leakage, etc.—from neighbouring circuits.

When an electrical impulse is started in a conductor, if the latter had neither resistance, capacity, nor self-induction, and if the insulation were perfect, the wave would move on without attenuation or distortion. The effect of resistance or of uniformly distributed low insulation, however, results in a definite attenuation which increases with the length of the circuit, and, further, the effect of capacity is to cause the wave to spread out, both forwards and backwards, this "talling," as it is termed, not only increasing the attenuation by lowering the amplitude, but causing distortion of the wave itself and also of the neighbouring impulses, with which it interferes. This distortion eliminates the higher notes and harmonics, and in extreme cases causes the voice to lose its characteristic tone, and ultimately to become inarticulate.

Now, it is obvious that it is a matter of extreme importance to ascertain to what extent each of these elements affects in the most material manner the limiting distance of speech, and much light is thrown on this subject by actual experiments made over long lines of various characters—overhead, underground, and submarine. As the result of many trials, it is found that with long circuits free from external disturbance, such as underground wires, the actual practical limit is fixed by the loss of amplitude of the waves—in other words, by the diminution of volume rather than by the loss of articulation—although when these limits are approached it is found that articulation begins to suffer, and when the line is still further increased, the tone becomes low and hoarse, and speech ceases to be practicable. This points to the fact that in actual practical work attenuation due partly to resistance and partly to electrostatic capacity are the dominant factors, and this attenuation when combined with disturbance from neighbouring electrical conductors actually determines the limits of speech. This view is supported by a comparison of the results obtained by calculation and those obtained by actual experiment. That in actual practice articulation is not materially affected up to the point when the volume of sound becomes too small for practical purposes is probably due to the fact that the inherent self-induction of an ordinary circuit suffices to prevent such an amount of distortion as might otherwise interfere with articulation at more moderate distance than those already experienced. Oliver Heaviside, in his "Electrical Papers" (vol. ii., p. 393), showed the extremely limited range of possible speech in paper cables, assuming an entire absence of self-induction in a closely twisted-up pair, and the extent to which this range is extended even by the limited self-induction which obtains in normal conditions. He thus early anticipated the practical results already referred to. At all events, calculations giving the limiting distance of speech on various types of conductors, based on attenuation only, are found to agree with actual experimental facts. The remaining factors, although they must have some influence on the results, can in practice and under conditions which obtain in a simple metallic circuit be neglected.

As a preliminary to the determination of the limits of speech, it is necessary to ascertain the degree of volume and articulation, or, in other words, the audibility, which may be accepted as satisfactory, and, further, to establish standard circuits with well-known constants of R, L, and K to which all lines may be reduced either by calculation, by experiment, or preferably by both. For this purpose, both in America and England, one of the types of ordinary lead-covered paper-insulated cables, in which the above con-

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stants are measurable, has been selected, and the dimensions of the English standard cable, which agree closely with American figures, are as follows: English — gauge, 20 S.W.G.; weight, 20lb. per mile; diameter, 36 mils; R (loop), 88 ohms; K wire to wire, 0·056 microfard; L, 0·001; insulation, 200. Now, in actual practice a telephone on an exchange circuit must be thoroughly effective whether joined through to another circuit a few yards in length or connected to a long-distance line some hundreds of miles long, but obviously it is quite unreasonable to expect that the conversations shall have the same volume and articulation in both cases, and, of course, when a long-distance line approaches the limits at which it is possible to converse, it is absolutely essential that the apparatus and lines shall be in the best working order, that each speaker shall raise his voice and speak distinctly and close to the transmitter, and that both correspondents shall have their apparatus in fairly silent rooms.

In considering this question from the practical point of view, it is necessary to take into account the variable conditions under which long-distance speech is frequently held. The insulation of long overhead wires may in this climate drop in extreme cases to a figure as low as the metallic resistance of the conductors themselves; slight inductive noises are never really absent, and occasionally they preponderate. In a paper on trunk telephones which I read before the Institution in November, 1896, I pointed out how difficult it was to obtain even an approximately perfect static balance between a telephone circuit and neighbouring wires subject to rapidly varying potentials. Again, the human element largely affects the result; indistinct and muffled speech, disregard of regulations in the use of apparatus, partial deafness, apparatus in noisy and unsuitable localities, all tend to limit long-distance speech, and to render the application of very accurate determinations difficult. In fact, it may be said that the limits of error in calculation, whether the empirical or the more accurate formulæ referred to later are used, are less than the limits of variation in practice, and that, as in all engineering matters, there must be a considerable factor of safety to ensure satisfactory intercommunication. Telephone administrations have carefully considered what are the extreme limits of effective commercial speech under the last-named conditions, and it is generally considered that from 42 to 46 miles of the above-named standard cable is the effective commercial limit, although conversations have been held by experts over 60 miles of such a cable.

This being accepted, two methods can be adopted for determining the limits of speed on various types of telephone circuits. In the first place, the attenuation is calculated for various types of cable, say, by Pupin's formula, in which the insulation, R, is so high that attenuation by leakage can be neglected, or by Campbell's formula for overhead wires when leakage must be assumed. By the use of these formulæ, tables of ratios which express the relative equivalence of each type of circuit to the standard cable are prepared, and the limit of commercial speech having been fixed in miles of standard cable, the limit on all other types of conductors is a simple matter of calculation. The second method, of course, consists in a direct comparison of all existing types of line with a standard cable. A lengthy series of experiments has been made on all classes of Post Office conductors—overhead, underground, and submarine—and they have been balanced by means of a standard apparatus to their equivalent lengths of actual standard paper cable. The equivalent lengths have also been calculated by Pupin's and Campbell's formulæ, and Table B shows the degree of concordance in the results, as also corresponding figures based on calculations made by means of the empirical formulæ already referred to. It will be observed that the calculated limits of speech based on attenuation agree absolutely with experimental results on all the underground cables. There are, however, variations in the calculated and observed results obtained on overhead lines, and these are no doubt due to variations in insulation and to slight disturbances which affect the audibility materially when approaching the limits.

Another method of investigating the problem of telephonic transmission has been undertaken at the Post Office, and although the experiments are not complete, I propose to attempt to show some of the results which exhibit graphically the attenuation which in practice takes place under varying conditions. Two circuits have been selected, one consisting of a mile of the standard cable already referred to, and the second consisting of 20 miles of similar cable. A Duddell's oscillograph has been used for observing simultaneously the curves due to the action of the induction coil at the transmitting end and the corresponding curves at the receiving end of the circuits. A number of letters, both vowels and consonants, have been rapidly spoken into the transmitter, and the respective transmitted and received curves for each have been recorded in the usual photographic manner. The results are not, I fear, quite so distinct as I could wish, but there are considerable difficulties in manipulation, which, perhaps, may be overcome later. One, for instance, is due to the great difference in amplitude of the curves at opposite ends of the long length of cable. The spot of light in the transmitting end travels over a longer range than at the received end, and the photographic exposures, therefore, vary in the inverse ratio of the amplitudes. However, I hope enough will be seen to make this line of investigation clear, and to prove to some extent the accuracy of the foregoing data. It will be seen that on the one-mile length the curves at opposite ends are almost counterparts one of the other, the difference of amplitude being inappreciable, and all the irregularities of each transmitted curve being faithfully reproduced at the distant end. Where, however, the longer length of cable is introduced, the difference of amplitude is most marked, and although it is perhaps somewhat more difficult to compare the shapes of the two curves, they still bear a substantial resemblance one to the other. I hope that when some of these curves have been carefully traced it will be possible to reproduce them in the *Transactions* in a more distinct form than is possible under present conditions. It will, no doubt, be observed that this method of reproducing the curves due to specific sounds affords a great improvement on the old phonautographic method. In the latter the sharp peaks on each curve which may be observed on the best of the slides just shown are all rounded off in most of the published illustrations, and no other result can be expected where levers are used to increase amplitude. The oscillographic method of producing these curves should be of considerable use in the study of vowel and other elementary sounds.

It is, of course, obvious that any marked improvement in the normal types of telephone apparatus will tend to extend the ranges given in the tables. Further, it will be observed that these ranges are based on a 43-mile limit of standard cable, although under favourable conditions, and with expert users of the telephone, much longer distances are practicable. These limits also presuppose that the telephone is joined directly on to the line, and they have to be cut down when the exchange apparatus and the subscriber's line are added, by an amount equal to their equivalent mileage Such tables as these admit of a determination of the gauge and type of conductor necessary to serve any given locality, it being borne in mind first that in a country like Great Britain, where main trunk lines pass through towns of considerable size every few miles apart, it is difficult to carry heavy-gauge wires intact from one extremity to the other—*i.e.*, lighter gauge open wires and underground work have to be introduced in sections to overcome obstacles, and, further, that telephonic communication differs from telegraphic in so far as this, that where the former is concerned any given town may require to be put through to any other town within the general telephonic range of the service. It is, therefore, obvious that in laying-out and adding to a system of telephone trunk communication, the extended use, either of small-gauge conductors or of underground work generally, is absolutely inadmissible. Such conductors with limited range can only be used under well-defined conditions. It follows that to provide an efficient and economical service it is necessary to make a careful study of the country as a whole and to lay out the trunk lines in such a manner as to deal with the maximum traffic with the minimum weight of copper, and to provide for general intercommunication by the shortest possible lengths of trunk circuit. It will,

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of course, be borne in mind that the foregoing remarks apply to unloaded circuits—*i.e.*, those not fitted with artificial inductances. Incidentally, the following curves may be of some interest. They represent measurements made with a sechometer on various types of loop, and they illustrate very graphically the fact that on short lengths the self-induction predominates largely over the capacity. As the length of circuit increases the curve first rises, but as the capacity effects increase more rapidly than the inductances, the curve reverses and falls until a point is reached in which the self-induction and the capacity neutralise one another.

I have already referred to the question of increasing the self-induction of telephone lines by the addition of induction coils at definite lengths. In America the question has been dealt with by Dr. Pupin, and considerable work has been done in that country in the direction of loading underground cables, as it is termed. The Post Office took up the subject at an early date in connection with its main underground lines, and a marked measure of success has already been obtained. In one case that may be taken as an illustration a cable containing 56/100lb. conductors, was loaded by the insertion of coils at intervals of a mile; the original factors were R = 17 ohms, K = 0·053 microfarads, L = 1·4 millihenries, and the total added inductance per mile amounted to 40 millihenries, the original R being raised to 21·34 ohms per mile by the addition of the coils. The equivalent range of speech was, however, increased from 66 to 176 miles. In the Post Office experiments on its long-distance lines so far, the use of iron in any portion of the coils has been found to be deleterious as compared with coils without iron cores. True, the volume of sound was always materially raised where iron was used, but at the cost of articulation, whilst a judicious addition of self-induction without iron always improved both the volume and the articulation. Very satisfactory results have, however, been obtained in America and in Germany by the use of ring-coils with extremely fine iron cores, and further progress in this direction may be anticipated. On this subject a valuable paper was read by Dr. Hayes at the recent congress in St. Louis, in which he shows how under suitable conditions the attenuation in long lines is materially diminished by the addition of suitable inductances properly spaced. His paper is a valuable contribution to our knowledge of the subject. Experiments with overhead conductors have not proved so satisfactory as with underground cables. The variation in the insulation of the open wires upsets the balancing due to the coils, and lightning troubles have affected the coils. For the present, at all events, this method of increasing the range of open conductors of limited gauge cannot be considered so satisfactory as the corresponding results with underground work, and opinions as to the future of open wire loading appear to be somewhat divergent.

Unsolved Problems.

Finally, there are the unsolved problems in connection with electrical methods of communication to consider. These are neither few nor unimportant. Dealing with the different heads of my address in order, the telegraphic problem is by no means finally solved, notwithstanding the years which have elapsed and the growth of the system since its introduction. A means whereby telegraphic messages can be received at high rates of speed in type or written character ready for immediate issue to the public or the press appears to be one of the desiderata of the future. That this need is fully realised is shown by the ingenious inventions that have from time to time been received and experimented with by the most important of the telegraphic administrations in Europe and America. Incidentally, I think I may truly say that one of the most painful duties imposed on the heads of a telegraph service is the rejection of inventions on which an untold amount of skill and labour have been expended, but which for one reason or another are not fully adapted for practical requirements. I have reason to hope, however, that we are now within a measurable distance of a satisfactory solution of one branch of the problem just referred to.

Next, in wireless telegraphy, there is the difficult problem of perfect tuning which will obviate all mutual disturbances between different wave-lengths, and, in addition, it can, I think, scarcely be said that we have arrived either at finality in the matter of wireless receivers. In fact, the impression left on one's mind after a study of all the methods so far evolved is that we are even now far from having a thoroughly effective or reliable receiving arrangement, if we compare the reliability of wireless with that of telegraphic or telephonic communication. Then in telephony there are at least two fundamental problems which await solution: first, the invention of an effective telephone relay or repeater; and, secondly, a method of extending the range of communication in submarine cables. In reference to the existing practical limits of speech on circuits of different types, it will be evident that these limits are such that it is not always possible to meet the requirements of the public over Continental areas of great extent, or in cases where long submarine cables are necessary. Until recently all attempts to design a satisfactory telephone relay had failed, but the American Telegraph and Telephone Company have now under trial an instrument termed an Exalter, which, when placed in a suitable position on a long line, materially improves the communication. I tried this recently between New York and Chicago, and I hope shortly to have an opportunity of experimenting with it on our long-distance lines and cable circuits. It is the first step that costs, and we may now look forward hopefully to other developments.

Notwithstanding the very great advances made in the modern switchboard, the problem of affording intercommunication between very large numbers of subscribers is by no means finally solved. The largest multiple that can be fitted in practice on one board does not exceed 20,000 lines, and not only in London, but in several American towns, provision is being made in one building for numbers varying from 40,000 to 60,000 telephones, two or three separate exchanges being provided in one building. That this duplication and triplication of exchanges is the final solution of the problem no one would, I think, venture to predict, and, as I have already hinted, there are indications that the difficulty may be met in another manner. The submarine cable problem for telephonic use is not an easy one, as guttapercha, which, so far as our present experience goes, must be used in some form, has such a relatively high electrostatic capacity that it has not been found practicable to use it for really long cables, and the problem of loading, which at first sight would appear to offer a solution of the difficulty, has not yet been met in a satisfactory manner. Again, although much has been done in the direction of improving the methods of telephone switching—and only those can judge what progress has been made who are familiar with, for example, the modern central battery board, and can compare its working with that of the older forms—still we are by no means near finality, and there are possible improvements and modifications looming in the not distant future which may profoundly modify our present practice.

Finally, I have little doubt that the progress of electrical means of intercommunication will in the future go on unchecked, and that those associated with and responsible for such progress will in the course of the next few years bring about such developments that they will be in a position to compare in no unfavourable manner the advance of these particular branches of our work with that which we can foresee in all other branches.

SOME OBSERVATIONS RESPECTING THE RELATION OF STABILITY TO ELECTRO-CHEMICAL EFFICIENCY IN HYPOCHLORITE PRODUCTION.*

BY W. POLLARD DIGBY, A.M.I.E.E.

Any person referring to Herr Viktor Engelhardt's encyclopædic monograph on hypochlorite production, and examining in detail any of the tables or curves, cannot but be struck by the fall in the yield of available chlorine per kilowatt-hour as the amount of available chlorine in the solution increases. Diagram No. 1 is a reproduction of a typical instance. Curve A represents the falling

* Paper read before the Faraday Society, Oct. 31.

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current efficiency in percentages of the theoretic yield; Curve B represents the energy efficiency in kilowatt-hours per kilogramme of available chlorine; while Curve C represents the salt consumption in kilogrammes of sodium chloride per kilogramme of available chlorine. To these curves the writer has added the curve marked D, which, for the given solution, shows the percentage between the chlorine present in the solution as sodium chloride, and the smaller quantity which has been converted into available chlorine in the form of sodium hypochlorite. This curve depicts an obviously unsatisfactory state of affairs, when one considers that at the finish of the run only 17·48 per cent. of the chlorine initially present has been converted into hypochlorite.

Examinations of other tables show that the fall in current efficiency for the same apparatus, with the same specific gravity of solution, varies with the difference of potential between anode and cathode, or, in other words, with the distance between the electrodes if these remain constant in area. A particular example occurs on p. 136 of Engelhardt's book, where in Fig. 147, with a 24·5 per cent. sodium chloride solution, the current efficiency falls to 50 per cent., when the available chlorine present has reached 9 grm. per litre, the voltage being 4·0. By increasing the voltage to 5·5 the current efficiency does not fall below 50 per cent. until the available chlorine amounts to

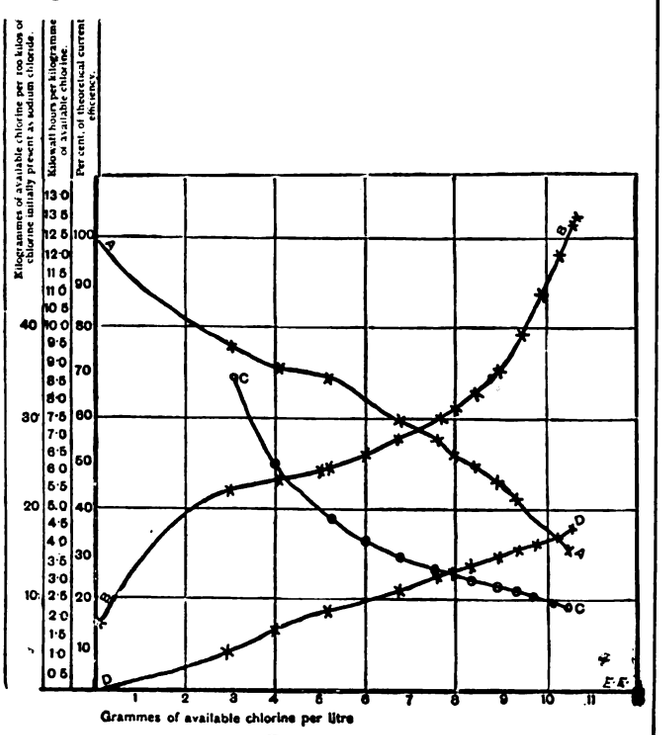

DIAGRAM 1.

15·2 grm. per litre. Raising the voltage still further to 6·5, the current efficiency remains above 50 per cent. until a strength of 17 grm. per litre is reached.

One hypothesis to account for this state of affairs would be that, other factors being constant, the amount of available chlorine produced from a sodium chloride solution depends upon the amount of unconverted sodium chloride actually present between the electrodes. In support of this view, the succeeding diagram in Herr Engelhardt's book may be referred to. In this is shown the effect of keeping the voltage constant at 5·5 volts, and increasing the amount of salt in the solution. The following figures are abstracted from that diagram.

Percentage NaCl in solution.	Strength attained in grammes of available chlorine per litre before current efficiencies fall to 50 per cent.	Percentage of chlorine in solution as sodium chloride converted into hypochlorite.
6·0	2·9	7·9
10·0	8·2	13·6
17·0	11·5	11·1
24·5	15·3	10·4

A comparison of the first and second columns shows that by regarding 50 per cent. as the critical point in the fall of the current efficiency, the maximum strength in available chlorine which can be attained before this point is reached increases with an increase in the density. The third column shows that a further explanation of the falling efficiency is necessary, as in the four cases cited the percentage of the salt converted into hypochlorite is by no means constant. A partial explanation may be afforded by a study of the stability of the solution, and in a consideration of the ratio of the volume of the electrolyte to the amount of electrical energy required per hour.

The factors which go to produce a really stable solution of sodium hypochlorite, such as a solution which, kept in a dark amber-coloured glass-stoppered bottle, will only lose 5 per cent. of its strength per annum, or which, when standing in an open tank exposed to the air, will only lose one-half of 1 per cent. of its strength in 28 days, are numerous. Of these, temperature during manufacture is of supreme importance. The writer has also found it generally advisable to sacrifice a large part of a possible high electrochemical efficiency, and work with lower efficiencies when desiring to produce stable solutions. In cases, however, where the solution produced can be supplied almost immediately, as in the sterilisation of sewage effluents, or in the

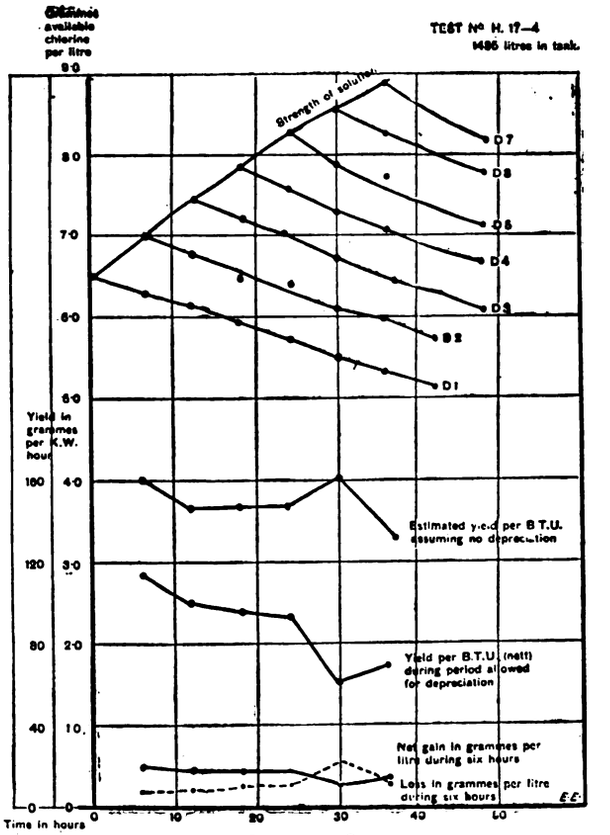

DIAGRAM 2.

bleaching of the materials used in papermaking, a small percentage of instability is practically immaterial so long as the ratio of storage capacity to the dynamo output remains small, say five times the hourly quantity of solution produced. If, as in a case recently investigated, the storage capacity represented from 50 to 70 times the average output, a depreciation in itself relatively small, absolutely prevents the commercial production of solutions containing 7 or 8 grammes of available chlorine per litre.

Attention was called to this matter by the fact that on one run with 2,250 litres of saline solution of a specific gravity of 1·086, it took four hours to increase the strength from 7·847 grm. of free chlorine per litre to 7·867 grm., during which time 4·688 kilowatt-hours were supplied to the electrodes in the tank. This amounted to a net increase of 45 grm., or less than 10 grm. of free chlorine per Board of Trade unit. A sample taken at the commencement of the four hours was found to have lost ·337 grm. per litre in four hours. Nearly the whole of the electrical energy supplied was, therefore, required to balance this total loss, 758·25 grm. in the tank. The real electrical efficiency (assuming that no depreciation had taken place) would thus have been in the neighbourhood of 171 grm. per kilowatt-hour. Subsequent analysis showed this

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abnormal rate of depreciation (of nearly 1 per cent. per hour) to be due to the presence of certain metallic impurities in the electrolyte, and special precautions were taken to reduce the amount of these in the succeeding trials of this type of electrolyser. If, however, the ratio of storage to hourly output had been within the limits suggested by the writer, this depreciation would not have proved an insuperable bar to the obtaining of a 10-grm. or 15-grm. solution on a commercial scale.

For working under the conditions ruling when the writer was conducting his tests, it became necessary to take special precautions to remove such impurities from the electrolyte. These precautions were fairly effective, but did not by any means eliminate the deterrent effect of the depreciation on the economic production of solutions containing from seven to ten grammes of available chlorine per litre. The following table gives the observations taken during six-hour intervals on test No. H. 17-4. Certain of the results are depicted on diagram No. 2. The upper part of the diagram shows the gradual increase in the amount of available chlorine present per litre, and the curves set off from this, D 1, D 2, etc., the strength at succeeding six-hour intervals of samples taken. These were placed in bottles, which were suspended in the electrolysing tank in order that they might be subject to the same conditions of temperature, etc, as the main volume of the electrolyte. It may be mentioned that the temperature of the electrolyte remained constant at 13·5deg. C., while the temperature of the surrounding atmosphere varied from 17deg. to 20deg. C.

TEST No. H. 17-4. 1,485 Litres in Tank.

Power supplied in B.T.U. during period.	Grammes of available chlorine per litre present in solution		Net grammes of available chlorine produced, *i.e.*, gained during period.		Grammes of available chlorine lost, *vide* depreciation best in period.		Estimated production assuming no depreciation.		Time between Tests.
	At start of period.	At end of period.	Total quantity. Grammes.	Net gain per kilowatt hour. Grammes.	Grammes per litre.	Total grammes in tank.	Total grammes per litre.	Yield in grammes per kilowatt hour.	
6·48	6·5	7·0	742·5	114·6	0·20	297·0	0·70	160·4	6 hours
6·48	7·0	7·44	653·4	100·8	0·20	297·0	0·64	146·6	6 hours
6·54	7·44	7·86	623·7	95·3	0·23	341·5	0·67	147·5	6 hours
6·54	7·86	8·27	608·8	93·0	0·26	386·1	0·67	147·5	6 hours
6.60	8·27	8·54	400·9	60·7	0·45	668·2	0·72	162·0	6 hours
6·60	8·54	8·85	460·3	69·8	0·28	415·8	0·59	137·7	6 hours

The next table, together with diagram No. 3, gives details of another run in which a larger volume of electrolyte was used, amounting to 2,038·5 litres. In this case the figures are given from the start of the run instead of for the end portion, as shown in Diagram 2. The depreciation tests were taken at 12-hour intervals. Owing to the precautions mentioned, the electrolyte contained fewer impurities, and the solution generally was more stable; owing, however, to the greater volume of the electrolyte, the net gain per kilowatt-hour was in the latter stages greatly inferior.

TEST No. H. 21-4. 2,038·5 Litres in Tanks.

Power supplied in B.T.U. during period.	Grammes of available chlorine per litre present in solution.		Nett grammes of available chlorine produced, *i.e.*, gained during period.		Grammes of available chlorine lost *vide* depreciation test in period.		Estimated production assuming no depreciation.		Time between Tests.
	At start of period.	At end of period.	Total quantity.	Nett gain per kilowatt hour. Grammes.	Per litre.	Total grammes in tank.	Total grammes per litre.	Yield in grammes per kilowatt hour.	
12·08	nil	1·50	3,058	253·1	—	—	—	253·1	12 hours from start.
12·48	1·50	2·90	2,854	228·6	0·03	61·0	1·43	233·5	12 hours.
12·48	2·90	4·18	2,600	200·3	0·05	102·0	1·33	208·5	12 hours.
12·30	4·23	5·20	1,977	152·6	0·04	81·4	1·01	162·5	12 hours.
11·96	5·20	6·14	1,915	160·0	0·10	203·8	1·04	177·1	12 hours.
12·50	6·14	6·91	1,854	148·3	0·21	428·0	0·98	160·5	12 hours.
12·48	6·91	7·59	1,386	111·0	0·20	408	0·88	143·7	12 hours.
12·48	7·59	8·08	908	80·0	0·40	816	0·89	145·3	12 hours.
12·40	8·08	8·54	938	76·0	0·33	672	0·79	129·8	12 hours.

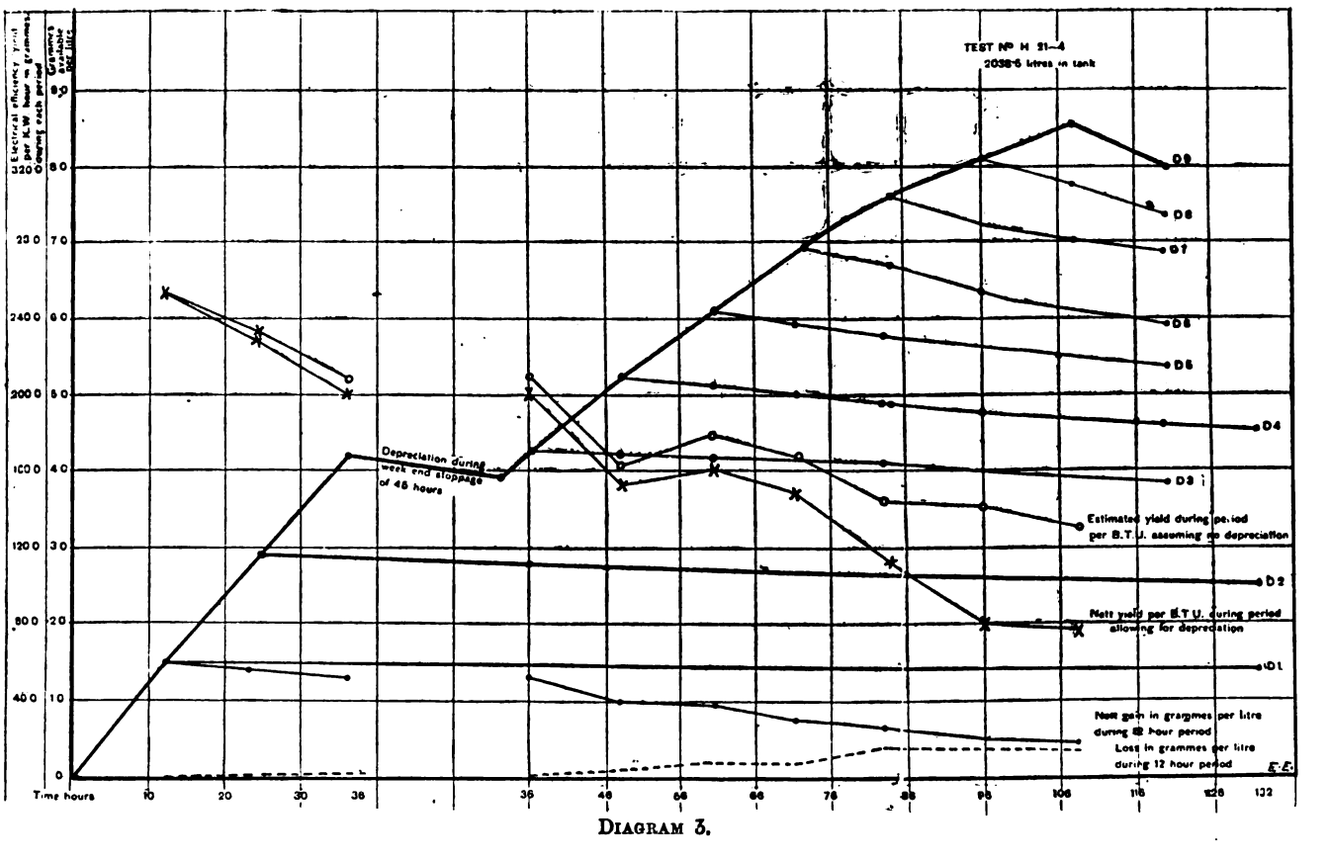

DIAGRAM 3.

Owing to the precautions mentioned, the electrolyte contained fewer impurities, and the solution generally was more stable; owing, however, to the greater volume of the electrolyte, the net gain per kilowatt-hour was in the latter stages greatly inferior.

In diagram No. 3, which illustrates the above table, a break occurs at the thirty-sixth hour, owing to the stoppage at the week-end. As stated, the samples set aside for measuring the depreciation were examined at 12-hour intervals, the Curves D 1, D 2, etc., indicating the loss in available chlorine of these. The effect of loss of strength of the electrolyte in the tank is appreciable when the strength of the solution has arisen to 4·18 grm. per litre. The margin between the actual efficiency and the estimated efficiency had the electrolyte remained unchanged in regard to its available chlorine contents is then about 4 per cent. The effect of the loss of strength, when the solution contains 8 grm. of available chlorine to the litre, adversely influences the yield per kilowatt-hour by over 60 per cent. as against the yield had the electrolyte remained stable, and no loss

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through depreciation needed to be made good. In this case the tank temperatures varied from 13deg. to 16·5deg. C., and the temperatures in the room from 19·5deg. to 23·5deg. C.

From his experience on these trials the writer is of the opinion that no test of the efficiency of any apparatus for the electrolytic productions of the hypochlorites can be regarded as complete without an estimation of the losses through instability, and a mention of the volume of the contents of the electrolysing tank. While stability of solution does not greatly affect the efficiency from any continuous type of apparatus (in which the sodium chloride solution is fed in at one end, and drawn off at the other end ready for use), it will materially affect the efficiency in any non-continuous apparatus such as that tested by the writer, or in any of the cases in which the electrolyte is circulated through an external cooling tank and returned to the electrolyser to be further worked up. The relation between the amount of chlorine present as sodium chloride and the amount of chlorine in the form of hypochlorite is unsatisfactory in most of the cases which have been chronicled by various investigators. Instability is one cause of this. But even allowing for this, the fall in efficiency is in no way proportional to the decrease in the amount of unconverted sodium chloride present in the solution. The factors which produce a markedly unstable solution are numerous, and further investigation is necessary. When the writer first considered the question of the relation of stability to efficiency, he thought it would have been possible to have plotted a curve indicating once and for all the probable amount of depreciation per hour for different strengths of available chlorine per litre. He has found that even with a cool electrolyte, a difference of one part of iron in 100,000 parts of water in the solution affects the depreciation curve to a marked degree. During the experiments to which reference has been made it was found impossible to keep the percentage of iron present at an even figure, and on this account no figures are given in these pages. It can only be said that during the run depicted on Fig. 3 the presence of iron was much less marked than in the run depicted in Fig. 2.

In conclusion, the writer desires to express his indebtedness to Mr. F. Ernest Pollard for valuable assistance rendered during the tests, in particular for localising certain ferric chlorides as one of the disturbing factors, which limited the economic production of solutions containing from 8 grm. and upwards per litre of available chlorine.

THE APPLICATIONS OF ELECTRICITY IN THE ROYAL GUN FACTORY, WOOLWICH ARSENAL.*

BY COLONEL H. C. L. HOLDEN, R A., F R S., MEMBER OF COUNCIL.

When it was suggested to me that I should put before the Institution, in the form of a paper, a description of what had been done in the matter of electric driving in the Royal Gun Factory, with which I have been associated since 1899, I felt some diffidence in complying with the request, because it did not appear that a mere description of what had been done in this direction would possess sufficient interest unless there was some notable departure from ordinary practice, since the electric driving of factories is now fast becoming the rule instead of the exception. As far as I am aware, some of the methods I shall describe and illustrate to you are departures from the ordinary methods in vogue, and on that account I am in hopes they may be of interest, and this must be my excuse for bringing them to your notice. I do not, however, intend to confine myself entirely to methods of electrical driving, but will describe more or less briefly other applications of electricity which have been found to be of use in this particular factory.

The question of the relative merits of individual motors for driving machine tools *versus* motors driving groups of tools has often been discussed, but no hard-and-fast line can be laid down as to when either system should be used, except, perhaps, for tools which require a large amount of power, certainly not less than 10 h.p. or 15 h.p. as a minimum; but the converse of this is not true, because it may often be expedient to employ a motor of even a fraction of a horse-power for an individual machine. It comes to this, therefore, that each individual case must be considered on its own merits, and this is the principle on which I have worked. In the case of a great many conversions of workshops to electric driving, all that has been done has been to substitute an electromotor for the prime mover previously used, be it steam, gas, or other engine, and though this may have effected an improvement in economy and other ways, it is not by any means as good as if the

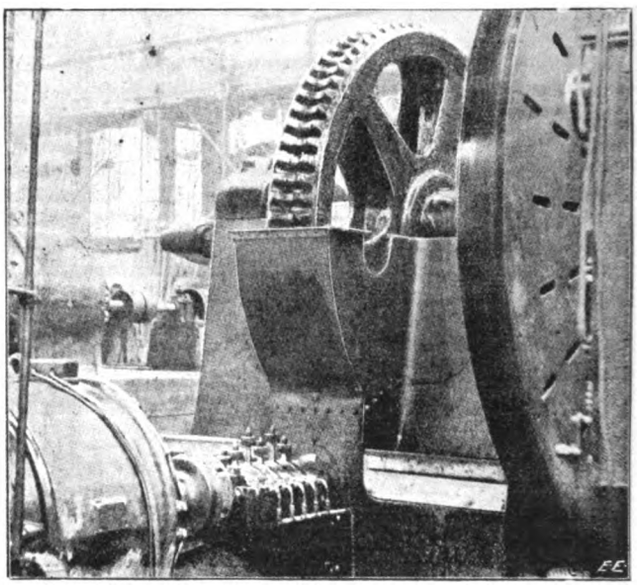

FIG. 1.

whole system had been remodelled with a view to electric driving throughout. I may here explain, for the benefit of the few of those present who do not already know it, that the work of the Royal Gun Factory consists of the manufacture of guns ranging from 3cwt. up to 60 tons, or even more, and also in the manufacture of the breech mechanisms or other adjuncts and appurtenances of the guns themselves. This work necessitates a very large range of machine tools, from boring machines 50 yards in length and lathes of 100ft. bed, down to the smallest milling machines and lathes. There is therefore plenty of

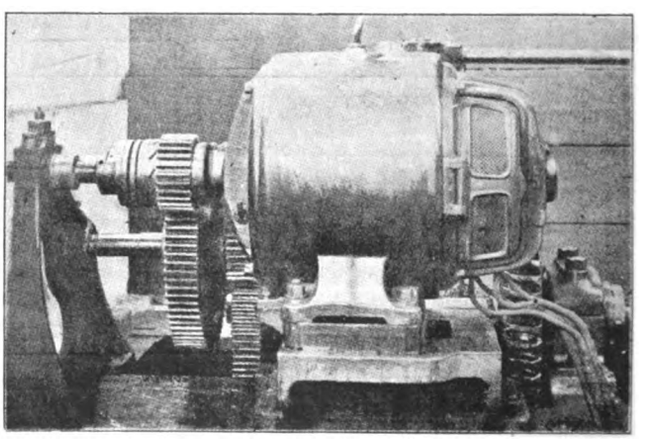

FIG. 2.

scope and opportunity for the employment of different descriptions of electrical drives. Although there were previously several instances where in the factory electromotors had been substituted for steam-engines, it was only in 1900 that I converted the first of two large boring machines to a direct electric drive by means of a variable-speed Schuckert four-pole motor of 25 b.h.p. (Fig. 1). The variation of speed was obtained by the now well-known method of varying the excitation of the fields, and the ratio in this case was 1 to 3·5 or so, giving speeds of from 250 r.p.m. to 880 r.p.m., which is amply sufficient range, without any further gear, for the work that is put into these machines.

* Paper read before the Institution of Electrical Engineers.

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The machines themselves are of the simplest possible description. The headstock which revolves the work carries between its bearings a large worm-wheel (Fig. 1), which is driven by a worm-shaft forming a continuation of that of the motor, but connected to it by a flexible coupling; the thrust of the worm-shaft, which in such large machines is very considerable, amounting to tons in some cases, is taken by a thrust bearing of marine type, and through this the cutting lubricant passes on its way to the boring bar; this is only a precautionary measure, but, nevertheless, a necessary one, as not only is it very important that the machines should not stop during a boring operation, but also, as they have to run from early on Monday morning till late on the Saturday night, and are only stopped for shifting or adjusting the work or tools, it is imperative that any trouble that could arise from a heated bearing should be guarded against; and I am happy to say that so far there has not been a single machine stopped from this cause. They run absolutely silently and without jar or vibration; indeed, in this respect the worm and worm-wheel, together with the electromotor drive, is ideal; and even if it have the defect that it is slightly less economical than spur gear, this loss is more than compensated for by the extra accuracy of the work done and the freedom from breakage of tools. It would be impossible in a spur-gear driven machine, I believe, to fine bore a hole 12in. to 20in. in diameter and up to 50ft. in length without a variation of 0·004in. in diameter, which is what these boring machines are called upon to do, and do to perfection, daily.

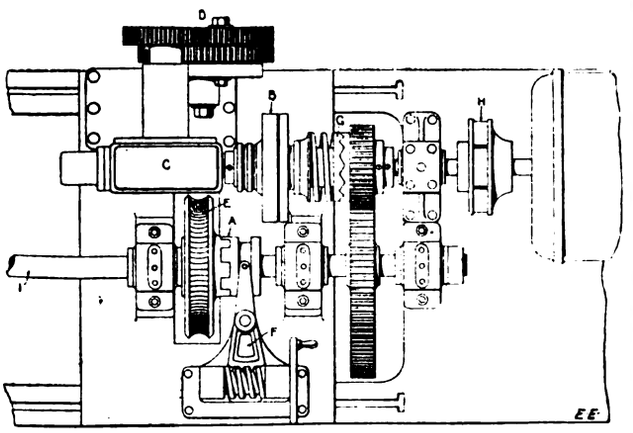

FIG. 3.

The feed of the boring bar in the machines described is worked from the motor by means of a shaft, which connects it with change gear, similar to that of a lathe, at the other end of the bed, 150ft. away. At this end there is also a 15-h.p. series motor, which can be mechanically coupled to the screw shaft moving the boring head and saddle, with the object of withdrawing or advancing one or both rapidly in either direction as required; in this case I have introduced a slip coupling (Fig. 2), which in the event of an overload not only slips, but also draws attention to the fact by making a hideous noise; this is, I think, better in many ways than the overload release, and much more convenient, of course, than a fuse which has to be replaced. It may be interesting to you to know that the change to motor driving, and the improved control of the speed, enabled us to turn out at once more than double the former amount of work done per week. It was considered necessary at first to put the control of the speed in the hands of the foreman only, and for him to lock up the shunt regulator; this is now found to be an unnecessary precaution.

A later development of this method of driving is one whereby the driving shaft, just mentioned as running the whole length of the bed, is entirely done away with, and the one motor, now a variable-speed shunt motor, does all the feeding of the boring bar, as well as the rapid advancement and withdrawal of it and the saddle, the latter weighing 10 to 12 tons or more. How this is effected is shown in the diagram of this feed gear in Fig. 3. The action of the gear is as follows: The motor drives the shaft through a flexible coupling, H. This shaft carries on it the magnetic clutch, B, and beyond the clutch the worm, C. It also carrier on a sleeve a pinion, and the overload clutch, G, and an armature. The worm gears into the worm-wheel above it, from which the change gear, D, similar to that of a screw-cutting lathe, and situate behind the worm-wheel, drives a horizontal shaft on which another worm engages with a second worm-wheel, E. This latter can be clutched mechanically by the claw clutch, A, to the screw shaft, I, actuating the saddle, The claw clutch, A, is moved by a handwheel in and out of position, and the lever, F, that moves carries a contact which only allows of the magnetic clutch, B, being in action when the claw clutch is disengaged. Thus, normally the drive is through the worm-wheels and the change gear, but when it is desired to move the saddle quickly, the magnetic clutch is energised, and the pinion on the motor shaft then drives a spur wheel which is keyed to the screw shaft, I, the latter being thus driven direct. The feed can be varied practically to any extent required between the extreme limits by the combination of change gears and the varying speed of the motor. This gear is worked entirely from the main switchboard by which the man starts and stops and controls the speed of the headstock carrying the gun tube, and the switches are so interlocked electrically that it is

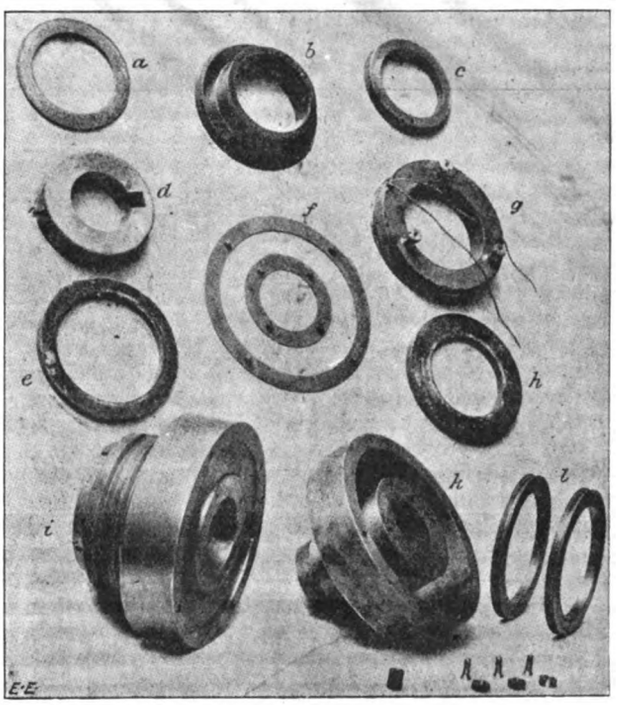

FIG. 4.

impossible either to start the feed gear or to leave it running unless the main motor is running.

It will be seen that there is a magnetic clutch employed in connection with this gear, and as such clutches appear in a good many of the illustrations in the paper, I may as well describe it in more or less detail now. This magnetic clutch is, of course, only a variety of a friction clutch, but it has advantages over the latter in that it can be used under conditions which would be impracticable, and in many instances impossible, for an ordinary friction clutch, owing to the fact that it can be as readily worked from a distance as from close at hand, whilst its action is quicker and more definite as to holding power, and it cannot possibly stick or seize. As will be seen from the accompanying illustration (Fig. 4), the clutch consists of five essential parts: the slip rings, *l*, for conveying the current to the coil, *g*; the circular magnet, *k*; the demagnetising rings, so-called, *f*; and the armature, which is merely a plain disc of Swedish iron or a piece of high-permeability steel. The remaining portions shown in the block are merely insulating rings, screws, and nut for building the parts into the complete clutch which is shown at *i*.

Two of the first clutches made over 15 years ago are shown in Fig. 5, and these are still in perfect condition. I am at present only using two types of these clutches,

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one rated at 6 h.p. and the other at 25 h.p. at 300 r.p m. Owing to the fact that the voltage of the supply circuit was 300, and also to the difficulty that there is in winding bobbins with a finer gauge of wire than No. 36 S.W.G., or 0·0076in. diameter, it was not practicable to make a smaller clutch than the size named, which is only 7·5in. in diameter; indeed, in this case even it is necessary to add 1,000 ohms resistance to that of the bobbin in order to reduce the current and prevent heating of the coil. Eight thousand turns of wire are employed in either case, the sectional area of the bobbin being one square inch, and the total capacity of the bobbin being 15·7 cubic inches for the

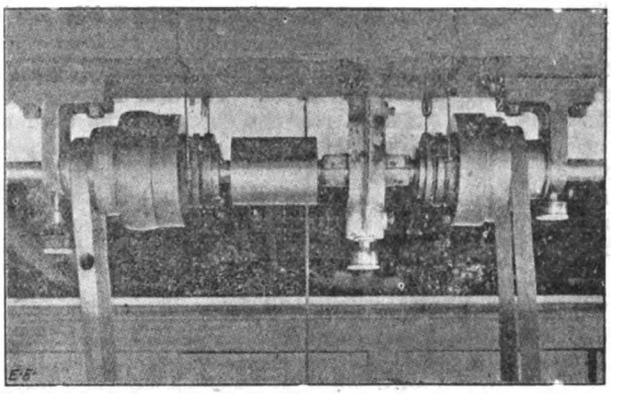

Fig. 5.

6-h p. and 32 cubic inches for the 25-h.p. clutch. Twenty-one watts are absorbed in the magnetising coil of the 6-h.p. clutch and about 42 in the coil of the 25-h.p. clutch. This gives an efficiency of under 1·5 watts per horse-power in the case of the 6-h p., which actually transmits 14·36 h.p. at 300 r.p m.; the 25-h.p. clutch is still more efficient. It will no doubt be readily seen that the diameter of the clutch has a more important effect upon the number of watts per horse-power transmitted than any other factor, and that it is quite feasible to transmit 1 h.p. for quarter of a watt or even less. The original pattern of demagnetising ring was a complete disc, which is simpler and not impracticable; but, obviously, some of the lines of force are uselessly diverted by it, and where high efficiency is desirable it should not be used. In the case of the clutch

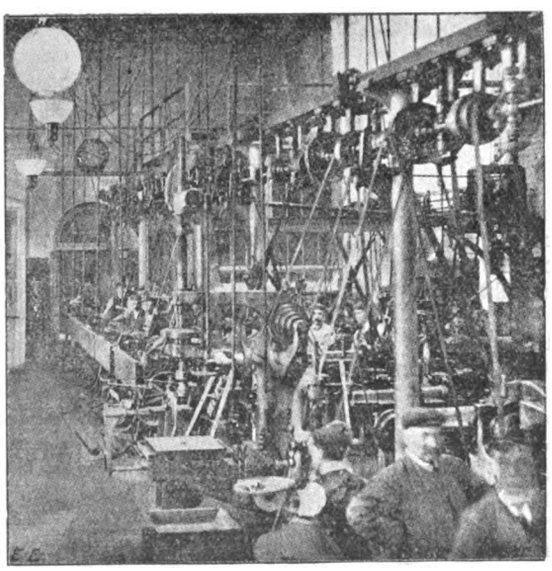

Fig. 6.

rated at 6 h.p. the horse-power transmitted at 300 revolutions is 12·73 with the complete disc as against 14·36 with the two rings—by perforating the disc with a ring of large holes concentric with the bobbin, very nearly the same efficiency is obtainable as with the rings—namely, 14·32 h.p. These figures, as regards horse-power transmitted, were obtained with the surface of the clutches dry and free from oil, and it seems hardly necessary to point out that the horse-power which can be transmitted, if they are well oiled, is considerably reduced; it is, therefore, necessary to arrange in designing the mounting of these clutches that oil shall not by any possibility work itself between the acting surfaces. I have not found any great difficulty in this respect. Where it is impossible or undesirable to prevent the adhering surfaces from becoming oiled, then the clutch must be rated 50 per cent. lower, or else made larger in diameter to transmit the same power as when kept free from oil. Some 117 of these clutches are in daily work at the Gun Factory, and are applied to a variety of purposes, some of which are illustrated in this paper.

A view of the gauge-room, Royal Gun Factory (Fig. 6), shows the method of driving the lathes and other machine tools which was introduced when the shop was remodelled some four or five years ago. I have also some views of existing shops in which the old system of driving is still employed, so that anyone who wishes may be able to appreciate the simplicity of the later system as compared with the former. In the new arrangement the motor—a 15-h.p.—is attached to the wall, and drives the main shaft, which runs down the centre of the shop, by means of a belt at a point about midway in its length at a speed of 450 r.p m. There is none of the usual counter-shafting and its multiplicity of belts; instead there is one cone pulley over each machine, driving the machine in the usual manner with a belt. These cone pulleys are, however, not carried on the main shafts, but on tubular bearings, through which the main shafts passes quite clear, while the bearings themselves are supported on brackets; the pull of the belt thus does not come upon the shaft when

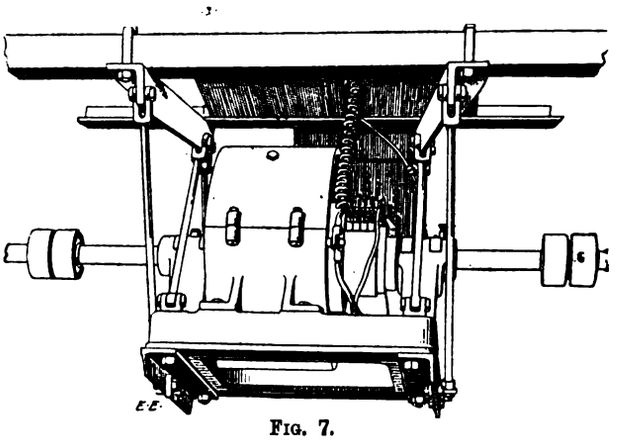

Fig. 7.

the cone pulley is not running and the machine is idle; the cone pulley carries the armature of the clutch at one end of it, and against this end the electromagnet with its collecting rings is keyed or otherwise fixed to the shaft. The pins of the demagnetising rings enter holes in its face, and keep this part of the apparatus in position. Very slight longitudinal play in its bearing is given to the cone pulley, and a slight bias is given to the belt drive, so that the tendency of the pulley is to run from the magnet when the latter is de-energised. It is found that by adopting this simple method no spring or other device is required to keep the surface from contact or rubbing when the clutch is not in action. The extent to which frictional losses are reduced can be imagined when it is explained that when the motor driving belt is thrown off and there is no current on the clutches, the main shaft can be revolved between the fingers. The switches used to actuate the clutches are of a selective type—that is, when the current is off, a pull at the switch rope puts it on, and a second pull cuts the current off again; this appears from practical experience to be more convenient than the ordinary belt-shifting method, in which two ropes are employed, one to put the power on and another one to cut it off. The base of the switch contains a condenser to render the extra current innocuous on breaking the circuit.

North East Shop.—This is the most recent shop built in the Royal Gun Factory, and was designed with a view to electric driving. The work done in this shop is in connection with the smaller kinds of guns and their mechanisms. It is a lofty building measuring 200ft. by 120ft., with the now common saw-tooth roof, and divided into four bays

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running east and west. There is a gallery running all round it for fitters and benchwork, offices, etc, and the large amount of glass makes it very light. Each bay is served by two eight-ton electric cranes. Altogether on the ground floor there are 83 machine tools, of which 21 are separately motor driven, the other 62 being grouped and driven from one of the four main shafts which serve the same number of bays. The method of driving these main shafts 200ft. long is by means of a 30-h.p. motor (Fig. 7) suspended from the girders and situated in the centre of the shaft, to each half of which it is coupled direct; the speed of the shaft is 250 r p.m.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

EXCESS PRESSURE RISES.

SIR,—In your issue of June 9, 1905, pp. 807 and 808, appears an interesting article as above. This subject is not treated upon in text-books, and is therefore of unusual interest. Could the writer give some data as to the approximate size and length of the water jet required to obtain a given resistance.—Yours, etc, G. MABILLE.

RESIGNATION OF THE WOOLWICH ELECTRICAL ENGINEER.

We gave particulars of this case last week. The matter came before the Woolwich Borough Council on Thursday night, Nov. 16, and was reported in the *Borough of Woolwich Gazette* as follows:

The General Purposes Committee reported receipt of a letter, dated Nov. 8, from Mr. J. B. Mitchell, resigning his appointment under the Council as borough electrical engineer, to take effect on Feb. 16, and they recommended that the resignation be accepted.

Councillor Widger entered his most serious protest against the most discreditable piece of business since the Council came into operation. The resignation, it seemed to him, was tantamount to dismissal. Some members of the committee had a spleen against the engineer, and the complaints had been sent to various councillors and not to the man direct. It was unfortunate that certain members attacked him personally. Mountains had been made out of molehills, and these individuals had been ready to jump down the throat of the engineer on the slightest pretence. The man had to stand all blame and got no credit for anything. He understood the engineer was brought up in the mayor's parlour before three gentlemen and he was practically called upon to resign. Later on he was called upon by two of the gentlemen to resign. He refused, but wire-pulling took place, and a notice of motion came forward asking him to terminate his engagement. He (the speaker) thought there would be some very serious charge, but he found none, and the only explanation was that it would be in the "interests of the borough." That was the only reason he could find. The resolution passed in the Electricity Committee, then he sent in his resignation to the General Purposes Committee. In 1899 the Plumstead Vestry appointed him electrical engineer, and he had made the Plumstead station what it is to-day. He considered the station a model for the whole of London. Later on he had the Woolwich establishment placed on his responsibility, and he had an increase of £100 in his salary, which showed he was giving full satisfaction. The present Council were now going in for "rush without reason." Three temporary servants had had to be retained at the last meeting of the committee. Instead of splitting up the work and calling in an accountant to do the work, or passing it to the proper department, the man was driven on the street—practically ruined, the man and his family. He was bound to say he had not, perhaps, had all the loyalty from his staff which he should have had. His subordinates had been consulted instead of the head, with the consequence that the man was ridiculed. But he believed the majority of the staff were not disloyal, and, in fact, he had heard that some of them almost felt that they would resign. It was the most disgraceful and discreditable action the Council had done.

Alderman Macnamara said that in committee he had given his reasons for moving the resolution which he moved at the committee in respect to the official. He now gave an account of what he alleged to be the condition of affairs in the department.

Councillor Syer said that those who had voted with Alderman Macnamara in the committee were ordered to do so. (A voice: "Nonsense" and "Hear, hear.")

Councillor L. J. Jones said it was true that three of them did interview Mr. Mitchell, but he denied that that official had used the words attributed to him by Councillor Widger. Mr. Mitchell was not asked to resign; they were not driving him in any fashion, and wanted to place the matter before him kindly. They told him the end of the negotiations were in his hands. If he had a proposal, they were prepared to consider it. It was the very last thing in their minds to injure him in any way. The committee waited for an answer from Mr. Mitchell, and then at a meeting he said he had made up his mind to do nothing. The opposition to that recommendation was made simply because they did want to see the electrical department in the borough a success. But if it were a failure now, it should be made a success.

Alderman Harper protested against the recommendation, and said he thought the Labour party should not have taken the case in their own hands, but should have consulted the chiefs of the minority.

The recommendation was carried.

PRIVATE BILLS AND PROVISIONAL ORDERS.

Notices have appeared in the *London Gazette* of intended application for private Bills or provisional orders as follows:

Electricity Supply.—The Northwood Electric Light and Power Co. (Pinner, Stanmore, Harrow Weald, and Edgware), Kent Collieries Limited (Company's Property), City of London Electric Lighting Co. (Power to Supply Railway, Navigation, Canal, and other Companies), Barry U.D.C. (Extension of Time, Transfer), Uxbridge and District Electricity Supply Co. (various places in Middlesex, Buckinghamshire, and Hertford), Metropolitan Electric Supply (Extensions in Middlesex, Herts, Bucks, Berks, and Surrey), Gelligaer and Rhigos R.D.C. (District), National Provincial Electricity Co. (Woodford, Essex), Stepney B.C. (Supply in Bulk, etc.), Electrical Distribution of Yorkshire Limited (Gomersal), National Provincial Electricity Co. (Boston), County of Durham Electrical Power Distribution (Ryton Urban District), ditto (Further Powers), ditto (Crook, Willington, Brandon, etc.) Ascot District Gas Co. (Electrical Powers), Portland U.D.C. (District), Crediton Gas Co. (Electricity Supply), Wantage Engineering Co. (Wantage and District), Additional Electric Power Supply Co. (Huntingdon, Bedford, Herts, Middlesex, and London); Foote and Milne (Sunningdale and District), ditto (Macclesfield), Urban Electric Supply Co. (Godalming Extension), Folkestone Electric Supply Co. (Hythe and Sandgate).

Power Companies.—Shropshire, Worcestershire, and Staffordshire Electric Power Co. (Extension of Area, etc.), Administrative County of London and District Power Co. (Surrey, Essex, Kent, and administrative county of London), South Wales Electrical Power Distribution Co. (rearrangement, etc.).

Tramways and Railways.—Cork City Railways and Works Co. (Cork), London Southern Tramways Co. (Lambeth and Camberwell), Newcastle-on-Tyne Corporation (City of Newcastle) Haslingden Corporation (Haslingden and Walthamstow), Rochdale Corporation (Borough), Mersey Railway (Motorcars), North and South Shields Electric Railway (Extension), London County Council (Blackfriars, etc.), Oxford Corporation (City of Oxford and Counties of Oxford and Berks), South Lancashire Tramways Co. (Extension), Oldham and Saddleworth District Tramways (Abandonment), Empire Electric Light and Power Co. (Romford and District), Nottinghamshire and Derbyshire Tramways Co. (Extension), London Outer Circle Railway (Middlesex and Essex), Bury Corporation (within and without the borough), Baker-street and Waterloo Railway (Various Powers), Metropolitan Railway (ditto), Middlesex C.C. (Edgware-road), Altrincham U.D.C. (Revival of Powers).

Light Railways—Mansfield and District Light Railway Co. (Mansfield, Sutton-in-Ashfield, and Skegby).

General Power Bills.—General Power Bills which include powers relating to electric light and tramways are also being promoted by the Newport Corporation, Corporation of London (Blackfriars and other Bridges), Todmorden Corporation, Huddersfield Corporation, New Mills U.D.C., Hull Corporation, Manchester Corporation.

PERSONAL.

We regret to learn that Mr. G. A. Grindle, M.I.E.E., of the Chloride Electrical Storage Co., was one of the victims of the "Hilda" disaster.

The Nelson Electricity Committee have appointed Mr. M. B. Henry, electrical engineer, Radcliffe, to succeed Mr. W. Alan Fraser as borough electrical and tramways engineer.

At the next meeting of the Llanelly Urban District Council the Estates Committee will recommend that, subject to the sanction of the Local Government Board of the proposed loan of £6,000 for electric lighting, Mr. J. C. Howell be appointed engineer and manager for the next five years at £200 per annum.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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DUTIES AND FUNCTIONS OF LOCAL AUTHORITIES.

This title is at the head of two articles by the Right Hon. Lord Avebury in the *Standard* on Monday and Tuesday last. Whatever emanates from the pen of Lord Avebury is worthy of all attention. These articles are followed by others which, drawing our conclusions from the one that has appeared on Battersea, will have no claims for consideration, and are not worthy of credence. The facts relating to Battersea are half truths, the conclusions drawn ridiculous, and the generalisations stupid. We are compelled to give our opinion in this manner, otherwise our general agreement with what Lord Avebury says might be taken to include the articles not due to that gentleman. Lord Avebury sets out once more the salient points that appeal to all those who consider the work of municipalities. Briefly, he tells us the local expenditure in 1868 was £36,000,000, in 1891-2 it was £76,000,000, in 1901-2 it was £144,000,000. Quoting Lord Stalbridge as to the rates paid by railways, in 1891 the amount was £2,246,000, in 1903 it was £4,493,000—an increase of 100 per cent. In 1898 the rates and taxes of the Gaslight and Coke Company worked out at 2·51d. per 1,000ft. of gas, in 1903 they worked out at 3·29d. per 1,000ft. of gas; the totals being respectively £220,000 and £289,000. The outstanding loans of local authorities in England and Wales have risen in ten years £155,000,000, and amounted in 1903 to over £370,000,000. Lord Avebury contends that under the new departure local authorities undertake many functions which used to be left and had better be left to private enterprise. He gives as the principal objections to the new departure:

1. That it will involve an immense increase in the municipal debt.
2. As there will not be the same stimulus to economy and attention, there will be a great probability, not to say certainty, that one of two things will happen—either there will be a loss, or the service will cost more.
3. The legitimate functions and duties of our municipalities are already enough, if not more than enough, to tax all their energies and fill up all their time.
4. In some cases the municipalities will defeat the very object they have in view.
5. It will involve municipalities in labour disputes.
6. It involves the creation of monopolies.
7. It is a serious check to industry, invention, and discovery.

These objections, as we say, are not new. We have at various times discussed them, but it is well to have them tabulated, and rediscussed. We are afraid we cannot, in some cases, accept the inferences to be drawn from the various statements as proof for the old as against the new departure. Each objection is considered, and, while generally in accord, we do not think some of the conclusions of any strength in the controversy. Lord Avebury, as, indeed, do all the supporters of certain companies, assumes that municipalities are almost criminal culprits as regards depreciation, obsolescence, etc, yet when the accounts of these very companies come to be examined it is doubtful if a single one of them, much less any half-dozen, provide to one-half the amount for these things that any single municipality in its ordinary working year does. The reference to Brighton has but a remote bearing on the subject, that to Cardiff contains a principle, though the item relating to reserve is unimportant. Before we can accept the point relative to reserve, we must come to an understanding about definitions. Cardiff, like

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all other municipalities, pays interest and has to provide a sinking fund, its upkeep is provided out of revenue, and so on, all to be considered when speaking of reserve. The point referring to rating is of great importance. The making of a paper profit by any system of undercharging is wrong, and in every case rating must stand in a prominent position. Assume that the undertaking is conducted in every respect as Lord Avebury would have it conducted except in the matter of rating. Assume, further, that the whole capital involved is found within the four borders of the constituency. The interest upon capital in usual business transactions is really paid by users—that is, by purchase of goods—and the selling price is settled with due regard to this point. In trade we may take it that interest and dividends are synonymous terms; interest is not necessarily fixed. It is fixed or constant as regards municipalities, hence the selling price should include this constant charge. Further, the cost of production must be included in the selling price. Lower or higher rating bears on cost of production, and if it should happen that the rating is lower than it ought to be and the price is fixed for normal conditions, profits are inflated. If buyers are given the benefit of lower cost, they will not have any right to complain. In the case of a municipality, the ordinary ratepayer may have to make up a deficiency of rates caused by the too low rating of the municipal undertaking. On the other hand, the buyer may be mulcted by too high a rating; but under any circumstances the town finances, as town finances, suffer by too low a rating, and the deficiency has to be made up by somebody; if not by users by other ratepayers.

CURRENT PHILOSOPHY.

I was on shift. I often am. The tramway load bobbed up and down like a plump excursionist having a dip at Blackpool. I sat on the handrail of the switchboard and mused. I often do. "Electricity is life," I said. Just then the machine circuit breaker came out with a bang. I took no notice—why should I? The big rotary hummed happily with nothing to do, and I mused on. "All the world's a power scheme, and all the men and women in it merely bits of it—dynamos, motors, transformers, switches, fuses, fittings, feeders, distributors, cars, and what not. Some men are born armatures. They spend their lives whirling in a given set of circumstances—a social field, cutting their lines in unpleasant places, and turning out energy to be sold at a profit—for whom? Some others standing aloof, doing no whirling, are shunts—merely by virtue of juxtaposition inciting others to work—directors, chiefs, managers. I ought to have been a shunt. I used to think I was an ornamental fitting, but that notion was soon knocked out of me. My respected governor held up the mirror to my astonished eyes, set up a revolving field around me, and off I went. I discovered I was only a rotor. He, my governor, spells it with two 't's.' He is an unpleasant man. When dealing with me he says he is a booster. The very thought of him excites all my back E.M.F., but, like an opposition coil in a tripping device, I'm no use till he's switched off. Some men, again, are transformers, and they are useful men. They take all the high-pressure ideas they can hold, and turn out comfortable low-pressure stuff that does what's wanted in the most efficient way. All engineers are transformers. They get ideas at high pressure from the professors at the institutes, run them round a few coils inside themselves somewhere, and hand out (after patenting) arrangements to do all sorts of things—cooking, warming, lighting, tram-driving, wheel-turning. Though it is well that they shouldn't forget that they are no use without the high-pressure notions of the professors. And the professors should remember that without their transformers they are merely dangerous mantraps for unsuspecting non-technical inquirers. Come to think of, it we are, most of us, transformers and spend our days turning our brains into bread-and-butter. Some men are recording voltmeters; they are always measuring the value of their fellows, and they always read low. One man I know acts as a synchronising panel to all his friends. If you get out of step with life, you go along to him and he soon puts you in phase, and you can take your full load. What is a policeman but a copper conductor? And what is ——" Just then the overhead linesman came in. "Wot O," he said, "I have just pulled off a double on the Lincoln and the Grand National." "Then," I said, regarding him sternly, "*you* are a double pull-off." He was just beginning to smile when the chief came up the stairs three at a time, and jambed in the circuit breaker. He whisked round savagely, said the trams had been stopped for half an hour, and wanted to know what the —— (he did really) I was thinking about. I gazed calmly on him for a brief moment and said, "Sir, you are merely a brush discharge. You fill the atmosphere with ozone." "Discharge am I, you young puppy? Then I start off by discharging you." And so he switched me off through a non-inductive resistance (a week's salary). There was no spark, and if anybody wants a tramway charge engineer they will please apply to WORM.

FORTHCOMING EVENTS

FRIDAY, NOV. 24.

North-East Coast Institution of Shipbuilders and Engineers. At 7.30 pm., first annual meeting (in the Lit. and Phil. Society, Newcastle-on-Tyne).

Physical Society.—At 5 p.m., "The Dielectric Strength of Air," by Mr. A. Russell; "On the Electrical Conductivity of Flames containing Salt Vapours for Rapidly Alternating Current," by Dr. H. A. Wilson; "On the Lateral Vibration of Loaded and Unloaded Bars," by Mr. J. Morrow.

Engineering Standards Committee.—At 11 a.m., conference of glow lamp makers at Institution of Civil Engineers.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., address by Mr. J. Swinburne, M.I.E.E.

SATURDAY, NOV. 25.

Institution of Electrical Engineers (Students' Section).—At 10 a.m., visit to tube tunnelling works.

Electrical Trades Union.—At 8 p.m., smoking concert (60, Farringdon-street).

R.E.V. (Electrical Engineering Section).—At 7 p.m., annual regimental dinner, Café Monico.

MONDAY, NOV. 27.

Society of Arts.—At 8 p.m., Cantor Lecture (I.), "The Measurement of High-Frequency Currents and Electric Waves," by Dr. J. A. Fleming.

TUESDAY, NOV. 28.

Institution of Civil Engineers.—At 8 p.m., "Waterways in Great Britain," by Mr. J. A. Saner, M.I.C.E.; "The Steam-Turbine," by the Hon. C. A. Parsons, C.B., LL.D., F.R.S., and Mr. G. G. Stoney, M.I.C.E.

Institution of Electrical Engineers (Manchester Local Section).—"Theoretical Considerations of Feeder Systems," by Dr. W. G. Rhodes, M.I.E.E.; "Street Cable Systems," by Mr. S. J. Watson, M.I.E.E.

WEDNESDAY, NOV. 29.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m. (at 92, Victoria-street), "Automatic Train Control," by Mr. H. G. Trust.

Society of Arts.—At 8 p.m., "The British Association in South Africa," by Sir W. H. Preece, K.C.B., F.R.S.

FRIDAY, DEC. 1.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "An Installation for the Bacterial Treatment of Sewage at Neath," by Mr. W. L. Jenkins.

North-East Coast Institution of Engineers and Shipbuilders.—Newcastle-on-Tyne, at 7 p.m., annual dinner (Westgate Assembly Rooms).

Rontgen Society.—Dec. 4, lecture by Mr. J. Butler Burke.

Institution of Electrical Engineers.—Dec. 8, annual dinner at Hotel Cecil.

Institution of Electrical Engineers (Manchester Section).—Dec. 8, "Electrification of Existing Steam Railways," by Mr. W. H. M. Parr.

Institution of Sanitary Engineers.—Dec. 13, dinner at Holborn Restaurant.

Junior Institution of Engineers.—Dec. 16, visit to works of Messrs. Johnson and Phillips at Charlton.

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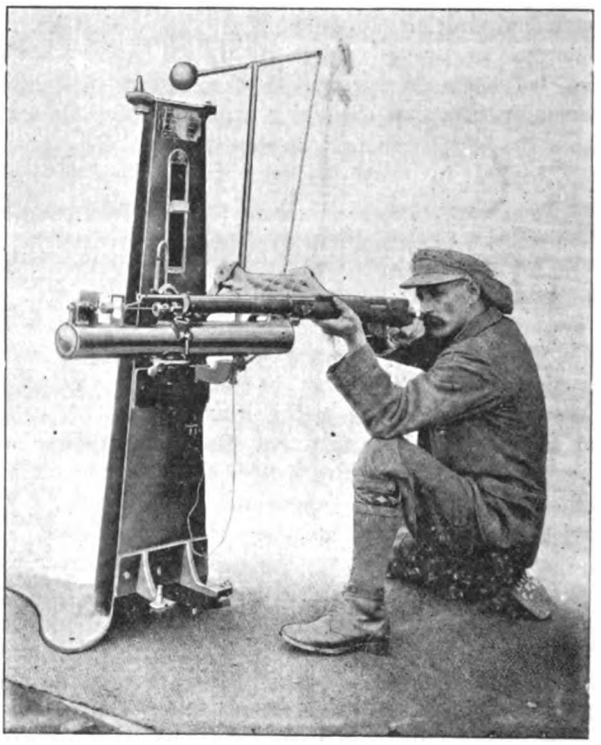
SUB-TARGET RIFLE.

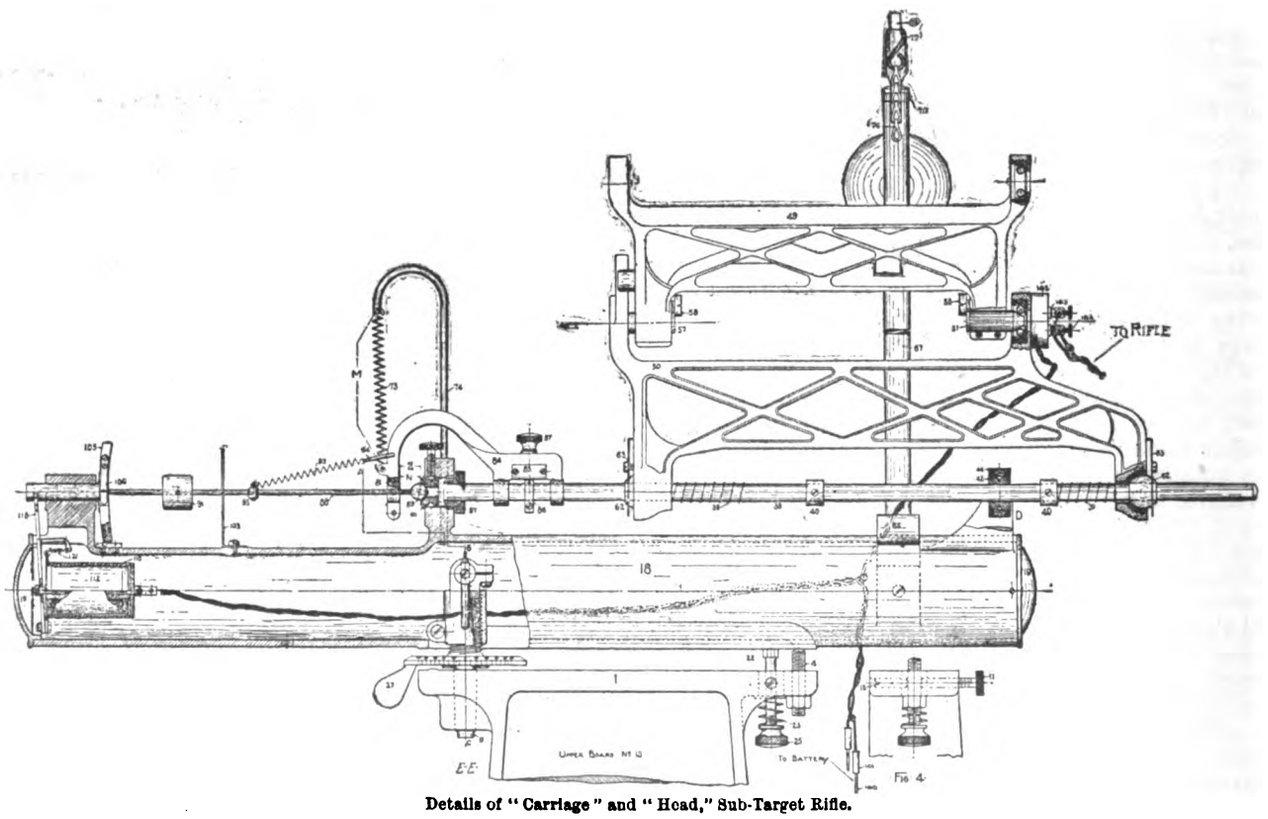
It is appropriate at a time when the nation is being roused to the importance of rifle shooting and the provision of more facilities for instruction that attention should be called to the sub-target rifle, invented by Mr. Henry Havelock Cummings, of Boston, Mass. The principle of this rifle may be explained with the aid of the accompanying illustrations. It will be seen that a strong and heavy upright pillar supports in any position required for shooting—standing, kneeling, or prone—a substantial tube. Above this tube there is placed a delicate rod capable of radial movement in all directions. At the forward extremity of the rod a needle point is fixed, and in a little grooved frame a small card target, about the size of a visiting card, is placed. That is the sub-target. The objective target is an ordinary target, placed preferably 20 yards away, which is ringed to proper dimensions to appear the size of a standard target at any desired distance, say 200 or 500 yards. An ordinary rifle is used for taking aim, being very ingeniously connected to the machine. For this purpose a carriage is provided, to which the rifle is attached. The carriage is mounted on ball bearings, and is connected to a steel radial arm swung on a four-point universal joint on the tube, which is called the "head" of the machine. This arm moves coincidentally with the line of sight along the rifle barrel, and transfers its gyrations, through an ingenious ball differential movement, to the scoring needle.

The weight of the parts attaching the rifle to the instrument is exactly balanced by the weight of the counterpoised ball seen in the illustrations, so that the marksman has only the weight of the rifle to support, and sufficient freedom of movement is given to allow of the rifle being aimed off the target in any direction. The relation of the objective target 20 yards away and the sub-target on the machine itself is determined by calculation of angles, but to allow for variations in eyesight, or constant peculiarities of aiming, the tube ("head") may be adjusted both vertically and horizontally by means of screws. These variations from the normal are recorded on two dials, one corresponding to degrees of elevation on the back sight, and the other to lateral movement for windage. In using the machine the marksman may first sight the rifle with the radial arm locked, so that if any adjustments are necessary to get the sights properly aligned on the bull's eye these adjustments can be made. Satisfied as to that, the radial arm is released, the rifle cocked, and the marksman aims at the objective target and pulls the trigger. On the tiny sub-target every movement of the rifle is indicated by the delicate pointer until at the pulling of the trigger the car darts forward and takes the impress of the needle, exactly corresponding to the aim on the objective target.



A J. Comber, King's Prize Winner, 1905, using Sub-Target Rifle.

The little sub-target is electrically actuated. There is a dry battery in the pillar, and the tube, or "head," contains a powerful magnet, the armature of which impels the target on to the needle when the circuit is closed.



Details of "Carriage" and "Head," Sub-Target Rifle.

This closing of the circuit results from pulling the trigger, a block of metal being placed within the breech of the rifle, to which is fitted mechanism for the purpose. Within this metal block is a cylinder parallel to the chamber, and at the forward end of it is a steel plunger resting upon the upper one of two

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platinum-tipped phosphor-bronze plates. When the trigger is pulled, the firing pin drives a piston through the cylinder and compresses the air in it in such a way that the steel plunger is caused to bring the two phosphor-bronze plates in contact and close the electric circuit. This process of air compression, in lieu of a more direct action, is adopted to delay the impress of the needle on the sub-target, until a slight interval of time has elapsed, to correspond with the period occupied by the movement of the firing pin, the ignition of the charge, and the travel of the bullet up the barrel. There can be used, if desired, a blank cartridge in the rifle, but as the apparatus is designed for aiming, not for shooting, this serves no purpose beyond that of accustoming the user to the noise of the discharge. Windage allowance can be taught by the instructor purposely deflecting the apparatus from its normal direction, with the aid of a lateral adjustment lever.

Thus there is nothing of the "exhibition-toy" character about this sub-target rifle. On the contrary, it is an invention of great practical utility, at once overcoming the difficulty with regard to sites for ranges, and simplifying the work of instruction to a remarkable degree. There are thousands of would-be marksmen who lack the time necessary to attain proficiency under the old conditions, but the sub-target rifle provides the means for changing all that. It even makes instruction at home a possibility, and for use in schools should prove invaluable In the United States and Canada it has been widely adopted, and is also used in H.M. Navy and Army. But its sale is by no means limited to the services and schools; it has a much wider field, and will, no doubt, do more to effect the end which Lord Roberts has in view than all the talk in the world. Readers interested might do worse than call on the Wilkinson Sword Company, Limited, 27, Pall-mall, London, S.W., where the sub-target rifle may be inspected.

NEWCASTLE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address by the Chairman,*

W. M. THORNTON, D SC, M ENG, MEMBER

§ 1. The Science and Art of Engineering.
§ 2. The Education of an Engineer.
§ 3. Research, a Good Investment.
§ 4. Research and Practice.

§ 1. In that distant time, a thousand years or so before the nvention—by Hero—of the steam-turbine, the most interesting study for man was man. What problems there were then of science and of art centred upon him as one engaged in a struggle with the great unknown forces of the material world. Our present knowledge of these would seem to those old-time thinkers superhuman, but the fact remains, though it is apt to be forgotten, that the true interest of it all is still in its relation to man. The wisdom and skill which are able to direct these forces of Nature on a large scale form now our wide profession of engineering, well described by Sir Oliver Lodge as "Half science, half art." The science of this is a compound of mechanics, physics, mathematics, and chemistry; the art that skill in the arrangement of materials which enables structural, mechanical, or electrical work to be carried out with the greatest efficiency and economy combined.

In spite of the fascination which problems of science or difficulties of art possess in themselves, they must always be for the few. There is still a wider personal interest in the men who work at them, and more in those who are preparing to take them up as a life work. I propose, therefore, to deal first with a few points bearing on the training of students or pupils for the profession of engineering.

Before the Industrial Revolution and the rise of the conception of free competition as an ideal, the craftsman was both designer and worker. In the process of time the truly creative side of engineering was separated out, and is located now in design-room, drawing office, and study; and since it is the object of the newer school to reduce the responsible thinking of workmen to a minimum, this separation must ever increase. In my works days, for example, engine-fitters as a class looked down upon turners as "machine men"; now, by the increasing use of steam-turbines and milling devices, this is slowly changing, and soon the greatest manipulative art will be that of knowing when to stop.

On the other hand, knowledge of natural phenomena, or science in its broad sense, becomes daily more necessary. Each newly-discovered property of matter is at once pressed into service, and it is the rapidity with which this has been done that gives to electrical engineering the attraction which it has for the lay mind. Those branches of engineering are most interesting which deal with the transport of human life. The deep sense of responsibility felt by every bridge and harbour builder extends to the naval architect, and in a less degree to the marine and locomotive engineer. Electrical engineering compared with these is yet "in its infancy," but when one considers the extreme importance of the electric telegraph and telephone, the transformation of the conditions of urban life by the electric car, or the absence of products of combustion in living-rooms, the results to humanity are already great.

In every branch of engineering there are three distinct classes—proprietors, executive staff, and workmen—each of which requires suitable training. The difference between that of the first two and the last is that a knowledge of the physical laws of Nature is essential for the former, and is to be gained best by a special preparatory education. For the latter a knowledge of a few properties of matter is sufficient to be gained during the practice of the trade. With the training of the artisan I do not propose to deal. His work may be regarded as purely an art, and is handed on through the ages by personal transmission from man to man. There is a transition stage between workman and designer found in the lower orders of draughtsmen. For all practical purposes they may be classed as artisans—they have received the same school training, and their knowledge of first principles is much the same. Every opportunity is now given for talented boys to rise in any class, and the educational systems of Germany and America are good examples of how this may be done well. These countries recognised, one seventy, the other thirty years ago, the value of training those whose industry requires either advanced technical knowledge or power of adaptability. The slower movement of our industries relative to theirs has given rise to much anxious thought and to the Mosely Commission. The result has been to emphasise the importance of having a highly skilled staff to carry out new ideas, the work goes on with so much more ease and certainty. There is no doubt that English manufacturers know their work as well as any in the world, but it is a good thing to have a large body of trained subordinates with ideas of their own and eager to have the chance of seeing them carried out. There are as yet few of this class in England compared with Germany and America, and I believe that this has been one cause of weakness.

§ 2. It may be well to consider shortly the course of training which experience has shown to produce good results. One can assume that a boy desiring to become an engineer of the better sort has been to a good secondary school, and that he leaves at the age of seventeen. He should then have an adequate knowledge of his own language and at least another (French or German by preference), the elements of Euclidian and co-ordinate geometry, algebra to the binomial theorem, trigonometry to solution of triangles, mechanics of a sound, descriptive kind, and a little chemistry and physics. This is not much to ask, for there are to my knowledge schools where this standard is reached without detriment to a general education, by boys who, in view of an industrial career, have been wisely directed. Those who have not been able with ordinary effort to attain to this moderate standard should be given the choice of another career. Classical scholarship can in the future only be afforded or attained by schoolmasters or men of leisure. There is certainly no greater handicap to a boy entering an engineering career than an education on the classical side of any public or secondary school. The pupil should, while his school work is fresh, be required to take the entrance examination at some university where engineering is taught, and this should be regarded as the finishing point of his school life.

One enters now upon debatable ground. Is it better to go straight from school into the works or to college? A boy fresh from school rapidly absorbs the spirit of the place in which he lives. If he is in the shops and left to himself, it is a fact that he soon takes the workman's view, and may learn to regard foremen and managers as, in a sense, his natural enemy. The effect is, however, more far-reaching. It has the tendency to set his future thinking on a lower mental plane. To have large interests and a wide outlook cannot be too early impressed upon a plastic mind, and the workman's view, judging by his talk, lacks both of these. This can, of course, be corrected by wise home influence, but the necessity for direction is not always seen. There are manufacturers who prefer to have a boy straight from school, and it may in many cases be more to their interest, but no desire for cheap labour, or material to mould in any particular direction, should take precedence of the highest national efficiency. I thought once, probably guided by own experience, that it was well to have works before college—one knows what one ought to know so much better—but after many years of close contact with students of both kinds I have come to think that, on the whole, the gain in works' knowledge, and stimulus, is more than counterbalanced by the loss of clear thinking and recognition of first principles which

* Delivered on Monday, Nov. 20, 1905.

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prove so valuable later. In addition to this, a boy serving an apprenticeship first rarely has a chance of showing ability within three or four years; his lack of knowledge keeps him back, whilst one somewhat older and familiar with the principles and more important constructional details of the work has often an early opportunity to make a name as a keen and reliable fellow, provided that he enters the works with an open mind and is still willing to learn. There is another reason why college should directly follow school. If it is true that the latter is a miniature world, it is still more true of a university, and in this respect our non-residential colleges are closer to the conditions of after life than cloistered Oxford or Cambridge. There is no place where the strenuous life, mental and physical, may be lived more fully than here.

All colleges which provide a three or four years' course in engineering insist on a sound knowledge of the elements of mathematics, physics, and chemistry. The first year is, therefore, almost entirely occupied with learning or revising these, a few descriptive classes or a little geometrical drawing being added for stimulus. If possible, mathematics should be continued through all three years. The power of facile thinking with abstract quantities, though it may rarely have direct expression in after life, is of immense service to engineers. The more advanced laws of heat and elasticity and electricity, and the simpler quantitative and more advanced descriptive treatment of technical subjects will form the second year's course. That of the third year is entirely technical, and of such an order that a student should have little difficulty on its completion in judging for himself the significance of any new suggestion or advance in practice or theory. A fourth year may well be occupied in experimental work on new ideas.

Technical or "bread" subjects, as the Germans call them, have only within this last year been recognised by Government as having educational value, and the rise of the demand for higher technical education is an interesting study. It is a well-known fact in the history of education that "A new standard or fresh subject of education is impossible without the strong impulse of social or professional interest."* About forty years ago there was, as an outcome of the democratic ideas at work in England during the earlier part of the century, a general desire for a national system of education. This was the strong social impulse which resulted in the Education Act of 1870. The necessity for higher education was soon after felt, and the rise of the university college movement began; but from that day to this technical subjects have been regarded either as self-supporting or unworthy of support. I suppose any use of public money for that purpose would have savoured of class legislation, but without the strong backing of professional interests, medical, engineering, or chemical, university colleges would long ago have degenerated into high schools.

Civic patriotism has played a large part in the development of the larger educational ideals. In Liverpool there are twenty-five departments in the University, each endowed with £10,000. Manchester, Birmingham, Leeds, and Sheffield can all show like results. We are rather isolated here in Newcastle, but we shall no doubt in time feel the wave from the centre of activity further south. Perhaps we are stunned by the shock caused by Mr. Carnegie's gift of £2,000,000 to Scotland. Since 1870 the growth of industry upon Tyneside has been phenomenal. Thousands have made fortunes, millions have been employed. The great coal industry, with its connected shipping interests, rests on a substratum of efficient technical knowledge. Shipbuilding and all branches of engineering are to be found here in highest activity, and it is not too much to say that Tyneside owes an appreciable share of its success to the high standard of training maintained by this college throughout the last thirty-four years. Notwithstanding this, we have no permanent endowment for any one of our twenty departments.

§ 3. The most rapid and fruitful return for endowment is in the field of research. It is now generally agreed that the function of a university establishment is both to teach and to extend the boundaries of knowledge. Scientific research falls under two heads. There is, on the one hand, that close study of facts more or less known in order that accurate information may be had for industrial purposes. This is embodied in the National Physical Laboratory, which, being supported by public funds, directs its attention to work of immediate industrial value. On the other hand, there is speculative search into the unknown on lines suggested by unique chains of thought, arising from new observations or strong co-ordinated thinking. Work of this latter kind cannot be undertaken to order. There are times of inventive activity in which ideas come rapidly. Then follows the patient experimental search for truth where so many fall out. Now if it is to come at all, a time of speculative activity almost inevitably follows the completion of a university course, and, it may be, the taking of a degree. It is then that encouragement and, perhaps, pecuniary help are of vital importance to a young student. He should have the opportunity of seeing how to carry out ideas by watching or helping in the research work of his professor, and the advantage is mutual. The enthusiasm of a pupil is the most refreshing thing that can come into the life of a teacher, and the friendship or sympathy of the elder man is always greatly prized by the younger. After all, in the light of the immense unknown, the difference between teacher and taught is very small. It is only the case of one student a little in advance helping another along the same road.

There is in connection with experimental research a disregard by many, though not all, manufacturers of much promising material. We take our young engineers from college and put them for years to routine work which untrained men do as well or better, and are disappointed that they do not show striking results, forgetting that two things are necessary to progress—the man and the opportunity. Medical and engineering students are of much the same calibre, and yet the former are given the opportunity for experiment—under guidance—immediately on graduation. I would suggest that men with a first-class college record should, instead of being treated as beginners, be taken into the confidential departments, design or test room, and set to work on new things, at first under supervision. Of course if there are no new things to work at, the industry is stationary or retrograde. They say no man becomes a good glass-blower until he has broken 10lb. of glass in the process of learning. There should also be some similar allowance made for crude ideas in engineering—say, ten pounds sterling. Fuses cover a multitude of sins in the test-room, and it would take a good deal of work to reach this limit. One result of college training is to produce a large crop of ideas more or less crude out of which finished articles may emerge. In a large industrial centre where there is, as here, close relationship between college and works, I would suggest that where there are not men and instruments available in the works, senior students should be lent occasionally to do a week's work—say, with an oscillograph on wave forms, or on the effects of armature reaction, or in studying interpolar induction or commutation in special cases.

§ 4. The interdependence of science and industry has been a fruitful theme for a hundred years. I do not think it too much to say that all the machines which grow to great size and power begin as little more than toys in the inventor's workshop. The first Parsons turbine, and certainly Faraday's original device for producing electromagnetic rotation, are small enough beside a 10,000-kw. set. One never knows to where an experiment a little off the beaten track will lead. I have recently had a good example of this, on a small scale, which may be of interest to you. Some years ago I made a few experiments upon bacteria, working mostly with typhoid germs on account of their sensitiveness. During these I found that M. Lortet had discovered what I was looking for, that alternating currents cause them to orientate and place themselves along the lines of flow, but he failed to find any effect with direct currents. As a matter of fact bacteria of all kinds, living or dead, orientate in the same way under either direct or alternating electrification.

On thinking over the cause of this, it was found that the movement depended entirely upon the relative conductivity of the organism and the surrounding liquid. So that the former behaves as a rod of iron in a magnetic field, or one of a dielectric in an electrostatic field, the same laws governing lines of stress or steady flow whether of electricity, magnetism, heat, or liquids. In searching for the cause I found that glass orientates in oil, but not in water, and that carbonised silk filaments are very sensitive in either. Some time after I wished to design an apparatus to indicate the state of charge on cables, in order to see whether they were safe to handle. The simple electroscope was first thought of, but rejected as not mechanically strong enough to be placed in a platelayer's hands. It then occurred that one might use the same thing on a small scale, observing the movement in a kind of linen-tester's microscope. On trying this I noticed a small spark pass between two particles of carbon suspended in oil, and the idea at once came, why not look for the sparks? In 10 minutes or so after this the first "voltascope" was made and tried on a 2,000-volt circuit, and a little while later on 20,000 volts. The instrument as it is now made consists of a glass tube containing oil and short fine carbon rods. Contact is made across the mains through a heavily-insulated wire having an ebonite or fibre handle with sharp steel points to get good contact. It works equally well with direct and alternating currents, and in any position. As soon as contact is made the carbon filaments become polarised and form an irregular chain, along which a small current passes, jumping across minute gaps between the particles, and so forming sparks which are instantly extinguished by the oil, their constant appearance and extinction giving the tube the effect of scintillation.

It is a far cry from bacteria to an electric life-saving device, but the same line of thought led further to the invention of the high-tension voltmeter shown. So far as I know, this differs from other forms in the use of a *dielectric* needle or quadrant. A short ellipsoid of paraffin or sealing wax is suspended by a fine silk or quartz thread between brass plates, contained in a glass globe about 15cm. diameter. Theory indicates that the torque on the suspension is proportional to the square of the voltage,

* W. H. Woodward, "Erasmus Concerning Education," p. 85.

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and this is found to be experimentally true. One uses the instrument in the same way as a Siemens dynamometer or the Ayrton-Mather voltmeter of the same type. The ellipsoid is brought to a balanced position between stops by rotating the torsion head. The lowest voltage to which it is sensitive is about 500, and I have used it to measure spark-gap voltage up to 100,000. Since specific inductive capacity varies with frequency, a simple correction must be applied for this.

There is a still further extension of the same theme. One can measure the permeability of iron by the torque on a long ellipsoid suspended in a magnetic field, and in the same manner one can determine by this instrument the dielectric constants of all solids, liquids, or gases when a litre of the latter can be obtained. The effect is a function of the relative permettivities of ellipsoid and medium, and a comparative series may be readily formed and checked by reference to air. The fact that the results are comparative, and that the zero position of the moving system is the same for all, enables one to work with considerable accuracy. The ellipsoids must be made very carefully. Messrs. Hilger can be relied on to do this.

These examples, given for what they are worth, serve to show that a little research with a microscope may lead to results quite unthought of at the time in an entirely different subject and on a different scale. The microscope might be much more used in electrical engineering than it is at present, if, indeed, it is used at all. We know now that the permeability of iron depends upon the size and distribution of the crystals of carbide of iron in the metal, and that these are changed by the heat treatment this has received. Why should we not estimate permeability by polishing a surface on the metal, observing it through a microscope, and, if necessary, photographing it. After a time, by collecting a set of standards, the quality of any specimen might be assigned in a few minutes by inspection. We have timber merchants selecting wood by inspection of the grain; why not makers of machines selecting magnetic iron and requiring ironmakers, when quoting, to send a micro-photograph of the material?

To carry out research work with any chance of achieving a definite advance, there must be sound preliminary training, and thus we return to the first theme of education for those who will be in a position to do or direct it. There are, we may be sure, hidden in the future, advances in science and practice fully as great as those which we have inherited and which have come to pass in our day. They will come by long and patient search in workshop, laboratory, and study by those men who are, as it were, the growing points of science, thrusting down into fresh, dark, fruitful soil the roots by which the spreading tree of human knowledge is upheld.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Chairman's Address.

BY S. L. PEARCE, M.I.E.E.

Gentlemen,—My first duty on taking the chair this evening is to express to you my sincere thanks for the honour you have done me in electing me the chairman of the Manchester Local Section of the Institution of Electrical Engineers for the present session, and to further express my sense of the responsibility placed upon me during the occupancy of a position that has been filled by the most eminent electrical engineers in this centre, under whom this section has risen year by year until it now holds the first rank amongst the provincial branches of the parent Institution. However inadequate my qualifications for the position may be, I am sure that the hearty co-operation of the committee and all members of the section will be extended to me in my endeavour to emulate the work of my predecessors and successfully discharge the duties of the chair.

It is gratifying to be able to chronicle a steady increase in the membership of the section, which now numbers 84 members, 212 associate members, 149 associates, and 313 students. The success which has attended the formation of the students' section deserves special mention, and the movement will increasingly prove a boon to the younger members of the profession and a source of strength to the section generally. It may not be out of place this evening, at the opening meeting of our session, if I proffer a few remarks to the younger members present before dealing with the main subjects of this address. The power of this country to maintain or to improve its status in the electrical engineering world in the future depends largely on the students of to-day, and the use of present-day opportunities. It is not my intention to discuss this evening what are the essentials of an adequate training for an electrical engineer, or as to whether the period of practical work should precede the college training, or *vice versâ*, or whether both should run concurrently. No doubt many of you have had, or are having the benefit of, sufficient technical training, and have acquired a general knowledge of many subjects allied more particularly to electrical work, but this much needs emphasising to-day, that much of the benefit so derived will be lost unless you see to it that it has a practical application. Mere text-book science will not alone suffice for the student to-day, and when the problems of what has been termed "heavy electrical engineering" are so much to the fore, it is of more and more importance that a practical knowledge of the mechanical side should be acquired. There are many branches in the profession open, but you cannot hope to become a specialist in each. A man who runs a supply undertaking is not usually an expert in dynamo or motor design, nor is he expected to be. By all means acquire a general knowledge of the progress that is being made in the various branches of electrical engineering, and keep abreast of the times, but do not attempt to specialise in each. The meetings of your section, if fully taken advantage of, will certainly prove of great value as a means of exchanging ideas and gaining experience in the preparation and discussion of papers. It has been stated that "the power of putting ideas on paper is that which differentiates an engineer from an able mechanic." Certainly the preparation of an article or a paper will force you to think out a question for yourself, and enable you to come to definite conclusions, thereby gaining confidence. I have no doubt that the session on which you are entering will, in the value of the papers to be contributed, and in the interest thereby aroused, be a thoroughly successful one, and I trust every student will do his utmost to advance the interests of the section.

It is customary for the chairman of an institution such as this to deal in his presidential address with that branch of the work with which he is more intimately connected, or to survey the general progress of electrical science and works throughout the world. The former of these subjects was ably dealt with by my predecessor last year in his comparisons between British and American practice, so that one subject is removed from the list to choose from. The second subject requires a far wider knowledge and a far abler pen than mine to deal with, so I propose to briefly touch on some few of the recent advances made in electrical work generally, and incidentally to indicate some of the problems that yet await solution. The past year has not produced any revolutionary changes in the sphere of electric lighting, but, spurred on by the competition from the gas industry, improvements have been made which tend to the cheaper production of light. The "Nernst" lamp has been more extensively adopted for inside lighting, and in many cases has been able to successfully compete for side street lighting with the incandescent gas mantle. The original form of this lamp, known as the "A" type, with vertical glower, up to quite recently proved the most satisfactory, and it is questionable whether it is likely to be superseded by the latest or "D" type, which employs an enlarged spiral burner, supported in a horizontal position, and giving about 75 c.p. with an energy consumption of about 115 watts. The distribution of light from a horizontal burner is hardly as satisfactory, from a street-lighting point of view, however suitable this type may prove in more confined situations. Want of uniformity is still a failing with Nernst lamps, and this is most apparent in the life of the burners, and is also noticeable in the rate at which the candle-power falls off. Owing to the burners being largely composed of magnesia salts, which have an affinity for moisture, it must not be overlooked that electrolytic action will be set up in damp atmospheres, and will account for the great percentage of burner failures in wet weather. It will no doubt be possible for the manufacturers to overcome this difficulty. The most striking development in the production of a more efficient incandescent lamp is the tantalum, which may be now taken as having successfully emerged from the experimental stage. As its name implies, the metal tantalum has been used in the construction of the filament. A feature of the lamp is the exceptional length of filament required owing to its low resistance, and the ingenuity displayed in evolving a compact and yet suitable form of structure for its support. The lamps are made in voltages from 50 to 120, burning in series or single parallel. A recent series of tests show that the filament of a tantalum lamp increases in resistance with an increase of voltage, and, therefore, increases with the current and temperature. This is an important point of difference between this form of lamp and the ordinary carbon filament. Consequently variations in voltage do not have the same effect in the increase of candle-power emitted—speaking roughly it requires twice the amount of change in voltage applied to the tantalum lamp as the carbon-filament lamp to produce the same change in candle-power. Further, the same increase in voltage for both lamps will give an efficiency gain in the case of the tantalum lamp of about one-half that of the carbon-filament lamp. Fitted with clear globes, an energy consumption of 1·7 watts to 1·84 per mean horizontal candle-power and 2·2 watts to 2·47 per mean spherical candle-power was obtained. The distribution of light in a horizontal direction is remarkably uniform, and is in excess of that given by a carbon-filament lamp, but in an end-on direction is less; the percentage of

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candle-power emitted end on to that emitted in a horizontal direction in the case of the tantalum lamp being approximately 30. The useful life of these lamps and the reduction in light emitted do not differ materially from the ordinary carbon-filament type, and the power taken during the life of the lamp is practically constant. Tantalum lamps having a 25 per cent. lower efficiency than those just described, with a reduction of some 35 per cent. in light emitted, have been produced to give a useful life of double the number of hours of burning. Of the same order may be mentioned the osmium lamp, with an even lower energy consumption, which, as soon as the initial difficulties in connection with the weakness of the filaments have been overcome, will mark a similar advance in the production of a more efficient incandescent lamp. Interesting results have attended the experiments made by lamp manufacturers in the States to obtain a new carbon filament. Briefly, the chief characteristics may be said to be due to the proper application of excessively high temperatures to the ordinary carbon filament. This high-temperature treatment is, however, but one beneficial step in the whole process of metallising the filaments. It was found that carbon filaments treated with graphite underwent very remarkable changes when subjected to a temperature of 3,000deg. to 4,000deg. C., and subsequent investigations proved that the change was practically all in the treated coating and not in the filament proper. Metallised filaments having a useful life of about 500 hours, with a fall of 20 per cent. in light emitted, are being produced with an energy consumption of about 2·5 watts per candle, as against 3·1, which latter may be taken as the best figure obtainable with an ordinary high-efficiency carbon-filament lamp. In the case of all these new forms of lamps, an increase in first cost is admissible, having in view the higher efficiency and smaller energy consumption.

The mercury vapour lamp has not met with much favour so far in this country, and the progress made in its development is so small that it can hardly be said to have emerged into a practical stage. Attempts have been made to add some red rays, but apparently with little success, and, as sentiment after all still plays an important part in our everyday life, the objectionable colour of the light must to a great extent act as a deterrent to its extensive adoption. A very rapid falling off in the candle-power is noticeable after a comparatively few hours of burning, which may be partly due to the deposit which is formed on the inner surface of the tube. From the point of view of mere efficiency, the various forms of the mercury vapour lamp mark a distinct advancement, their radiation efficiency being five to six times that of the carbon-filament lamp. Until, however, the practical problem of adding the necessary red rays is solved, the lamp is not likely to be brought much into very extensive use.

In the arc lighting world, manufacturers have chiefly given their attention to the improvement of the enclosed "arc" and the development of the "flame" arc. In the case of the former, the absorption of light due to the use of a second or outer globe, and the resultant reduction in efficiency, has been responsible for the production of the type known as the single enclosure. Such a step has meant that the enclosed lamp will possess many of the good points of the open arc whilst retaining the special advantages pertaining to the closed type. The practical convenience of having a lamp capable of burning for at least 120 hours without renewing the carbons is obvious, and must be of great commercial value. A further result of the enclosure of the carbons is found in the lengthening of the arc, whereby the lamp can be made to take a much higher voltage across the arc, and no difficulty is now experienced in running enclosed arcs singly on 200-volt circuits. The improvements that have brought the "flame" arc into its present state have been directed chiefly towards simplifying the feeding devices, and to the manufacture of the electrodes. These lamps have their carbons either arranged parallel or inclined towards each other, instead of vertically above one another as usual, the arcs burning under a reflector, being usually controlled by magnetic influence so as to direct the light to the best possible advantage. The early defects of the feeding mechanism in this class of lamp, so as to keep the arc in a fixed position under the reflector, were responsible chiefly for the unsteady and unsatisfactory light that was produced. The impregnation of carbons with calcium, magnesium, or other salts has received considerable attention of late, and many forms of electrodes of a composite nature have been devised with the object of securing the steadiness of the arc, the lessening of the rate at which they are burnt away, the elimination, as far as possible, of the noxious vapours that are given off, and a lower first cost. One of the main objections to the "flame" arc is the fact that it does not admit of being enclosed, although efforts are being made to partially secure that end by the employment of magazines which shall contain sufficient carbons to obtain 50 hours of burning. The perfect magazine lamp has been coming for a long time; whether present-day manufacturers will meet with any better success than those who have previously attempted is an interesting point. The outlook is distinctly promising. Mention may be made of the interesting lamp known as the "magnetite," which has been brought forward in America; wherein black oxide of iron is used as one of the electrodes, the other, or upper electrode, being of copper of such a section that the heat developed is conducted away as fast as it is generated—the copper never getting very hot, therefore, does not burn away. The light is emitted from the magnetite vapour formed, and the rate at which the lower electrode burns away being $\frac{1}{8}$in. per hour. Various salts are added to the magnetite electrodes for the purpose of increasing their life, and it is said to be possible to obtain a life of 500 hours with an 8in. electrode.

Enough has been said to show that the modern tendency in the development of the electric lamp is to produce luminosity by intensely heating some adjunct which usually takes the form of some rare earth or metallic oxide. To take a parallel, we have the limelight, produced by heating to an intense degree a cylinder of lime, or the Welsbach incandescent, by the heating of a mantle impregnated with metallic salts; so in the electrical world there is the Nernst lamp, in which the burner, composed of metallic oxides, is heated electrically, and the flame arc lamp, with the carbons impregnated with special salts to give added brilliance. The question of the testing and certifying of carbon-filament incandescent lamps has been lately receiving the attention of the Municipal Electrical Association, with a view to securing uniformity of practice amongst lamp manufacturers and a more accurate and reliable grading of lamps. If the recommendation of the report drawn up by the Municipal Electrical Association be in the main adopted by the Engineering Standards Committee, there is little doubt that it will lead to a discontinuance of the use of lamps offered at low prices, which are wasteful in energy consumption and do not give the amount of light specified. It does not appear advisable that municipalities and supply companies should trade in lamps, and the desired end can be attained by enabling all and sundry who trade in lamps to submit them to the local testing authority. Such a plan, if adopted, would have the effect of raising the average efficiency of lamps in use, reduce consumers' accounts, and minimise the unfair and unnecessary advantage which is given to the gas industry by the present use of inefficient incandescent lamps.

In these days of strenuous competition with the gas industry for the lighting of the streets in our large cities or towns, it behoves all interested to take every advantage of the improvements that have been made if this work is to remain in our hands. The application of the intensified or high-pressure system of gas lighting has found favour in many quarters, and is a competition that has to be seriously faced. We had an example of this only recently in London, when tenders were invited for the lighting of the new thoroughfares of Kingsway and Aldwych. With this exception, however, no town of any size appears to be reverting to gas as the result of definite comparative tests between the two rival systems. On the other hand, lighting by electricity is considerably on the increase. Special mention should be made of the present lighting of Fleet-street, London, by gas, but it is clear that this change is made only as an experiment, and cannot be possibly regarded as a case of the supersession of electricity by gas. Against this may be set the fact that the Westminster Council, after conducting extended comparative tests between arc lighting and the high-pressure gas systems, have entered into contracts for a considerable period for street-lighting with the electrical supply companies. That the improved systems of gaslighting are economical as regards amount of gas consumed, maintenance, and labour must be admitted (a figure of 1·08d. per 1,000 candle-power hours being given as the inclusive cost in one instance.) It should be remembered that in the case of incandescent mantles, and more particularly those used on high-pressure lamps, the condition of the mantle will account for great variations in the average candle-power, and this is a point to be taken into consideration when comparing the rival systems on the correct basis—viz., the average total cost per candle-power per annum. Electrical engineers have not much difficulty in showing on this latter basis a superior economy for electric lighting. What the incandescent mantle has done for the gas industry it appears more than probable the flame arc lamp will finally accomplish for the electrical industry. Available figures from recent tests show that the total cost per candle-power per annum of a system of street-lighting using flame arcs is some 30 to 50 per cent. more economical than high-pressure gas, according to whether the arcs are long or short hour. The really burning question is what degree of illumination is necessary and adequate for a given area. So often comparisons are made between the costs of lighting per mile of route, either electrically or by gas, when the relative degree of illumination between the two is out of all proportion. Such comparisons are absolutely useless, very misleading, and give rise to extravagant statements on behalf of the rival illuminants.

One other point touching on this question of street-lighting. On analysing some of the published returns for electrical street-lighting, it will be observed that with a system of open arcs the cost of current may be taken as varying from 50 to 60 per cent. of the total charges, and the cost of the carbons, trimming, and general maintenance the remainder. With a system

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of "single enclosure" lamps it has been found that the cost of current is some 90 per cent. of the total, the maintenance and other charges amounting only to some 10 per cent. It is pretty evident, therefore, that any system giving long hours of burning has a great commercial value, and it is to be hoped that this may be capable of extension to "flame arcs" by the successful development of the magazine lamp.

(To be continued.)

OLYMPIA MOTOR SHOW.

The fourth international exhibition of the Society of Motor Manufacturers and Traders was opened on Nov. 17, and will remain open until Nov. 25, inclusive. The show was opened with a luncheon, at which Mr. Sidney Straker, A.M.I.C.E, presided over a large and distinguished company, including the Hon. A. Stanley, M.P., Lord Montague of Beaulieu, Lord De La Warr, Lord Russell, Lord Suffield, Sir Ernest Clarke, the Mayor of Hammersmith, Sir Alexander Binnie, the Earl of Wilton, Sir John T. Thornycroft, Sir J. Clifton Robinson, Mr. L. Gomme (clerk to the London County Council), Colonel Holden, R.A., Sir Vincent Hill, Colonel Fox, Sir J. Macdonald, and others.

After the loyal toasts had been honoured, the Hon. ARTHUR STANLEY, M.P., in proposing "The Society's Exhibition," advocated the establishment of a central road authority to deal with the main roads, not necessarily in an executive but in an advisory capacity. He also advocated the employment of the unemployed on the construction of motor roads. He believed this could be done without a penny of new taxation or increased expense. If to the £1,800,000 already contributed by the Government they added the amount received in motorcar and cycle licenses and the amount received in fines, it would amount to something like £2,000,000 per annum, which was the amount, as nearly as he could ascertain, which was spent on the main roads.

The CHAIRMAN, in his reply, said that in connection with the present and the last show the society had spent over £10,000 in order to make the building suitable for their purpose. No second show would be held next year, and, therefore, all sections of motors would be included in one show in November next.

The previous show was held last February, when the decision was taken to hold subsequent exhibitions in the month of November. This decision was based on the fact that more cars are now used in this country than in France, and that London is the chief market of the world. Moreover, it was agreed that for the home manufacturers the month of November was the most suitable time of year. The applications for space immediately following last February's exhibition were such as to enforce the necessity of obtaining increased accommodation, which has been done by the improvement of the annexe to Olympia. The increased space has been chiefly devoted to commercial motor vehicles and marine motors. The space allotted in both these sections has been almost exactly doubled. A further increase of space has been obtained in the gallery, which has been somewhat relieved by the creation of a new section—that for carriage work and components—which is located in the annexe. This is the first occasion on which the importance of the home manufacture of such component parts has been recognised by a special section, showing the great advance in this direction.

There are 264 stands, and the increase in the number of exhibitors is equivalent to about 20 per cent., there being over 300 exhibitors as against 250 last February. The foreign representation is complete. The tyre section is located on the south side of the gallery, and contains several new exhibitors. The machinery section is in the recess on the south side of the annexe. Special attention is called to the marine section, which is very interesting. The motorcars, as before, occupy the whole of the main hall, with the exception of the portion nearest to the annexe, where the commercial section begins. In this section the chief point of interest is the large number of public service vehicles. The building has been greatly improved by the cleaning of the glass roof, as well as by the new roof over the annexe, whilst the electric lighting and the decoration are both on an approved scale. The gangways have been increased, the warming and ventilation reorganised, and there is seating accommodation in the gallery, where Lieutenant Charles Godfrey's band performs daily. The electrical exhibits are again very few, but we saw some beautiful carriages of the Electromobile Company, which are in every respect similar to those described by us on previous occasions, the company having found their type answer so well that they have adhered to it, with the exception of a forced lubricator direct off the motor, which, we are informed, ensures a saving of 2 per cent. We were also told that the contact breaker used has resulted in a saving of £1 per year in maintenance on the cars where the appliance is in use. We also noticed three front-driven carriages exhibited by the Kriéger Electric Carriage Syndicate, Limited.

Magnetic ignition is applied to most of the vehicles in its various well-known forms, and there is a good show of accessories of all kinds.

PHYSICAL SOCIETY.

At the meeting of this society on Nov. 10, Dr. C. Chree, F.R.S., vice-president, in the chair,

A paper on "*The Question of Temperature and Efficiency of Thermal Radiation*" was read by Mr. JAMES SWINBURNE. It has long been known that various surfaces have different emissivities, and it is generally held that at a given temperature some bodies radiate a larger percentage of their total radiation in the form of light. This view is largely based on some experiments by Evans and Bottomley. Evans's experiments really show that if two filaments, A and B, of the same area but of low and high emissivities respectively are run to give the same light, the filament, A, of lower emissivity will give a higher efficiency, and it will give a still higher efficiency if run so as to use the same power as B. This is a natural consequence of the different emissivities, and does not at all show that A gives a higher efficiency at the same temperature as B. Prof. Bottomley's experiments are criticised on the ground that he used no photometer, and his reasoning attacked on the ground that he makes the same slip as Evans in confusing difference of emissivity with difference of efficiency at the same temperature. It is urged that a body, A, at the same temperature as B cannot give out radiation corresponding to a higher temperature of B; for if it could, and A and B were enclosed in a perfectly reflecting space, A would heat B to a higher temperature than A. It may be said that A can have a higher efficiency than B, not by giving out rays corresponding to B at a higher temperature, but by omitting to give some of the longer radiations than B gives. If this were true, a hot body might be surrounded by a thin case of A lined inside with a substance which only emitted and absorbed long waves. The case would then take in long and give out short waves, though colder than the source. High efficiency or selective emissivity are always sought in polished, grey, or white surfaces like flashed filaments, platinum and other metal wires, and rare earths. If there were such a thing, it should be found not in white but in black bodies, as a body which is a specially good radiator of light when hot should be black when cold. Lummer's curves of the distribution of energy for a "black body" and polished platicum are compared, and show somewhat higher efficiency for platinum; but the comparison is difficult. The behaviour of flashed lamps and incandescent gas mantles is explained by the difference of emissivity, without any need for selective emissivities.

The Secretary read a letter from Dr. J. T. BOTTOMLEY, in which he stated that the author's paper seemed to be to a large extent an attack on his work on radiation. He could not see that Mr. Swinburne had made a single experiment in support of his proposition that "in the case of pure temperature radiation, the light efficiency is a function of the surface temperature only." No amount of discussion such as the author asked for could do anything to prove or disprove this proposition. He failed to see that the author had worked out any logical proof of the proposition. The author had assumed that he (Dr. Bottomley) was incapable of matching the light-giving properties of two platinum strips placed side by side and properly arranged for this sort of comparison. The matching is exactly the same in principle as in shadow photometry, and in all the cases cited in the paper to which Mr. Swinburne takes exception, Dr. Bottomley's determinations agreed with those of his assistant, Mr. Evans.

Dr. J. A. HARKER expressed his interest in the paper, and said that the question of radiation was of practical importance in the measurement of high temperatures by electrical resistance methods. He asked if two platinum thermometers, one bright and the other blackened, but identical in other respects, were transferred from an ice-bath into a sulphur-bath, would the final temperatures of the two thermometers be the same, and also would the thermometers approach their final temperatures at the same rate?

Prof. H. L. CALLENDAR, referring to Dr. Harker's questions, stated that if the sulphur bath was in an isothermal enclosure, the two wires would reach the same ultimate temperature although the blackened one would reach it quicker. The difference, however, would be small. With fine wires the loss of heat by conduction through the gas is more important than the radiation loss. The loss by radiation is proportional to the surface, but the loss by conduction is not, and it, therefore, becomes relatively more and more important with the fineness of the wire. With regard to the action of incandescent mantles, he thought the author's theory was reasonable and satisfactory.

Mr. MAURICE SOLOMON said he did not agree with Mr. Swinburne's contention that in the case of solids there was no such thing as selective emissivity, but that all bodies at the same temperature radiated light of the same efficiency. Selective emissivity existed in the case of incandescent vapours, and if it was consistent with the laws of thermodynamics in such a case, it could not be inconsistent in the case of an incandescent solid. With reference to the incandescent mantle, the explanation put forward by the author did not seem satisfactory. It was difficult to believe that the very small differences in colour between a thoria, a thoria-ceria, and a ceria mantle could account for the enormous differences in their candle-powers.

Prof. W. E. AYRTON referred to experiments which he had carried out which tended to show that the temperature of a Bunsen flame was lowered by an incandescent mantle. He had also found that small pieces of mantle heated in a platinum boat to various temperatures just below the melting point of platinum never looked brighter than the platinum. If, however, a small hole was made in the bottom of the boat and coal-gas passed in, the mantle immediately became brilliant.

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Mr. SWINBURNE, replying to Dr. Bottomley, said that his main argument was that he had not made experiments. In the investigation of a question such as that considered in the paper it was possible to prove much by means of experiment, but it was also possible to attack the problem by thermodynamic reasoning. He expressed his interest in the fact that Prof. Callendar had referred to his views as reasonable.

HAMMERSMITH ELECTRICITY ACCOUNTS.

From the accounts of the Hammersmith electricity department for the year ended March 31, 1905, it appears that the total expenditure on capital account to that date amounts to £210,994. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	7,991	9	1
Repairs, etc., of buildings and plant	2,207	18	2
Distribution of electricity	1,329	5	0
Attending and repairs to public lamps	1,467	15	6
Management expenses, salaries, etc.	2,095	4	6
Rents, rates, and taxes	1,432	12	3
Costs of mortgages	51	4	0
Insurance of boilers, engines, etc.	310	5	9
Special charges	2,026	13	4
	18,913	6	7
Gross profit for year	16,856	12	4
	£35,769	18	11

Cr. Income.	£	s.	d.
By sale of current for private lighting	30,329	8	10
Public lighting	4,498	7	10
Meter rents	73	0	4
Miscellaneous receipts—rent of motors, etc.	869	1	11
	£35,769	18	11

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	195,890	0	0
Reserve fund account	2,500	0	0
Sundry creditors and deposits	3,007	4	4
Contractors' deposits with tenders	52	11	6
Balance of accumulated net profits	8,452	3	5
	£209,901	19	3

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	186,373	8	8
Sundry debtors for current supplied, etc.	8,826	13	8
Stores on hand	1,203	12	1
Cash in hands of engineer	4	12	8
Cash in hands of treasurer	13,493	12	2
	£209,901	19	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		3,456,570
Quantity sold { Private consumers by meter 2,475,727 / Public lamps by contract 472,906 }		2 948,633
Quantity used on works		456,306
Total quantity accounted for		3,404,939
Quantity not accounted for		51,631
Total maximum supply demanded (kilowatts)		2,426

Number of public lamps: 225 arcs, 48 incandescents.

BEXHILL ELECTRICITY ACCOUNTS.

The accounts of the Bexhill electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £52,179. We give herewith abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	2,817	0	9
Distribution of electricity	331	10	7
Attending and repairs to public lamps	501	12	1
Rents, rates, taxes, and insurance	209	7	7
Management expenses, salaries, etc.	768	2	10
Law expenses	4	9	1
Excess expenditure on electrical exhibition	56	15	9
	4,688	10	8
Amount carried to net revenue account	2,568	10	5
	£7,257	9	1

Cr. Income.	£	s.	d.
By sale of current by meter	4,469	0	9
Sale under contracts	54	6	6
Public lighting	2,444	4	8
Rental of meters and other apparatus	234	14	7
Miscellaneous receipts	85	11	0
	7,287	17	6
Less bad debts written off	30	8	5
	£7,257	9	1

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—outstanding on loan account	42,513	18	5
Sundry creditors	238	16	1
Treasurer's account, overdrawn	7,350	1	3
	£50,102	15	9

Cr. Assets.	£	s.	d.
Capital account—amount expended, less depreciation	46,302	0	7
Sundry debtors for current supplied	1,848	13	3
Other debtors	2	10	2
Stores on hand	238	15	1
Cash in hand	134	19	9
Balance at debit of net revenue account	1,575	16	11
	£50,102	15	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		510,285
Quantity sold { Private consumers by meter 249,572 / By contract 5,005 / Public lighting 156,682 }		411,259
Quantity used on works and exhibition		17,416
Total quantity accounted for		432,725
Quantity not accounted for		77,562
Total maximum supply demanded (kilowatts)		371

Number of public lamps: 48 arcs, 257 incandescents.

WATFORD ELECTRICITY ACCOUNTS.

We give herewith abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., by the Watford electricity department for the year ending March 31, 1905. The total capital expenditure to end of past year was £64,642.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	3,886	0	1
Distribution of electricity	137	18	0
Attending and repairs to public lamps	183	19	9
Rents, rates, and taxes and insurance	137	19	3
Management expenses, salaries, etc.	632	2	2
Special charges	1	12	3
	£4,979	11	6
Amount carried to net revenue account	3,638	1	2
	£8,617	12	8

Cr. Income.	£	s.	d.
By sale of current per meter, less discounts	4,428	17	6
Public lighting	3,962	13	3
Rental of meters and other apparatus	160	13	4
Sale and repairs of apparatus	66	8	3
	£8,617	12	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount outstanding on loan account	49,259	12	1
Due to bank on temporary loans	9,231	1	0
Sundry creditors	262	13	10
Balance at credit of net revenue account	221	15	4
Sums provided by Council's general fund	2,485	1	5
	£61,460	3	8

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	58,490	13	1
Sundry debtors for current supplied	2,688	5	10
Stores on hand	236	0	0
Debtors for meter rents	43	2	6
Cash in hand	2	2	3
	£61,460	3	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		698,762
Quantity sold { Private consumers 252,515 / Public lamps 316,677 }		569,192
Quantity used on works, etc.		67,686
Total quantity accounted for		636,878
Quantity unaccounted for		61,886
Maximum supply demanded (kilowatts)		431

Number of public lamps: 8 arcs, 1,800 incandescents.

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NEW COMMITTEES.

The following committees have been appointed:

DARLINGTON.—*Electricity and Light Railways*—Aldermen Wilkes and Swinburne; Councillors Wooler, Stairmand, Benson, Dixon, Starmer, Crooks, Robinson, Eastwood, and Oliver.

HULL.—*Tramways*—T. B. Atkinson, W. H. Cockerline, W. Hakes, T. G. Hall, E. Hanger, J. H. Hargreaves, D. Livingstone, W. G. Millington, E. Ombler (in the place of Mr. G. Sipling), C. Raine, E. Robson, G. L. Scott, J. Shaw, W. G. Wharram, and W. Wheatley. *Electric Lighting* — F. Askew, T. B. Atkinson, G. J. Bentham, J. Brown, H. Dean (in the place of Mr. G. Sipling), J. W. Gould, E. Hanger, F. O. Hare, D. Livingstone, W. G. Millington, J. Pybus, J. H. Robins, T. S. Taylor, W. Wheatley, and S. P. Wood.

JARROW.—*Electric Light and Tramways*—Aldermen Armstrong and Handyside, and Councillors Archbold Connor, Dillon, Hall, Ramsey, Reavley, and Rose.

LIVERPOOL.—*Electric Power and Lighting*—Councillors R. Dart (chairman), M. Muspratt (deputy chairman), H. McCubbin, F. Smith, W. Boote, T. Burke, H. S. Higginbottom, H. Jones, R. Pritchard, A. L. R. Rathbone, H. R. Rathbone, C. H. Rutherford, T. Shaw, H. Wilson, J. Wilson.

LIVERPOOL.—*Tramways*—Sir Charles Petrie, Sir Thomas Bland Royden, Bart; Councillors F. Smith, J. Duncan, A. T. Salvidge, jun., W. H. Williams, J. S. Harmood Banner, M.P., J. Bibby, R. H. Bullen, W. Denton, J. L. Eills, C. F. Garner, H. S. Higginbottom, S. M. Hutchinson, R. Kelly, T. Kelly, E. L. Lloyd, W. W. Walker.

NELSON.—*Electricity and Tramways*—Alderman W. Reed (chairman), the mayor (Alderman Nelson), Aldermen Haycock and Hartley; Councillors Nelson, Dimsdale, Pattry, Lambert, Smith, A. E. Wilkinson, and E. Wilkinson.

WARRINGTON.—*Electricity and Tramways*—Aldermen Bolton (mayor), Evans, Pierpoint, Smethurst, Tinnion; Councillors Craik, Ellison, Lord, Maginn, Peacock, Pemberton, Wilkinson.

WEYMOUTH.—*Electric Lighting*—The Mayor, Messrs. Whettam (chairman), Lovell, Bagg, Morris, Smith, Honebon, Blakey, Bridle, and Stewart.

APPOINTMENTS VACANT.

Electrical Engineer, Radcliffe Urban District Council. Salary, £150 to £172 per annum.

Wireman for electric light and power plant. Applications to Box 29, *Electrical Engineer* Office.

Representatives for an electrical contracting firm. Applications to Box G 33, *Electrical Engineer* Office.

Laboratory and Workshop Assistant, Battersea Polytechnic, S.W. Commencing salary, 20s. a week.

Assistant Lecturer and Demonstrator in Electrical Engineering, Leeds University. Salary, £175 a year.

Junior Assistant, Peterborough Corporation. Salary, £1 per week. Applications by Nov. 30. See advertisement.

Improver. Wages, 10s. per week. Applications to Box 702, *Electrical Engineer* Office. See advertisement in last issue.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office.

Electrical Engineer, colliery in the North of England. Applications to Box Q 11, *Electrical Engineer* Office. See advertisement.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Switchboard Attendant. Wages, 25s. per week. Applications to Box R P 5, *Electrical Engineer* Office. See advertisement in last issue.

Junior Charge Engineer. Salary, 30s. per week, rising to 35s. Applications to the Borough Electrical Engineer, 335, High-street, Cheltenham.

Mechanical Draughtsman, Birmingham University. Salary, £250 per annum. Applications to the Secretary before Nov. 27. See advertisement in last issue.

LEGAL INTELLIGENCE.

ACTION FOR DAMAGES.

Bainbridge v. the Postmaster-General and Crane.

This was an appeal heard before the Master of the Rolls and Lord Justice Mathew on Saturday last from an order made by Mr. Justice Walton at Chambers allowing the plaintiff to add the Postmaster-General as a defendant to an action brought to recover damages for personal injuries alleged to have been caused by the negligence of the defendants or their servants. The alleged negligence consisted in want of care in repairing a footway after the laying of some telegraph wires at Wigan. The action was originally brought solely against Mr. Crane, the Post Office sectional engineer of the district, under whose directions the work had been done. Subsequently the plaintiff took out a summons to add the Postmaster-General as a defendant to the action. The application was to add him personally by name. The district registrar made an order adding the Postmaster-General, not by name, but in his corporate capacity. The Postmaster-General appealed from that order to the judge at Chambers. Mr. Justice Walton refused to strike out the Postmaster-General's name, being of opinion that the question whether the Postmaster-General could be sued was an important question in the action, and was not a matter to be determined on a summons, but he gave leave to appeal.

The Master of the Rolls held that Mr. Justice Walton had been wrong in not stopping the action against the Postmaster-General. In point of fact, he thought the learned judge seemed to have done little more than invite the Court of Appeal to consider the question, but in point of form they must reverse his decision and allow the appeal.

Lord Justice Mathew delivered judgment to the same effect.

COMPANY PETITION.

In the Chancery Division on Tuesday, Mr. Justice Buckley heard the petition of S. T. Biggs and another for the compulsory winding-up of the British Pioneer Electric Light and Power Co. of India. The petitioners asked for an adjournment in order that they might have an opportunity of considering and answering the company's affidavits, which were filed the previous night.

For the company, it was stated that this petition was by a shareholder who was opposed by all the other shareholders, and the difficulty that had arisen was entirely due to the delay of the petitioners. It was of extreme importance to one of the persons concerned that the petition should be disposed of at the earliest opportunity.

The petitioners, however, said they wished to have access to the documents in connection with the sale of a concession for a tramway in Bombay to the British Electric Light Co., and a contract given to a small company, of which two of the directors were the principal shareholders, and the judge ordered the case to stand over for a week.

TRAMCAR AND CART.

Action for Damages.

The Manchester Corporation were the defendants in a case heard at the Manchester Assizes before Mr. Justice Ridley on Monday, when they were sued by a carter named George Meyers for damages for personal injuries alleged to have been caused by the negligence of the defendants' servant. It appeared that a Corporation tramcar and the plaintiff's cart came into collision in Stockport-road at a point near the junction with John-street, where the road is somewhat narrow. The plaintiff on driving out of John-street crossed the tramline to get to his proper side of the road. While he was doing so the car came up and struck a wheel of his cart. The plaintiff was thrown out. On behalf of the defendants the negligence was denied, and the accident was declared to be due to the plaintiff's own conduct. After hearing the evidence, the jury found a verdict for the plaintiff, damages £250, and judgment was entered accordingly.

SALFORD TRAMCAR ACCIDENT.

At the Manchester Assizes on Friday last, before Mr. Justice Ridley and a common jury, Robert Spencer, carriage proprietor, of Bury, sued the Salford Corporation for damages alleged to have been caused to a wagonette in the Bury Old-road on Sept. 2.

The plaintiff was stated to have been driving from Belle Vue to Bury. When he was near Singleton-road, in the Bury Old-road, he had to traverse the looped tramcar lines which at that point occupy nearly the full width of the road. While he was on the loop the last car to Whitefield overtook his wagonette and crushed it into the bank and the hedge. The plaintiff was thrown from the vehicle and sustained injuries.

For the defence, evidence was called to show that when the accident happened the plaintiff was endeavouring to pass the tramcar, and that the collision was due to this cause.

The jury accepted the version of the affair given by the plaintiff, and awarded him £50 damages and costs.

TELEGRAPH POLES.

Judge Russell, at the Farnham County Court on Wednesday, was asked to settle a dispute between the Postmaster-General and the Farnborough Urban District Council as to whether wooden or iron posts should be used for a telegraph wire along Sycamore-road, Church-lane, and Pirbright-road, Farnborough. The Council insisted upon iron poles being erected, and the Postmaster-General objected on the score of expense.

HIS HONOUR said he did not see any really serious difference between creosote poles and iron. The only question seemed to be the obstruction. Both creosote and iron poles were, at the best, unsightly. He thought the application of the Postmaster-General was a reasonable one, and he therefore gave his sanction for the erection.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

An extraordinary general meeting of this Company was held this week at Winchester House, E.C., for the purpose of confirming the resolution passed on the 30th ult., which was to the effect that, irrespective of any remuneration to which the directors may be entitled under the articles of the association, they shall receive for their services during the year ended June 30, 1905, the additional sum of

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750 guineas, such amount to be divided among them as they may agree. Mr. H. Wolfenden presided.

The resolution was confirmed.

LANCASTER AND DISTRICT TRAMWAYS.

At the annual meeting of the Lancaster and District Tramways Co. on Saturday last, Councillor A. Bell (chairman) reminded the shareholders that in 1901 Messrs. Kershaw and Co., of Birmingham, contracted with their directors to purchase the undertaking for £45,000, subject to the Corporation extending the period when they would have the right of purchase beyond 21 years. That, however, the Corporation would not grant, and now Messrs. Kershaw and Co. had again approached the Corporation with a fresh proposal, which would lead to the early conversion of the system to electric traction. If the Corporation were not willing to purchase the concern, they ought not to put any impediment in the way of other people purchasing it and doing the work.

BURY, ROCHDALE, AND OLDHAM TRAMWAY.

A meeting of the shareholders of this Company was held in Manchester on Tuesday to receive the liquidators' report. Two years ago the authorities decided to compulsorily purchase the undertaking, and the arbitrator fixed the price at £162,675, which was considerably in excess of the most sanguine expectations. The liquidators have paid off the debentures with interest, and up to the present time have made a total distribution of 31s. per £1 share.

The CHAIRMAN (Mr. J. Coomer), who presided at the meeting, explained that the liquidators had now a balance in hand of £1,620 but they had yet to receive the costs incurred subsequent to February, 1904. There were liabilities amounting to £1,100 incurred by the old company prior to its reconstruction, but the creditors could not be found. The Court was being asked to allow the liquidators to insert advertisements for these creditors, and if they could not be found to say that the £1,100 should pass to the present shareholders. With the additional costs to come in it was estimated that there would be an available balance of £3 300, subject to the retention of the £1,100. It was decided that the two liquidators be allowed £1,000 for their services, which would leave a balance of about £2,300. This was equivalent to an additional shilling per share, and would bring the total distribution to 32s. per £1 share. If the liquidators are not allowed to retain the £1,100 belonging to the old creditors, there will still be a balance sufficient to pay another 6d. per share. Two years before the arbitration proceedings the Company's shares could have been purchased at 4s. each, and just prior to the commencement of the arbitration they were being sold at 10s. each.

RENO ELECTRIC STAIRWAYS.

The accounts of this Company for the period from April 12, 1902, to Dec. 31, 1904, show, after meeting debenture interest, a debit to profit and loss of £2,400.

CAPE ELECTRIC TRAMWAYS.

The report for the year ended June 30 shows a net profit after providing for debenture interest and redemption of £33,550, which, with the balance brought forward, makes £34,342. The reserve fund has been credited with £8 000 and dividends amounting to 5 per cent. have already been paid. The tramways carried in Cape Town 15,020,503 passengers, earning £180 905, against 15 902,998 passengers, earning £195 015 during 1903-1904. In Port Elizabeth 4,227,576 passengers were carried, earning £45,708, against 4,509,786, earning £50,157 for the preceding year. In connection with the shortfall in the gross revenue of £17,558 the directors call attention to the most unsatisfactory conditions which have weighed upon and still depress the entire business situation in Cape Town, Port Elizabeth, and the Cape Colony generally, and as to which at the present no improvement seems in any way apparent. The Camps Bay tramline, leased from the Cape Town Consolidated Tramways and Land Co. has again proved a disappointment, and the year's working, including the rent paid to the Consolidated Co., shows a loss of £13,225, but against this, the report states, must be set the considerable revenue derived by the Cape Town system through the operation of the Camps Bay tramways.

WEST INDIA AND PANAMA TELEGRAPH.

The report of this Company for the half-year ended June 30, 1905, states that the amount to credit of revenue is £32,773, against £34,581 for the corresponding half of 1904. Expenses have been £23,230, against £23,437, leaving a balance of £9,543, to which is added £1,756 interest on investments and £494 brought forward from last account, making a total of £11,793. It is proposed to pay 6s. per share on account of arrears of dividends to June 30, 1905, on the first preference shares, £10,369, carrying forward £1,424. This will leave the following dividends in arrear: on the first preference shares £3,456, and on the second preference shares £14,007. It was pointed out in the last report that at the date of its issue there was a decrease in the traffic receipts. This decrease continued for the remainder of the half-year, and amounted in the aggregate to £993, as compared with the corresponding period of 1904. The traffic receipts for the current half-year also show a decline. The directors have to report that the British Guiana subsidy of £4,500 per annum, voted for 10 years from Jan. 1, 1892, in consideration of the Company's laying a new cable between that colony and Trinidad, and continued at that rate up to March 31 last, has from that date been reduced to £3,000 per annum.

NEW COMPANIES REGISTERED.

African Rubber Co., Limited.—Capital, £70,000. Objects: to acquire and develop the Boniaka rubber concessions on the River Ancobra, near the small town of Baria. Secretary and registered office: A. Parkes, Moorgate Station-chambers, E.C.

Makin and Co., Limited.—Capital, £1,000. Objects: to acquire the business carried on at Sheffield as Makin and Co., and to carry on the business of electricians, electrical, and mechanical engineers, etc. Registered office: 23 and 25, Division-street, Sheffield.

J. S. Fairfax and Co., Limited.—Capital, £12,500. Objects: to adopt an agreement with J. S. Fairfax for the acquisition of certain patents granted to him, and to carry on the business of mechanical, hydraulic, marine, electrical, traction, and general engineers. Registered office: Kew Bridge Engineering Works, 100 and 102 Strand-on-the-Green, Chiswick, W.

Cumberland Power Syndicate, Limited.—Capital, £5,000. Objects: to adopt an agreement with J. Sturgeon, B. H. Thwaite, A. R. Chorley, and J. Paterson, and to carry on in Cumberland and elsewhere the business of an electric power and power gas supply company, and that of electricians, electrical, and general engineers, etc. Registered office: 4, South-parade, Leeds.

Evans's Carburetter and Motor Pump Syndicate, Limited.—Capital, £2,000. Objects: to acquire certain patents for inventions relating to (1) new and improved carburetters and vaporisers for internal-combustion engines; (2) to motor pumps; (3) to a compound nozzle for blowing compressed air, with a suction principle in combination therewith; (4) to a radiator to be attached to internal-combustion engines, for cooling water and for other purposes in connection therewith; to develop, deal with, and turn to account the same, or any improvement thereon; to carry on the business of mechanical and electrical engineers, etc.

Liens Registered.

Northern Counties Electricity Supply Co., Limited.—A memorandum of satisfaction in full of mortgage debentures bearing various dates from March 30, 1904, to Jan. 12, 1905, inclusive, securing £87,000, has been filed.

Llanrwst Electricity Supply Co., Limited.—Four debentures, dated Oct. 30, 1905, securing in all £1,000, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holders: A. P. Elworth, Sandbach; R. Conway, Mostyn street, Llandudno; and O. I. Jones, Plas yndre, Llanrwst.

Northampton Electric Light and Power Co., Limited.—Issue on Nov. 4 of £300 debentures, part of a series created June 3, 1895, to secure not more than two-thirds of the paid-up capital for the time being, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £33,200.

Manchester Motor Co., Limited (Birmingham).—Issue on Nov. 2 of £1,738. 1s. 5d. debentures, part of a series created by resolutions of Dec. 19, 1904, and Jan. 12, 1905, to secure £19,000, charged on the company's undertaking and property present and future, including uncalled capital, subject to first mortgage debentures securing £50,000. No trustees. Total amount previously issued of same series, £16,076. 1s. 4d.

CONTRACTS FOR ELECTRICAL SUPPLIES.

St. Pancras.—The Borough Council invite tenders for supplying lead-covered and armoured cables. Tenders by noon on Nov. 30. See advertisement.

London, W.—Messrs. Grice and Co., Addison Wharf, Warwick-road, Kensington, require a 10-ton electric derrick crane with 60ft. to 70ft. jib, continuous current.

Yarmouth.—Tenders are to be invited by the Port and Haven Commission for an electrically driven crane. Including foundations, etc., the cost is estimated at £2,000.

Bermondsey.—Tenders for new plant, estimated to cost £5,390, will shortly be advertised for. An estimate is being prepared for condensing plant, for which tenders will be invited.

Glasgow.—The Corporation invite tenders for (1) electric light installation, etc., and (2) the heating and ventilating for Pollokshields District Library. Tenders by 10 a.m. on Nov. 27.

Glasgow.—The Corporation invite tenders for the supply of 1,000-kw. motor-generators and high and low tension sub-station switchgear. Tenders by Dec. 4. See advertisement.

Ebbw Vale.—The Urban District Council invite tenders for free wiring and supply of incandescent lamps. Tenders by 12 noon on Nov. 25. Full particulars in advertisement columns.

Omnibus Lighting.—A London motor omnibus company is open to receive proposals for the lighting of its vehicles by acetylene or electricity. Apply to Box 306, Willing's, 125, Strand, W.C.

Salford.—The Corporation invite tenders for the wiring of the higher-grade Council school for girls, Victor-street, Salford. Tenders to the Director of Education, Chapel-street, Salford, by Nov. 30.

Sao Luiz.—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 16. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Warrington.—The Tramways Committee invite tenders for the supply and erection of (1) overhead gear; (2) steel rails, fishplates, and fishbolts. Tenders to the Chairman of the Tramways Committee, Town Hall, Warrington, by 12 noon on Nov. 28.

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Madrid.—The Public Works Department have opened a competition for a scheme for electric tramways from Zumárraga to Azcoitia (Provinz Guipúzcoa). Particulars may be obtained from the Direccion general de Obras públicas. Offers by Jan. 16, 1906.

Launceston (Tasmania).—Tenders are invited for the supply of 500 or more electric meters and for maximum demand indicators. Tenders to Mr. C. W. Rocher, town clerk, Town Hall, Launceston, Tasmania, by 12 noon on Jan. 15. See advertisement in last issue.

Aston Manor (near Birmingham).—The Public Works Committee invite tenders for the maintenance of a portion of their tramway system for 12 months from Jan. 1, 1906. Tenders to the Chairman of the Public Works Committee, Council House, Aston Manor, by noon on Nov. 24.

Whitchurch (near Cardiff).—The Asylums Committee of the Corporation invite tenders for the following plant, to be delivered and erected at the asylum: (Section 1) battery of accumulators, with booster; (2) engines and generators; (3) switchboard. Tenders to Mr. J. L. Wheatley, Town Hall, Cardiff, by Nov. 27.

Castlerea.—The Rural District Council invite tenders for the construction of works for lighting the town of Ballaghaderreen: (1) builders' work; (2) hydraulic turbine plant; (3) electrical work. Specifications and particulars may be had from Mr. C. Mulvany, M.I.C.E., Engineer's Office, Athlone, on payment of £1 as a deposit, returnable after receipt of bona fide tender. Tenders by Dec. 23.

Poplar.—The Guardians invite tenders for the supply and erection of the following plant at the children's homes and schools now in course of erection at Hutton, Essex: (Section X) steam-engines, dynamos, pipework, etc.; (Y, part 1) main switchboard, wiring, motors, etc.; (Y, part 2) fire-alarms, telephones, and electric bells. Tenders to Mr. G. Herbert Lough, clerk, Guardians' Offices, 45, Upper North-street, Poplar, E., by 6 p.m. on Dec. 13.

Christiania.—The Norwegian Telegraph Department are calling for tenders for the supply of 3,000 kg. of bronze wire. Tenders from British firms should be lodged *by their agents* in Christiania by midday on Dec. 1. The conditions of tender can be seen by agents on application to the telegraph authorities at Christiania, Bergen, Stavanger, and Orendal. Apart from the usual Customs duties, a preference of from 10 to 15 per cent. is given to Norwegian manufacturers.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension to that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Australian Commonwealth.—Tenders are invited by the Deputy Postmaster-General, Brisbane, for the supply and delivery at the Departmental Stores, Brisbane, of insulators, phosphor-bronze wire, copper sleeves, binders, and tapes. Tender forms, specifications, and conditions may be obtained from, and samples seen at, the Stores Branches, Postmaster-General's Department, Sydney, Melbourne, Adelaide, and Brisbane. Tenders by noon on Dec. 18.—Separate tenders are required by the Deputy Postmaster-General, Melbourne, for the supply and delivery at Melbourne of (1) 10 miles of 26-pair lead-covered paper-insulated telephone cable; (2) 1 mile of 155-pair lead-covered paper-insulated telephone cable (12½lb. conductors); (3) 5,000 barrel insulators delivery within three months of date of acceptance of tender. Tender forms, specifications, etc., and sample of insulator, may be seen at the General Post Offices, Melbourne, Sydney, Brisbane, Adelaide, Perth, and Hobart. Tenders must be endorsed "Tender for ——," as the case may be, and addressed to the Deputy Postmaster-General, Melbourne. They may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. Tenders by Dec. 17.

RESULTS OF TENDERS.

Stourbridge.—The Guardians have accepted the tender of Cross and Cross, Walsall, for the supply of electric bells, telephones, and tell-tales.

Acton.—The Urban District Council have accepted the tender of the Sloan Electrical Co. for the supply of carbons for the next 12 months.

Sheffield.—Messrs. Vickers, Sons, and Maxim have placed an order for a turbine complete, with condenser, etc., in the hands of Willans and Robinson, Rugby.

Yarmouth.—The Guardians have accepted the tender of Messrs. Cooper and Cunningham, at £19. 19s. 6d., for extension of the telephone system at the workhouse.

Yarmouth.—Two extra cars are to be purchased for the Gorleston and Southtown district, under the original contract with the British Electrical Engineering Co., at £507 per car.

London. — The South Metropolitan Electric Supply Co. (late Blackheath and Greenwich Co.), in view of the extension of their works at Greenwich, have just placed their contracts for the turbine and condensing plant with Willans and Robinson, Rugby.

Worksop.—The Urban District Council have accepted the tender of Chamberlain and Hookham for the supply of electrical slot meters, and that of the Pulsometer Engineering Co., at £200, for water-softening plant.

North-Eastern Railway Co.—It is reported that the above company have placed an order for the early delivery of 200 truck frames of a patent design with the Brush Electrical Engineering Co., of Loughborough.

Poplar.—The Borough Council have accepted the tender of Messrs. Geipel and Lange for provision of plant for the manufacture of disinfectants, at the sum of £325, and an expenditure not exceeding £100 is authorised for the erection and equipment of a shed for the plant.

Battersea.—The offer of Chitty Bros. for the purchase of scrap carbons at the central electric generating station at the rate of 35s. per ton has been accepted. The Lighting Committee recommend the acceptance of the tender of the Electric Construction Co. to provide and fix an electric motor of 15 h.p., together with all accessories, gearing, shafting, etc., at £358. 10s.

London County Council.—The following tenders have been received: (1) for the supply, delivery, and erection of 12 steel coal trucks required for use at the Greenwich electricity generating station:

Kerr, Stuart, and Co., London*	£990	0	0
S. J. Claye, Long Eaton	1,098	0	0
Mountain and Gibson, Bury	1,254	0	0
Hurst, Nelson, and Co., Motherwell	1,290	0	0
T. Davies Limited, Widnes	1,293	12	0
Flavell and Churchill, London	1,317	0	0
Brush Electrical Engineering Co., Loughborough	1,596	0	0

* Recommended for acceptance.

(2) 150 car ploughs, British Westinghouse Electric and Manufacturing Co. (the work to be executed by staff of the tramways department, under the direction of the chief officer of tramways, for a sum not exceeding £1,800).

St. Marylebone.—The Electricity Committee have received the following tenders for the supply of cables:

W. T. Glover and Co.	£7,581
Siemens Bros.	7,516
Callender	7,502
W. T. Henley's Telegraph Works Co.	7 333
British Insulated and Helsby Cables	7,333
St. Helens Cable Co.*	6,405

* Recommended for acceptance.

The same committee also recommend the acceptance of the tender of Elliott Bros., at £2,318. 5s., for the supply and erection of the switchboard at the south end of the generating station; the tender of Chadburn's (Ship) Telegraph Co., at £215, for the supply and fitting of telegraph instruments in connection with the switchboard at the generating station; and the placing of an order with C. A. Parsons and Co., at £1,754, for two spare armatures required for the dynamo at the generating station.

BUSINESS NOTES.

TRACTION.

Geneva Tramways Co.—The traffic receipts for the month of October amounted to £7,993, being an increase of £186 on the same month of the previous year.

Leeds.—The Tramways Committee of the City Council have decided to begin running motor omnibuses from Headingley to Adel along Westwood-lane as early as possible.

Peru.—We understand that various street railway lines are to be changed from horse to electric traction, and a new electric railway is projected to run between Chorillos and Lima.

Cleethorpes.—The District Council have decided to permit the tramway company to extend the electric tramway along the new King's-parade, provided certain conditions are complied with.

Musselburgh.—The Musselburgh and District Electric Light and Traction Co. give notice that they intend to apply to Parliament for powers to construct tramways in Musselburgh and the surrounding districts.

Oxford.—The City Council have decided to apply in the next session of Parliament for an Act authorising them to take over the existing tramways, and to reconstruct and adapt them for the use of electric power.

Manchester.—It is stated that the London and North-Western Railway Co. are considering the project of electrifying their line from the Manchester Exchange Station to Eccles and Patricroft, a distance of about six miles.

Renfrew.—Complaints were made at a recent meeting of the Town Council that workmen's fares on the tramcars were higher in that borough than in Glasgow, and it was decided to lay the matter before the manager of the Glasgow trams.

Buenos Ayres.—The Public Works Committee of the Buenos Ayres City Council have reported favourably on the project of Messrs. R. von Wentzky und Co. for a system of electric tramways to the suburbs of Villa Devoto, Villa Rita, etc.

Radcliffe.—A letter from the Tramways Committee was read at the last meeting of the Radcliffe Council to the effect that the former could not see their way to grant the request of the latter for an improved service of trams on the New-road section.

Weymouth.—With regard to the application of the Great Western Railway Co. for leave to deflect slightly the tramway line on the quay, the borough surveyor has advised that such deflection could be made with safety, and the mayor, on behalf of the Council, has consented to the work being carried out.

Norwich.—At the adjourned meeting of the Town Council a number of complaints were levelled against the Norwich lectr

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Tramways Co. for their irregular service of cars and other inefficient arrangements, whilst the Council's action in leasing the cars instead of working them themselves was adversely criticised.

Newcastle-on-Tyne.—The tramway employés (motormen and conductors) struck work on Saturday last, but resumed again on Monday morning after a tentative peace had been arranged. Much rioting took place, and the disturbances resulted in the enforced withdrawal of the cars from the streets. Reference to the cause of the strike is made elsewhere.

Tramways Over the Bridges.—A conference was held on Monday to protest against the rejection by the House of Lords of the Bill authorising over-bridge tramways. The members of the conference formed themselves into an association, to be called the North London Over-Bridge Tramways Association, and an influential executive of 20 members was formed.

Twickenham.—Complaints have been made by the District Council against the action of the tramways company in opening roads without giving notice to the Council. The Council feel that, as the highway authority it is entitled to receive notice from anyone opening roads, and have invited a conference of representatives of the districts concerned to consider the matter.

Kensington.—The Harrow-road and Paddington Tramways Co. propose to proceed at once with the work of reconstructing their tramway in Harrow-road for the electrical working of the system, and are prepared to do the work while the Borough Council are excavating and laying creosoted deal blocks on concrete in portion of the Harrow-road. To this the Council agree.

Devonport.—The Tramways Committee have decided to erect tramway passengers' shelters in several parts of the borough. The first shelter will be built at the junction of Albert-road and Exmouth-road. A sub-committee has been appointed to make inquiries with a view to the revision of fares on certain routes, and to consider the proposal for additional stopping places on the company's system.

Liverpool.—Notice has been given that at the next meeting of the Tramways Committee a proposal will be made for the reconstruction of the tramway lines along Everton-road to be proceeded with forthwith, and the Everton Church and Pierhead service established *via* Everton-road, Lowhill, and Erskine-street, returning *via* Brunswick-road and Everton-road (instead of *via* Shaw-street), as soon as possible.

Hyde Park.—The First Commissioner of his Majesty's Works states that, subject to certain conditions, electric carriages will be exempt from the rule prohibiting motor carriages from entering Hyde Park between the hours of 4 p.m. and 7 p.m. during the months of May, June, and July. There is no intention, however, of admitting motor-cars other than electric cars to the park during the prohibited hours.

Siam.—It is reported that an electric tramway has just been installed in Bangkok. This line, which is 12½ miles long, was opened on Oct. 1 by the King of Siam, who fastened the last bolt in the track and turned on the current in the power-house. With the exception of the royal car, for the building of which native or Chinese workmen were employed on the spot, the machinery and cars were manufactured by Messrs. Dick, Kerr, and Co.

Dundee.—The Tramways Committee of the Council were engaged on Monday in the consideration of a report of the manager relative to the opening of the Dundee and Broughty Ferry line, which will take place towards the end of the year. With regard to the covering of cars, the manager was instructed to report fully as to the coverings in use on other systems, while suggestions as to fares and other matters were deferred for consideration at a meeting to be specially convened.

Brazil.—The contract between the State Government and the Companhia Cantareira for a tramway service in the town of Nictheroy and the "barca" service across the bay has been renewed. The company are obliged to substitute electric for animal traction, to extend existing lines, and construct new ones. The works will cost about 5,000 contos—*i.e.*, 5,000,000 milreis, or about £333,000. The company are permitted to buy electric force, and therefore need not make an installation.

Folkestone.—At last week's meeting of the Town Council it was reported that Mr. Sellon was preparing plans and particulars with regard to the construction of an electrical tramway system from the top of Folkestone-hill to New Romney, and he would shortly apply to the Council for an interview. At present Folkestone Corporation are bound by a resolution to construct tramways over certain routes, and they must be on the surface-contact principle. It is supposed that in the course of a few weeks something definite will be heard in the matter.

Essex.—There was a large gathering of North Essex landed proprietors and agriculturists at the town Hall, Great Bardfield, on Monday, in support of a scheme to provide that part of the county with a light railway. It was pointed out that the nearest railway station was 12 miles away, which rendered impossible the establishment of dairies on the farms. Among those who agreed to be nominated directors of the new company and to represent the agricultural interests were Sir Fortescue Flannery, M.P., and Mr. H. T. Laun, who promised to raise £100,000 towards the project.

Hastings.—The company approached the Town Council with a request to be released from the bond of their agreement not to erect an overhead system of trams on the front, and proposed that the Council should consent to a one-clause Bill giving them the power they originally sought. The Tramways Committee, however, recommended the Council to adhere to the position they had all along taken up, and this it was agreed to do, after some discussion. The Hastings Tramway Co. intend applying during the forthcoming session of Parliament for powers to construct and work an overhead system of electric trams in the borough.

Fareham.—The work in connection with the construction of the Gosport and Fareham tramways has been so far completed as to enable a trial to be run over a portion of the line, which took place last Friday. A car was taken from the power station at Hoe Ford, and proceeded over the line to the terminus near Fareham railway station. The car ran at a steady pace on the journey, the several curves and crossing points being taken very easily, and altogether the trial was deemed to be most satisfactory. There remains a little more work to be done near Brockhurst, but the date for the running of the service has not yet been fixed.

Plymouth.—The Tramways Committee on Monday received a petition from the motormen and conductors, who number over 80, for an increase in wages. It was explained that before the introduction of the Sunday service the men worked 63 hours a week, but had the Sunday free. Since the inauguration of the Sunday service they have worked alternate Sundays without increase of pay, but, as compensation, the service being worked on the double-shift system, the hours of labour were reduced to 54 per week. At present the motormen receive a minimum of 21s. a week, rising to 24s., while the conductors earn from 17s. to 19s. a week. The committee decided to increase the wages of the motormen by 1s. a week, raising the minimum to 22s. and the maximum to 25s., and fixed the wages of the conductors at a minimum of 17s., increasing to 20s.

Leith.—The Tramways Committee of the Town Council at a meeting on Thursday last remitted to the Provost's Committee to confer with the Corporation of Edinburgh—if Edinburgh so desired—with reference to the suggested extension of the tramway lines from Seafield to Portobello, from Bonnington to Granton, and from Newhaven to Granton. It was agreed to intimate to Edinburgh that Leith had refused their consent to the National Electric Construction Co. to make a line through Leith to Queen's Ferry. The sections of the Leith electric tramway system between the foot of Leith Walk and Seafield and on Commercial-street, including the swingbridge which spans the harbour at the latter place, were inspected by Colonel von Donop on behalf of the Board of Trade on Wednesday, these being the last to be completed. Immediately afterwards a service of electric cars was put on the routes, and the whole system is now in full working order.

Southend.—At a meeting of the Town Council last week the Light Railway and Electric Light Committee's report on the proposed tram extension was brought forward for adoption. For High-street the committee recommended a service of single-deck cars. The gradient of the Pier-hill would be altered from 1 in 9·77 to about 1 in 11, and other improvements would be made. From the deviation past the Half-way House there would have to be an entirely new road, and it was proposed that the track be laid on sleepers. Colonel Burges had given sufficient land to put down a double instead of a single line. The total extra cost for this would be approximately £3,000. Colonel Burges would also give them land right up to Ness-road. To the Cambridge Hotel the track would be on sleepers, and from there to the High-street, Shoeburyness, the track would be laid on the system now in use. In opposing the report it was said there was a feeling throughout the borough that the time was not ripe for the adoption of the scheme. In the end the whole matter was referred back to the committee for further consideration and fuller reports.

Grimsby.—The tramways company are prepared to construct the Hainton-avenue extension upon the Corporation's conditions with regard to paving, etc., but they refuse to carry out the Welholme-road extension. The Highways Committee have decided that, unless the company were prepared to carry out both extensions on the Corporation conditions, and to complete them within 12 months of the date of the provisional order, the Corporation would oppose any effort made to secure a provisional order for the Hainton-avenue extension only. It was stated at the recent meeting of the Highways Committee of the Council that negotiations were now proceeding between the tramway company and the Great Northern Railway Co. with regard to a proposal by the latter to construct excursion platforms at Weelsby-road. The railway company contemplate carrying excursionists to Weelsby, whence, if satisfactory arrangements can be made with the tramway company, they will be carried to Cleethorpes by electric car. In view of these proposals the committee decided to ask the tramways company to endeavour to obtain an agreement with the railway company permitting the construction of a subway at Weelsby-road at some future date.

Durban.—In his annual report as general manager of the Durban municipal tramways, Mr. H. N. Thomas, late manager of the Huddersfield Corporation tramways, states that although the total income, as compared with the year 1904, is less, this is accounted for by the fact that in the income for 1904 is included a sum of £2,000, transferred from maintenance account to capital account, so that the actual earnings of the department for 1905 are greater. The net surplus appropriated to borough fund shows an increase of £1,247 over the previous year. The percentage of operating expenses to income will compare very favourably with any large and best managed system of any home towns. There is a decrease in the operating expenses per car mile, from 11·77d. to 9·90d. The length of route is 13⅝ miles, length of track 22 miles, maximum grade 1 in 14, sharpest curve 70ft., weight of rail (straight track) 90lb. per yard, weight of rail (curve) 105lb. per yard, number of cars in use 46, average number of cars in daily service 44, seating capacity of cars 54, car mileage 1,097,230, average car mileage per day 3,006, mileage per car per day 68, passengers carried 11 848 191, passengers carried per day 32,460, passengers carried per mile 11·73, total traffic receipts £88 280. 7s. 6d., average receipts per day £241. 17s. 3d., average receipts per car mile 19·328d., average receipts per passenger 1·77d., average receipts per head of population, based on 40,000. £2. 4s. 1d., number of times population carried, based on 40,000, 294.

New South Wales.—We have received a copy of the "Jubilee" number of the *New South Wales Railway Budget*, which was specially got up in celebration of the jubilee of the Government Railway. The number contains short biographical sketches of leading railway and

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tramway officials in the colony, and is illustrated by a number of beautifully executed photographs. The history of the railways is also related, commencing at the period at which construction assumed a tangible form in Australia. It is interesting to see a faithfully reproduced drawing of the first station buildings erected in 1855 in Parramatta and Sydney, when the neighbourhood was still desolate bush, and to watch the gradual extensions and developments which take place in subsequent years, culminating in the erection of a building which in 1905 adequately represents the commercial activity and prosperity of the capital of one of our most enterprising colonies. A series of meetings were held under the auspices of the Railway Institute during the anniversary services. Photographs are given of the late Mr. E. M. G. Eddy, the erstwhile chief commissioner of railways, and his successor, Sir Chas. Oliver; Mr. W. M. Fehon (commissioner), Mr. H. McLachlan (secretary to the commissioners), Mr. James Fraser (engineer-in-chief), Mr. J. E. S. Corns (goods manager), and other officials. Mr. G. Holt opened discussion on "Tramway Accidents" at a recent meeting of the Sydney Tramway Officers' Association. In a comprehensive and able address he was able to show that, notwithstanding the narrow streets and congested traffic, tramway accidents in Sydney were not numerically more than in England and America, and that the vast majority of these were directly due to passengers boarding and leaving cars while in motion.

Belfast.—At Monday's meeting of the Tramways and Electricity Committee a report was submitted by the general manager of the tramways, in which he stated that the result of the trial of the three engines provided for the special purposes of operating the tramway system brings about a very serious state of affairs. He would require two engines working under full load during a day of 17 hours to work the whole service of 174 cars, together with a third stand-by engine, also capable of working under full load in case one of the others had to be stopped for any reason. The full electric service, therefore, cannot be commenced until Mr. M'Cowen (the electrical engineer) is satisfied that all three engines are capable of working under full load for a lengthy period. The manager further expressed the opinion that the complete service could not be put into operation until Feb. 1. He suggested that in the meantime the southern lines be worked with one engine under three-quarter load, having the second engine as a stand-by, and leaving the third engine in hands of the builders in the hope that they can do whatever necessary to the engines until they are capable of running under full load non-condensing for a lengthened period. It was announced that the Board of Trade inspection would take place on Wednesday, the 29th inst., but that would apply only to part of the system, and the representatives of the Board would have to return at a later date to complete the work. It was also reported that on the Shore-road the telephone wires were actually lying on the wire through which the current for the tramcars would pass, and Mr. M'Cowen considered that it would be impossible to work that route until this state of affairs was remedied. The Lord Mayor expressed the hope that the southern portion of the system would be opened on the 30th inst.

Hythe.—A special meeting of the General Purposes Committee of the Town Council was held last week at which a deputation from the National Electric Construction Co. was received relative to the proposed construction of an electric tramway between Sandgate, Folkestone, and Hythe. The proposal of the company has been before the committee for some time, but the latter's requirements as to widenings, etc., were considered out of proportion to the scheme. Mr. Cownie, joint manager and secretary of the company, who attended on their behalf, said that his company had carefully considered the question of routes, and they came to the conclusion unless they could get a tramway along High-street the scheme would not be worth going in for, so far as Hythe was concerned. Then if they proposed putting tramways down some of their streets, he was afraid they would have very considerable opposition from the ratepayers in High-street, as it was found always that the trade of the town followed tramways, and by taking the tramways through other streets they would be taking a great deal of the trade away from the High-street. They wished, if possible, to get the Council's support. They had got the support of Sandgate, and they had also got the support of Folkestone, so far as the committee were concerned. The company were prepared to pay to the Council the sum of £2,000, so that they could do whatever widenings they liked. The company, said Mr. Cownie, would also be prepared to pay £1,500 to the Council for all the widenings they had already done. The maximum fare would be 1d. a mile, but for a through fare it would be less. We understand that the Council will further consider the matter when plans have been deposited. It had been moved and seconded previous to the arrival of the deputation, that the Council at the present time do not give their consent, reserving to themselves the right to act after the plans have been deposited in accordance with the standing orders.

London County Council.—At Tuesday's weekly meeting of the Council, the Highways Committee reported that their attention had been called to the fact that there appeared to exist no direct authority to make by-laws regulating the use of the tramway subway from the Victoria-embankment to Southampton-row authorised by the London County Council's Act. They recommended, and it was agreed, that authority should be sought in the next session of Parliament to enable the Council to make the necessary by-laws. In respect of the Council's application for the compulsory acquisition of Holloway car-shed site, the Highways Committee recommend that powers be sought for the purchase of a further site with an area of about 3¾ acres in Pemberton-road for the erection of a car-shed and sub-station in connection with the electric working of the northern section tramways. In consequence of the unsatisfactory conditions of the lines, and the impracticability of working them at all remuneratively, it is proposed that the tramways which have been transferred to the Council from the London, Camberwell, and Dulwich Tramways Co. be abandoned. It is also recommended, with a view to preventing overlapping, that, in lieu of the existing ½d. fares upon the Greenwich route of the Council's tramways, ½d. fares be charged for journeys between the undermentioned points: (1) Blackfriars Bridge and Elephant and Castle; (2) Westminster Bridge and Elephant and Castle; (3) Waterloo Bridge and Elephant and Castle; (4) Elephant and Castle and Tower Bridge-road; (5) Tower Bridge-road and Dun Cow, Old Kent-road; (6) Dun Cow and Canal Bridge, Old Kent-road; (7) Canal Bridge and Old Kent-road railway station; (8) Old Kent-road railway station and New Cross-gate; (9) New Cross-gate and Marquis of Granby; (10) Marquis of Granby and High-street, Deptford; (11) High-street, Deptford, and Devonshire-road; (12) Devonshire-road and King William-street; (13) King William-street and the present terminus at Greenwich.

LIGHTING AND GENERAL.

Colwyn Bay.—It is proposed to borrow £10,000 for electric lighting purposes.

Barnsley.—Sanction has been obtained to borrow £2400 for public lighting at Worsborough.

Woolwich.—The Borough Council intend to support the London County Council's Wiring Bill.

St. Pancras.—The Borough Council have decided to support the London County Council's Wiring Bill.

Derby.—On account of the Royal Show, London-road will be lighted by arc lamps as far as the showground.

Gravesend.—Application is to be made for a loan of £7,000 for extension of plant at the electricity station.

Stourbridge.—The Council are dealing with an electric power company in regard to the execution of their provisional order.

Weardale.—The Council are approaching the Stanner Steelworks with a view to lighting the district by electricity from the company's plant.

Liversedge.—The Urban District Council have confirmed a previous resolution that borrowing powers should be applied for for £1,500 for electric supply purposes.

Hendon.—The Rural District Council are corresponding with the Northwood Electric Power Co. *re* their application for supplying electric light for the district.

Ebbw Vale.—Operations have actually commenced for the supply of electricity for public lighting, and will probably be completed before the end of the present winter.

Swansea Telephones.—We understand that the Corporation have just completed the connecting-up for intercommunication between the municipal and National services.

Wandsworth.—A notice from the County of London Electric Supply Co. of intention to lay electrical conduits in South-street, Wandsworth, has been approved.

Trowbridge.—The Urban District Council have decided to charge the National Telephone Co. 1s. per pole for 35 poles to be erected in Bradley-road for telephonic purposes.

Stockton.—The Rural District Council are applying for an extension of the time in which to carry out the provisions of the electric lighting order received some years ago.

Ramsgate.—St. Mary's Church is the first place of worship in the town to be electrically lighted. The installation has been carried out by the Ramsgate and District Electricity Supply Co.

Llangollen.—The agreement drawn up in accordance with the tender accepted by the Council for the lighting of the entire urban area by the Llangollen Electric Lighting Co. is ready for sealing.

Montrose.—An electrical exhibition is being held in the Burgh Hall, Montrose, by the North of Scotland Electric Light and Power Co., under the direction of the company's manager, Mr. Harold Hale.

Calcutta Tramways Co.—An interim dividend of 3s. 6d. per share on the old shares (being at the rate of 7 per cent. per annum, free of tax), on account of the profits for the half-year ended June 30, is announced.

Holyhead.—The Urban District Council have arrived at a settlement with the National Electric Construction Co. in regard to an amount of £609 claimed under which the company receives £256, plus £30 for lamp fittings.

Agency.—Messrs. Bray, Markham, and Reiss have appointed Messrs. J. Parkinson and Co., St. Nicholas-buildings, Newcastle-on-Tyne, their sole agents for Northumberland, Durham, and the Cleveland district of Yorkshire.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the four weeks ending Oct. 27, 1905, were 358,193, compared with 288,297 units in the corresponding four weeks of the preceding year.

London Gazette.—The first meeting in the estate of Harry Jones and Gwilt Lloyd Cathrall, plumbers and electrical engineers, Chester-street, Wrexham, will be held at Crypt-chambers, Eastgate-row, Chester, at 12 noon on Nov. 29.

British Aluminium Co.—The directors of the British Aluminium Co. have decided to pay an interim dividend for the half-year ended June 30 last at the rate of 6 per cent. on the "A" preference shares, and 7 per cent. on the 7 per cent. preference shares.

Kensington.—An application from the Notting Hill Electric Lighting Co. relative to proposed extensions of their mains in Latimer-road and Boundary-road, and three out of five applications received from the Post Office for permission to lay pipes for telephone wires, etc., have been agreed to.

Taunton.—The recent temporary failure of the electric light was caused by the breakdown of a couple of pipes connected with one of

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the boilers at the Corporation works. The damage was put right during the night. The new boiler which will soon be installed at the works will prevent a similar occurrence.

Ipswich Engineering Society.—At the last meeting of the Ipswich Engineering Society the newly-elected president. Mr. Frank Ayton, chief engineer of the Corporation electric works, delivered an address upon the subject of "Present-Day Features in the Generation, Distribution, and Utilisation of Electric Power."

London County Council.—On Tuesday it was agreed to lend the Battersea Borough Council £9,218 for street lighting purposes and the Fulham Borough Council £25,000 for electric light installation. Sanction was also given to the borrowing by the borough of Stoke Newington of £6,715 for electric light installation and meters.

Erith.—The Works Committee, after discussing with the surveyor and the electrical engineer the question of the rearrangement of the lamps along the tramway routes, have asked these two officials to submit a joint report upon the subject, with plan showing the position of present lamps, the tramway poles, and proposed scheme of rearrangement.

Woodford.—Out of 3,646 circulars sent out to obtain the opinion of the ratepayers as to the advisability of applying for a provisional order under the Electric Lighting Acts 1,554 replies have been received, and of these 456 answered "Yes," 1,052 answered "No," and 36 were irregular. Consequently the application for a provisional order will not be proceeded with.

Chelmsford.—After a very severe fight with the local gas company the Chelmsford Electric Light Co. have obtained the street-lighting contract for a number of years. The 300 half-ampere A type Nernst lamps to be used are being supplied by the A.E.G. English Manufacturing Co., who hold the Nernst lamp patents for Great Britain, all British Colonies, Asia, Africa, South and Central America.

Indian and Colonial Trade Inquiry Offices in the City.—The India Trade Inquiry Office, at 73, Basinghall-street, London, E.C., has been established for the purpose of supplying the general public with all available information as the commercial products, manufactures, and trades of British India. The Canadian, Cape of Good Hope, and Queensland Governments have opened offices in the same building.

Edmonton.—The District Council have received a letter from the Board of Trade asking why no steps have been taken to carry out the obligations of the Council under their provisional order, and for reasons why the order should not be determined. The Council has directed a reply to be sent asking for an extension of time until the agreement with the North Metropolitan Electric Supply Co. was completed, and explaining the facts.

Bury.—The District Chamber of Commerce recently discussed a complaint made by the Bury Manufacturing Co. with regard to the charge for trunk calls to Bradford, urging that Bury was at a disadvantage, and asking the chamber to take up the matter. It was also mentioned that the charge for calls from Whitefield to Bury was 6d. It was resolved that strong recommendations be made to the National Telephone Co. asking them to provide a remedy.

Lowering Gear.—We are informed by the London Electric Firm, George-street, Croydon, that their "one working part" arc lamp lowering gear is meeting with considerable favour by reason of its unique and practical design and construction, and that although it has only been on the market a very short time it has been supplied to two Government departments, 16 corporations and supply companies, several railways, and a large number of contractors, including a single order for 50 complete sets.

Dorking.—The Urban District Council's Electricity Committee have received a letter from Mr. Trentham, enclosing one from Messrs. Edmundsons, further pressing for the Council to reconsider and sanction the laying down of the cable necessary for the Deepdene supply, and expressing their willingness to relieve the Council from all liability and risk in the matter pending the approval of the Local Government Board being obtained to the loan. We understand that the Council have declined to alter their previous decision.

Telephone Extensions.—The Association of Chambers of Commerce has been informed by Lord Stanley that at present it does not seem possible for him to hold out hopes of any material extension of existing facilities for telephonic communication with the Continent, but he fully appreciates its importance to the mercantile community. The extensions which have been possible during recent years are detailed, and Lord Stanley adds that the communication between Liverpool and Antwerp, and between this country and Holland, has been found to be impracticable.

New Issues.—A prospectus has been issued by the Newquay Electric Light and Power Co. Capital, £15,000 in £1 shares. Secretary: E. Ernest Smith, 66, Victoria-street, Westminster. The object is to take over and work the parliamentary powers granted in 1904 to Messrs. Foote and Milne for the supply of electricity for public and private purposes with the Newquay Urban District Council's area. The construction of the works will be undertaken by Messrs. Foote and Milne. Letters of allotment and regret have been posted in connection with the issue of £150,000 4½ debenture stock of W. T. Henley's Telegraph Works Co.

Dunkeld.—A hitch has occurred in the telephonic arrangements. Work had been begun consequent upon an agreement between subscribers and the Postal Department for the establishing of a telephonic district which included Pitlochry. A number of the signatories, however, belong to Birnam, and the Department having announced that this part can only be included on payment of an additional amount, an indignation meeting was held last week, at which it was decided that the whole of the subscribers renounce the agreement if the Department do not give way. The resolution has been sent to the secretary of the Department for further consideration.

Bermondsey.—The electrical engineer has reported on the ventilation of the Council chamber, and we understand that the following estimate for the work has been adopted: fan and motor, with starters, £41; galvanised sheet-steel duct house and labour, £55—£96. The Electric Lighting Committee report new consumers equal to 468 8-c.p. lamps, and state that the number of lamps connected to the mains are now 52 421 lamps for private consumers and the equivalent of 4 646 lamps for public lighting, a total of 57,067 lamps. The highest load observed this year was 575 kw., as against 437 kw. for the corresponding period last year, an increase of 32.

Beckenham.—The clerk is taking steps to open the necessary accounts on the Council taking over the management of the electric lighting works, and in future the dust destructor and electric lighting works will be treated as separate undertakings. For the present the destructor is to be credited with £143 per annum, the estimated value of the steam supplied by the destructor and used for the generation of electricity, and the electric lighting account debited with £150 per annum, the amount hitherto charged to the British Insulated and Helsby Cables in respect of the cost of collecting the electric lighting charges and of clerical work and book-keeping performed in respect of the undertaking.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to British Aluminium Co.'s 30,000 ordinary shares of £5 each, £2 paid, and £300,000 5½ per cent. Loch Leven debentures of £100 each. The committee have ordered the undermentioned securities to be quoted in the official list: Adelaide Electric Supply Co.'s 10,000 6 per cent. cumulative preference shares of £5 each (fully paid), Nos. 1 to 10,000; Amazon Telegraph Co.'s further issue of £35,900 5 per cent. debentures of £100 each, Nos. 1,251 to 1,609; and Anglo-Portuguese Telephone Co.'s £50,000 5 per cent. first mortgage debenture stock.

Elgin.—The Town Council have received a report by Messrs. Buchan and Hogarth, Edinburgh, on the proposed electric lighting scheme in combination with a refuse destructor. The engineers considered they would obtain 4,500 lamp connections, and recommended the adoption of the low-tension three-wire system, with a continuous current, and 230-volt lamps. The estimate of the capital expenditure at the end of the first year is £16,200, and at the end of the fourth year £17 300. The engineers estimate that the revenue from the first year's working of the scheme would have a loss, due to the heavy capital charges, of £273 but that at the end of the fourth year there would be a profit of £342, which would go against the losses of the first year or two. The report is being printed and distributed amongst the members of the Town Council.

Electricity Shares.—The electric share market has not displayed much activity during the past week, the *Financial Times* says, the tone has continued dull, and the majority of changes in prices are in a downward direction. Supply descriptions in particular have been weak, though the declines are not of serious extent as a rule. St. James's and Pall Mall ordinary and preference have each receded ¼ to respectively 13¼ and 8¼. Kensington and Knightsbridge at 11½, London preference at 5, Charing Cross at 7, and County of Londons at 10 have fallen ¼ while Westminsters have declined ⅛ to 12½. Chelseas, however, have improved ¼ to 6⅛. Among manufacturing descriptions India Rubbers have risen ⅛ to 16½, and Electric Construction preference ⅛ to 2¼, but Telegraph Constructions have relapsed 1½ to 33, and British Westinghouse preference have dwindled 1/16 to 2⅞. In the traction division, Bath Electric Trams have been in demand, the ordinary having risen 1s. 6d. to 19s. 6d., and the preference 6d. to 20s. 6d. Anglo-Argentine Trams have hardened 1/16 to 8 13/16, but Buenos Ayres and Belgranos have fallen ¼ to 2⅞.

Victoria Falls Power Scheme.—The Duke of Abercorn, K.G., who presided at the last meeting of the British South Africa Co., referring to what he called the great project of the African Concessions Syndicate to transmit power from the falls to the Witwatersrand Mines, said he was informed that the highest engineering authority had been obtained in support of the immediate realisation of this enterprise, and, though it would be premature for him to say much more upon the point, he understood that negotiations for the sale of power were already proceeding, and that there was good hope of success. If so, the company, as the owner of half the capital of the Concession Syndicate, and of a reserved interest in profits, would have an important direct interest, and would also reap the indirect results which may be expected to flow from the carrying out of such an enterprise in the heart of Rhodesia. The Special Commissioner of *South Africa*, telegraphing from Cape Town on Nov. 21, says: "I have just had an interview with Sir Charles Metcalfe, who is returning to England by way of the east coast. He tells me he has discussed the great scheme for the transmission of electric power from the Victoria Falls to Johannesburg with a number of leading Rand men, who are convinced that the scheme is perfectly feasible. The Rand mining houses will probably conclude contracts which will have the effect of reducing the cost of their motive power by half, with a saving of at least two million pounds annually."

York.—The city treasurer, Mr. James W. Davison, has just issued his abstract of the municipal accounts for the year ending March 31, 1905. The electricity works have cost so far £124,490, the whole of which is laid out in buildings, plant, machinery, cables, etc. The year ended with a deficit of £2,946, which was transferred to a specially created suspense account, and which it is hoped to clear off in the near future. The revenue account shows that the expenditure for the year was £6 842; the generation of electricity costing £3,615; the distribution, £240; public lamps (wages and repairs), £617; rents, rates, and taxes, £453; management expenses, £923. By the sale of electricity £9,968 was realised, and the total revenue was £10,732. There was consequently a profit on the year's working of £3,890, but this was

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insufficient to meet the year's charges on interest and sinking fund, hence the necessity for a suspense account. During the 12 months the output totalled 1,114,692 units, of which 770,889 were sold to private consumers, and 133,111 used for public lighting.

Cheap Electricity.—Under the title of "Cheap Electricity for Power, Lighting, Heating, and Ventilating," the South Metropolitan Electric Light and Power Co., 37, Tranquil-vale, Blackheath, S.E., have issued a pamphlet, in which there is a map showing that their area of supply extends from the River Thames on the north to Anerley and Croydon on the south, and from Woolwich on the east to Lambeth and Camberwell on the west. In addition, the company may supply in bulk at the boundary line to undertakers (local authorities, companies, or persons) authorised to supply electrical energy for (1) tramways, partly within and partly without the company's area of supply, and (2) for other purposes. Among such authorised undertakers are the London Electric Supply Corporation, South London Electric Supply Corporation, County of London Electric Supply Co., Kent Electric Power Co., Bromley (Kent) Electric Light and Power Co., Croydon Borough Council, Beckenham Urban District Council, metropolitan borough of Woolwich, Poplar metropolitan borough, and the Charing Cross and Strand Electricity Supply Corporation.

Radcliffe.—The Electricity and Tramways Committee have been discussing letters from the British Aluminium Co., requesting the Council to authorise the Lancashire Electric Power Co. to furnish them with a supply of electricity for power purposes at their proposed works in Mount Sion-road, and from Messrs. A. and J. Gilbert and Co., who stated that if the Council are unable to supply electricity to their works for power purposes, the Lancashire Electric Power Co. were willing to do so if authorised. They have decided to ask the Lancashire Electric Power Co. to furnish a standard tariff, based on a sliding scale, at which they were prepared to supply power consumers in the district, the tariff to be in such form that it shall definitely apply to any power consumer irrespective of his position in the district, and that they be also requested to state the rate or amount of commission the company would be prepared to allow this Council in respect of the aforesaid supply, the committee being of opinion that a payment by way of consideration should be made by their company to the Council if arrangements were made with respect to the supply of electricity to the proposed works of the British Aluminium Co.

Stepney.—An extension of mains is to be carried out in Tenter-street, and an application from the secretary of the General Post Office, on behalf of the Postmaster-General, for the Council's permission to the placing of an underground telegraphic line along east and north sides of Glamis-road and Shadwell High-street from a point between Cable-street and Juniper-row to Love-lane, also along west side of King David-lane from Short-street to High-street, also to the building of boxes as required, has been agreed to. With regard to the charges for current, it is proposed that the charge for lighting, as and from June 1 next, at the rate of 8d. per unit for the first 30 hours' use of the maximum demand during each of the six months ending March, and for the first 20 hours' use during each of the six months ending September, and 1d. per unit for all further consumption in each month, any resolution or other act of the Council or their predecessors to the contrary notwithstanding, be, as and from Oct. 1, 1905, modified to the following extent: (*a*) that to any consumer whose total accounts, calculated on the undermentioned rates for any half-year ending June 30 and Dec. 31, reach £60 or over, or who is willing to guarantee this amount as a minimum payment for each such period, the charge for current for lighting purposes shall be 6d. per unit for the first 30 hours' use of the maximum demand during each of the six months ending March, and for the first 20 hours' use during each of the six months ending September, and 9d. per unit for all further consumption in each month; and (*b*) that in calculating the total amount of a consumer's half-yearly bill for the purpose of arriving at the minimum mentioned in (*a*), the accounts for lighting, power, and other purposes on the same or different premises be added together. Provided that where the accounts of various premises are so added together the average half-yearly account per service shall not be less than £15.

Dundee.—Mr. H. Richardson, the engineer, submitted to a meeting of Dundee Electrical Committee on Monday a report stating that the business of the department had grown to such an extent that the necessity of extra generating plant and feeder cables must be settled immediately, and could no longer be delayed. He pointed out that the district of Lochee had never yet been supplied with electricity, although in several directions it was required there. Apart from that, the load in the districts being worked was such as to give the present station and cables as much work as they could do; in fact, the cables to the West Park, northern, and Maryfield districts were overloaded to an extent which made it impossible to keep up a good pressure of supply through the winter. He estimated that to extend cables and machinery on the same low-pressure system in conformity with the present plant and system would cost as nearly as possible £35,000. This would enable the department to meet the extra work for lighting and power for the next two or three years, but the copper cables thus laid underground were, owing to the low pressure of supply system, far too expensive for the power they carried to these districts. The alternative was to put down a new power station on the high-pressure system of supply with the intention of driving little sub stations from it in each of the outlying districts—to begin with, say, two sub-stations, one at West Park and one at Maryfield—and adding others as required. This scheme would give the department a more elastic limit to its resources for the supply of electricity. It would also give an unequalled facility for the supply of cheap power for the development of all industries, because from such a station they would then be able to cope with it on a big scale, and with some possibility of commercial success. The cost of beginning such a station with two sub-stations would not be less than £75,000, exclusive of the land. It was, therefore, important that this matter should be faced and settled immediately, because the business of the department would not admit of any more delay in the plan of extending the present station or of forming the nucleus of a large station, which must be working by next winter. In these circumstances the engineer asked that he be given instructions to prepare specifications and to ask for tenders for (1) the installation of a new system and new power station, or (2) the extension of plant in the present generating station. After discussion it was decided, having regard to the great importance of the matter, to defer consideration for a month.

Fulham.—At Wednesday's meeting, the report of the Law and Parliamentary Committee was submitted with regard to the award of the arbitrator (Mr. James Swinburne) on the Council's claim for damages against the National Electric Construction Co. in respect of two fatal accidents at the public baths on Dec. 23, 1902. The arbitrator, after stating the steps in the proceedings, found as follows: "I find as a fact that the accident which occasioned the deaths was caused by the fact that certain iron pipes forming part of the installation supplied by the contractors under the said contract were not earthed—that is to say, were not electrically connected to earth. If the said pipes had been earthed, the accident would not have happened. The omission to earth the said pipes was a matter of design and not a matter of materials or workmanship, and was patent to any electrical engineer inspecting the installation. Apart from the reference to the rules of the Phœnix Fire Office above referred to, no indication was given on behalf of the Council to the contractors by drawings, specification, or otherwise that they were required to earth the pipes. Having regard to the state of knowledge among electrical engineers at the time of the contract and of the execution of the works, I have come to the conclusion that the omission to earth the pipes under all the circumstances of the case did not indicate a want of reasonable care or skill on the part of the persons responsible for the omission. Assuming that the contractors were responsible for the omissions, I find, as a fact, that they were not guilty of want of reasonable care or skill in omitting to earth the said pipes. It was admitted before me that, so far as this arbitration is concerned, the Council did not rely on any defects in the installation other than the omission to earth the said pipes. With regard to the rule of the Phœnix Fire Office above referred to, I find as a fact that in the case of the said pipes earthing would not have been desirable so far as risk of fire is concerned. It would, in fact, have been desirable so far as risk of accidents to bathers is concerned. The buildings and the electrical installation were inspected and passed in April, 1902, by the surveyor of the Fine Art and General Insurance Co., who were the fire office concerned in the risk. I find that the Council have expended the sum of £1,173. 13s. 1d. in respect of the matters in dispute in this arbitration, and that if they are entitled to recover against the contractors in this arbitration by way either of indemnity or of damages, that is the sum which they are entitled so to recover. The question for the opinion of the court is whether upon the facts herein stated the Council are entitled to recover the said sum of £1,173 13s. 1d. from the contractors in this arbitration. If the court answer the above question in the affirmative, then I find and award that the Council are entitled to recover from the contractors the said sum of £1 173. 13s. 1d., and I award and direct that the contractors do pay to the Council their costs of the reference and also the costs of this my award. If the court answer the above question in the negative, then I find and award that the Council are not entitled to recover anything against the contractors, and I award and direct that the Council do pay the contractors their costs of the reference and also the costs of this my award." The award has been stated in the form of a special case for the opinion of the court, and the Law and Parliamentary Committee have been advised by counsel that they ought to argue before the court the points of law reserved. The case has been set down by the contractors for hearing before one judge of the King's Bench Division, and the committee have given the town clerk instructions to brief counsel. The borough electrical engineer submitted the following statistics: House refuse—previously reported, 1905 6, 17,951 tons (1904 5 16 696); from Oct. 20 to Nov. 9, 1905 2 091 tons (1,839)—total, 20 045 tons (18,585). Trade refuse—previously reported, 375 tons (377); from Oct. 20 to Nov. 9 1905. 45 tons (36)—total, 420 tons (413). Clinker—previously reported, 4,890 tons (4,184); from Oct. 20 to Nov. 9, 1905, 439 tons (480)—total, 5 320 tons (4 664). Connections previously reported 1 631, 80,729 8-c.p. (1 304, 61,448); from Oct. 20 to Nov. 9, 1905, 29, 2,310 8-c.p. (22, 1,802)—total, 1,660, 83,039 8-c.p. (1,326, 63,250). Consumers not yet ready for connection, 3; consumers not yet paid deposits 3. A transformer station is to be erected and fitted with two 30-kw. transformers, and cables are to be extended at a total cost of £353.

PROVISIONAL PATENTS, 1905.

Nov. 13.

23241. Improvements in laying electric conductors. John Henry Chilcote Brooking, 85, Northumberland-road, Old Trafford, Manchester.

23267. Momentum engine and electrical self-generation dynamo and motors. Benjamin Charles Pole, 19, Imperial-buildings, Ludgate-circus, London.

23298. Improvements in and relating to electrical safety devices for guarding against burglary and the like. Carl Jacob, Thanet House, Temple Bar, London. (Complete specification.)

23312. Improvements in connection with the electro-deposition of copper and other metals. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

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23313. Improvements in removing metallic cylinders from mandrels on which they are electro-deposited. Sherard Osborne Cowper-Coles, 4, South-street, Finbury, London.

23320. Improvements relating to sockets for receiving electric lamps, plugs and the like. Frederick Millington and Albert Hugh Miller, 322, High Holborn, London.

Nov. 14.

23328. Improvements in electrical conduit tubing joints. Alexander Harold Hoar, 32, Barnsdale-road, Harrow-road, London.

23379. Improvements relating to pendants or like supports for electric lamps. Hubert Chippendale Smith, 18, Southampton-buildings, Chancery-lane, London.

23402. Improvements in electric furnaces. Paul Girod, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 24, 1904, being date of application in France.) (Complete specification).

Nov. 15.

23437. Improvements in and relating to incandescent electric lamps. The British Thomson-Houston Company, Limited. 83, Cannon-street, London. (The General Electric Company, United States.)

23438. Improvements in and relating to electric distribution systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23439. Improvements in and in the manufacture of heat radiators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23440. Improvements in and relating to electric distribution systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23441. Improvements in and relating to electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23442. Improvements in and relating to methods of manufacturing incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23446. Divers' and miners' portable and electrical lamp. William Dentith and Harry Midgley, 30, Baillie street, Rochdale, Lancs.

23447. Improved electrical lamp for photographing in the dark. William Dentith and Harry Midgley, 30, Baillie-street, Rochdale, Lancs.

23449. Electric working of mine shafts. James Swinburne, 82, Victoria-street, Westminster, London.

23451. A combined electric and automatic self-locking double railway carriage lock and spindle adaptable, final fastener unpickable and burglar-proof. Henry Taylor, 238, Wednesbury-road, Pleck, Walsall.

23474. Improvements in and relating to the electro-deposition of metals, alloys, and the like. Mary Kezia Dooley Roberts and Edward Woodriff Jaffray, 2, Church-gate, Nottingham.

23507. An instrument for demonstrating the kinetic energy of the α-rays emitted by radium and other radioactive bodies. Charles William Raffety, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

23526. Improvements relating to electrical furnaces Benvenuto Platschick, 7, Southampton-buildings, Chancery-lane, London.

Nov. 16.

23547. An improved method of fixing the grooved casing covers as used for the wires in electric lighting. William Mills and Frank Tobias Paine, High-lane, Marple, Cheshire.

23553. Improvements in electric motors and similar dynamo-electric machines. Veritys Limited and Paul Arthur Hirsch, 11, Burlington-chambers, New-street, Birmingham.

23561. Improvements in electricity meter meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

23569. Improvements in electric accumulators. Ernest Bailey, William Plews, and Thomas Wade Anderson, 5, York-place, Leeds.

23582. Improvements in electrical switches. William McGeoch and Co., Limited, and Walter Leonard Barber, 35, Temple-row, Birmingham.

23584. Improvements in electric motor apparatus applicable to machinery of all kinds requiring force. Thomas James Howell and Edwin Joseph Richardson, 41, Brook-street, Grosvenor-square, London.

23595. Improvements relating to electric railways and tramways on a road-contact system. Gustav Paul, 37, Essex-street, Strand, London.

23624. Improvements in electric circuit breakers. The Felten und Guilleaume-Lahmeyer-werke Akt.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 22, 1904, being date of application in Germany.) (Complete specification.)

Nov. 17.

23656. Improved top electric roller for electric stop-motion frames. Arthur Broadbent, 69, Maud-street, Rochdale.

23661. Improved arrangement for the regulation of speed of compensated single-phase motors. Engelbert Arnold and Jens Lassen La Cour, 34, Castle-street, Liverpool. (Date applied for under Patents Act, 1901, Nov. 21, 1904, being date of application in Germany.) (Complete specification.)

23662. An expanding terminal connection for electric cables and the like. Claude Harold Robinson, Carlton House, Pontypool, Monmouthshire.

23710. Improvements in and relating to transformers and the like. Arnaldo Paolo Zani, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23722. Improvements in and relating to systems of connections for telephone offices with separated plug service and means for signalling whether an operator is unoccupied or engaged. Deutsche Telephonwerke R. Stock und Co., G. m. b. H., Thanet House, Temple Bar, London. (Date applied for under Patents Act, 1901, Nov. 17, 1904, being date of application in Germany.) (Complete specification.)

23728. Improvements in or relating to shade holders for incandescent electric lamps. Henry Simmonds, 7, Southampton-buildings, Chancery-lane, London.

23738. Improvements in or relating to commutators and the like. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

23751. Improvements in brush contacts for electric switches. William Harding Scott, 47, Lincoln's-inn-fields, London.

23753. Improvements in electrical apparatus for regulating clocks. Robert James Rudd, 40, Chancery-lane, London.

Nov. 18.

23756. A new or improved junction box for electric cables. Edward Wilmer Hill, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

23803. Improvements in or relating to electrically-propelled vehicles. Carl Tunstill John Oppermann, 53, Chancery-lane, London.

23838. Improvements in and relating to apparatus for changing the frequency of alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23839. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London.) (The General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 7.

1904.

24573. Dynamo-electric machines. Batchelder. (Date applied for under International Convention, Nov. 12, 1903.)

24689. Electric storage batteries. Roselle. (Date applied for under International Convention, Nov. 16, 1903.)

24701. Electric motor control systems and apparatus therefor. British Thomson-Houston Company, Limited. (General Electric Company.)

24769. Electrical commutators. Nalder Bros. and Thompson, Limited, Nalder and Cox.

25010. Process for producing nitric acid by aid of electricity. William Phillips Thompson (Westdeutsche Thomasphosphat-Werke G. m. b. H.). (Rights under Patents, etc., Act, 1901, not granted.)

26175. Electric transformers British Thomson-Houston Company, Limited. (General Electric Company.)

26292. Joints between metal and vitreous materials and method of forming the same. British Thomson-Houston Company, Limited. (General Electric Company.)

28157. Actuating apparatus for magneto-electric spark ignition apparatus and the like. Unterberg.

28336. Brush-holders for dynamo-electric and like machines Veritys Limited and Rogers.

29015. Automatic control of electric circuits under overload. Siemens Bros. and Co., Limited, and Ledger.

29337. Method and means for the protection of electrical apparatus branched on circuits which are traversed (accidentally or otherwise) by currents of high frequency. Gaiffe.

29627. Electrical fire-alarm or other call apparatus. Shore and Heap.

1905.

2015. Brush-holders for electric dynamos or motors. Barker and Burleigh.

2545. Electrical regulation of clocks. Chandler and Bonniksen.

2850. Electrostatic watt and watt-hour meters. Wilson and Wilson.

4127. Automatic electric warning signals for railways and the like. Hollyer.

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3183. Automatic regulating apparatus for electrical installations with variable current consumption, worked by dynamos and accumulator batteries. Dick.

3664. Prepayment attachments for electricity meters Swan.

4233. Electric ignition devices for internal-combustion engines. Millington and Miller.

4379. Supply and regulation of the electric energy employed in the operation of arc lamps used in search-lights and like apparatus. British Thomson-Houston Company, Limited. (General Electric Company.)

6774. Towers or standards for supporting electric lamps Coverstone.

4848. Arc lamps. Justice. (Phönix Elektrotechnische G. m. b. H.)

5205. Trolleys for electric tramcars and the like. Bradley and Mason.

7068. Safety electric circuit closers Ottinger.

7620. Apparatus for the measurement of X-rays and other similar radiations. Gaiffe.

8614. Appliances for lighting gas lamps and the like by electricity. Thompson. (Freudenthal.)

10480. Night-sights with electric incandescent lamps for artillery sighting or for any instrument in which night sighting may be required. Bertalot. (Bouiau.)

10978. Telautograph apparatus. Brenner and Isaac. (Date applied for under International Convention, May 25, 1904.)

13588. Commutators of dynamo-electric machines Siemens Bros. and Co., Limited, and Berry.

13589. Method of and apparatus for cooling commutators of dynamo-electric machines. Siemens Bros. and Co., Limited, and Berry.

15290. Transportable telephone apparatus. Jacobsen. (Date applied for under International Convention, Dec. 16, 1904.)

17398. Telephone or like transmitters. Cutmore and Telaupad Syndicate, Limited.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	00 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	2¼ 2⅝
—— 4 per cent. Mortgage Debenture Stock	100 ..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	½-¾
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	93-97
—— 4½ per cent. 2nd Debenture Stock	100 ..	78-81
Callender's Cable, Debentures	100 ..	109-111
—— Ordinary	5 ..	11-12 xd
—— 5 per cent. Pref.	5 ..	5⅜-5⅞
Crompton and Co.	3 ..	1⅛-1⅜
—— 5 per cent. Debentures	100 ..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1⅜-1⅝
—— "A" Shares, 01-017,139	5 ..	2-2¼
—— 5 per cent. Debentures	100 ..	92-97
—— 4 per cent. Deb. Stock, Red.	100 ..	85-90
Electric Construction, Nos. 1 to 112,100	2 ..	⅝-¾
—— 7 per cent. Cumulative Pref.	2 ..	1⅞ 2⅛
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	12-13
—— 4½ per cent. Preference	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Telegraph Construction and Maintenance	12 ..	32-34
—— 5 per cent. Bonds	100 ..	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	12¼-12⅜
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10⅛-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11⅜-12⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	107-109
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105 xd
Brompton and Kensington, Ordinary	5 ..	9⅛-10
—— 7 per cent. Preference	5 ..	9¼-9⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9-9½
—— Nos. 60,001-80,000	5 ..	9-9¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅛-13⅛
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	105-108
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	7-7⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5 ..	4⅜-5
—— ditto (1903) 40,001-80,000	5 ..	4⅜-5
Chelsea Electricity Supply	5 ..	6-6¼
—— 4½ per cent. Debentures	100 ..	110-112
City of London, Ordinary	10 ..	11¾-12¼
—— 6 per cent. Cumulative Pref.	10 ..	13¼-14¼
—— 5 per cent. Debenture Stock	100 ..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	104-106
County of London Electric Supply, Ordinary	10 ..	9⅜-10¼
—— 6 per cent. Cum. Pref.	10 ..	12⅜-12⅝
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	111-114
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	102-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	6-6¼ xd
—— 4½ per cent. First Mort. Deb.	100 ..	108-110 xd
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	101-104
Havana Electricity, 1-15,000	10 ..	9-10
Hove Electric Lighting, Ord., 1-13,000	5 ..	8¼-8⅜
Isle of Wight Elec Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103 xd
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1 ..	15/16-1 1/16
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	11¼-12¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛
London Electric, Ordinary	3 ..	1⅜-2¼
—— 6 per cent. Pref.	5 ..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	99-102
Metropolitan Ordinary, 100,001-300,000	5 ..	10-10¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 4½ per cent. Cum. Pref.	5 ..	5⅜-5⅞
—— 3½ per cent. Mortgage Debenture, Red	100 ..	99-102
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0.9	5 ..	8-8⅛
—— do., 57,0 0-75,000	5 ..	8-9⅛
—— 5 per cent. Pref., 1-57,000	5 ..	6¼ 6⅝
—— do., 57,0 0-75,0.0	5 ..	6¼-6⅝
Notting Hill Electric Lighting	10 ..	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	98 100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6⅜ 6⅝
—— 4 per cent. Debenture Stock	100 ..	100 102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-103
Smithfield Markets Electric Supply, Ord 1-12,000	5 ..	2 2¼
—— 4 per cent. Debenture Stock	100 ..	76-80
South London, Ordinary	5 ..	3¼ 4
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16-15/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-108
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	13¼-14⅛
—— 7 per cent. Pref.	5 ..	8⅛ 8⅜
—— 3½ per cent. Deb.	100 ..	£8 100
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅛-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5⅛
Westminster, Ordinary	5 ..	12⅜ 12⅝
—— 5 per cent. Cum. Pref., 110,1 1-138,251	5 ..	6-6⅛
Electric Tramways.—		
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5 ..	5⅞-6⅛
—— Ord.	5 ..	8⅛-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	141-144
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	105-107
Barcelona Tramways, Ord., 1-20,000	10 ..	13⅜-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9,-10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101
—— 4½ per cent. Red Deb. Stock	100 ..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606.	1 ..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3⅜-4⅛ xd
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd.	100 ..	96-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	124-127 xd
—— Ord. Pref.	100 ..	113-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	106-109
—— 4 per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	103-105 p.c.
—— 4 per cent. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11-11¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	121-123
—— 4½ per cent. 2nd Deb. Stock	100 ..	98-100 xd
Buenos Ayres and Belgrano Trams.	5 ..	3⅜-3⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	106-108
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	98-100
Calcutta Tramways, 1-102,268	5 ..	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-108
Cape Electric Tramways, Nos. 1-480,000	1 ..	1-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	3¼-4⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13¼-14⅛
—— 6 per cent. Cum. Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14⅛
—— 6 per cent. Pref., Nos. within 1-60,0 0	10 ..	14⅛-15⅛
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14⅛
—— 4 per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5 ..	2¼-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8⅛
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	9⅜-10⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum. Pref.	10 ..	9⅜-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100 ..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8⅜-9⅛
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9¼-9⅜
—— 4½ per cent. Debenture Stock	100 ..	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,132 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c.
Electric Railways.—		
Central London, Ordinary	100 —	92-94
—— 4 per cent. Pref.	100 ..	101-103
—— ,, ,, deferred	100 ..	83-86
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 —	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	105-103 xd
—— 5 per cent. Pref. Stock '91	100	119-121
—— ,, ,, ,, '85	100	117-120
—— ,, ,, ,, '01	100	114-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3½-4½
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99½-100½
Waterloo and City, Ordinary	100	87-89

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111½-112½
—— Deferred Stock	100	107-108
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1¼-1⅜ xd
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d	£	d
Aberdeen Corporation	Nov. 18	1,166	1,154	+ 11	— h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 11	178	185	− 7	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 19	897	947	− 50	− 783	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 18	390	320	+ 70	—	2	2	,, 31	17,133	4,7 9,7 8	265,525	·85	14·5	8,866	—
Blackburn Corporation	,, 15	816	855	− 7	—	24	24	,, 25	48,875	8,661,720	986,353	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 2	340	350	− 10	—	17½	17½	,, 3	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 18	168	194	− 26	− 1,053	16½	16½	Dec. 3	31,846	2,325 677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 19	1,7 0	1,683	+ 107	—	40	38	March 31	95 765	23,235,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 15	1,209	873	+ 336	+ 9 021	16 82	16 82	,, 31	55,276	10,058,238	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 18	3,932	3,715	+ 216	—	96	77	,, 31	230,085	47,108,000	5,033,392	1·172	10·927	2,396	—
Brighton Corporation	,, 19	922	495	− 73	+ 382	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 17	4,579	4,631	− 52	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 18	958	1,015	− 17	—	10 60	10·60	March 3	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 19	262	269	− 7	− 1,338	8¼	8¼	,, 31	17,950	3,8 8 269	454,082	1·07	9 21	2 058	6·76
Cardiff Corporation	,, 18	1,729	1,731	− 2	+ 132	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 18	149	176	− 27	− 603	8·5	8·5	Dec. 31	10,713	2,935 00	359,756	—	7 14	—	5·18
Central London Railway	,, 18	7,215	7,057	+ 158	− 940	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65 10	57,931	35 80
City and South London Railway.	,, 19	3,095	2,963	+ 132	+ 281	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 16	564	567	− 3	+ 1,224	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6 64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Oct. 21	2 5	198	+ 7	—	4½	4½	,, 31	11,250	2,853,200	284,343	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Nov. 17	97	95	+ 1	− 30h	6¾	6¾	Dec. 3	6,358	402,511	110,738	3 79	13·7	942	7·33
Dublin U. T., electric cars	,, 17	3,778	3,706	+ 72	} —	47	46	,, 31	267,489	50,050,949	7,077,372	1 21	9 07	5,691	5 55
Dublin S. District, Electric	,, 17	795	841	− 45											
Dundee City Tramways	,, 15	835	817	+ 78	+ 1,276	23	23	May 15	44,695	1 ,611,525	933 005	90	1·49	1,913	7 13
East Ham Corporation	,, 18	721	561	+ 160	+ 3,012	23	23	March 31	36,652	13,689,658	863,816	64	10·18	2,994	6 79
Glasgow Corporation	,, 18	14,547	14,470	+ 77	+17,852h	144¾	143	May 31	756,480	195,767,519	7,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 18	1,311	1,1 2	+ 129	+ 1,529	35	35	,, 31	69,938	12,838,150	1,666,262	1 24	9·71	1,923	—
Hull Corporation	,, 18	2,101	2,039	+ 61	+ 565	27	26	,, 31	112,65	27,102,921	2,9 0,693	1	9 29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 15	109	106	+ 3	− 813	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Oct. 18	185	208	− 23	—	7½	7½	May 15	12,201	3,632,855	432,3 6	·775	6·51	—	7·649
Leeds Corporation	Nov. 18	5,352	5,091	+ 261	+ 4,090	89	89	March 2	298,233	64,223,6 6	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 18	1,957	1,745	+ 221	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 11	10,348	11,342	+ 6	+ 8,834	103	103	,, 31	547,625	16,642,663	12.166,419	—	—	—	—
Liverpool Overhead Railway	,, 19	1,336	1,449	− 113	− 1,442h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 11	13,671	12,837	+ 834	+67,421	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 18	141	142	− 1	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 16	85	108	− 23	—	2½	2	—	4,740	850 121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 18	12 025	11,679	+ 345	+17,016	149	131½	March 31	631,956	26,900,875	14,123,124	1 19	10 73	4,299	6 99
Metropolitan District Railway	,, 19	7,945	7,229	+ 716	+ 1,773	21*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 19	17,404	17,167	+ 237	+ 1,111	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 18	114	108	+ 10	—	—	2¾	,, 31	6,159	1,9 2,647	206,358	·83	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 18	2,972	3,591	− 619	+ 2,983	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 19	1 541	1,312	+ 229	+14,717	—	34	,, 25	65,553	13,466,245	1,501,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 18	1,3 0	1,462	− 72	+ 923	—	29	,, 31	95,702	19,625,32	197,499	1·17	11·63	—	—
Reading Corporation	,, 16	579	5 6	+ 13	− 480	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 18	7 5	341	+ 424	+18,746	6½	4¼	,, 31	14,881	2 837,110	336,547	1 24	9·24	1,102	7·92
Rotherham Corporation	,, 9	514	497	+ 37	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1 07	9 5	2,612	7·49
Salford Corporation	,, 20	3,831	3,728	+ 103	—	70¼	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 19	4,661	4,4 3	+ 228	+ 7,575	65¾	52½	,, 25	240,565	63,952 283	6,04 899	903	9·543	3,653	6·477
Southampton Corporation	,, 15	852	8 8	− 36	− 426	—	18	,, 31	49,365	9,294,77	1,108,3 9	1·27	11 02	—	7 85
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 17	737	460	+ 277	+ 5,735	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 5	1,187	1,117	+ 70	+ 1,15	20	20	,, 31	64,858	15,364,463	1,495,685	1 004	10 36	—	6·37
Swindon Corporation	,, 15	175	—	—	—	—	4½	,, 31	4,937	1,315,757	102,751	0 87	11·53	1,371	
Wallasey U.D.C.	,, 18	674	645	+ 29	+ 710	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11 94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6·33
West Ham Corporation	,, 16	1,814	1,008	+ 805	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 15	739	—	—	—	—	7½	,, 31	36,757	7,656,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Northampton Institute Engineering Society.—A meeting will be held this evening at 7.30 p.m, when a paper will be read by Mr. W. Chappell on "Water-Turbines as Applied to the Generation of Electricity." Dr. R. Mullineux Walmsley will take the chair.

Electrical Manufacturers' Association.—We have received from Mr. Walter Davenport (the secretary) an intimation that at a recent meeting of the members of this association it was unanimously decided that, owing to the enormous increase in the number of applications, they must reluctantly discontinue the practice of subscribing to annual beanfeasts, Christmas boxes, new year gifts, etc. In consequence thereof, the members of the above association have unanimously agreed to discontinue this custom.

Electrical Exhibition.—We are officially informed that the financial affairs of the recent exhibition are now so far advanced as to enable the management to announce that the exhibitors will receive a rebate of 25 per cent. upon the sums paid by them for space, while a very considerable sum will be available for benevolence. The fact that the exhibition was an unqualified success from every point of view is satisfactory not only to the executive committee, but to the exhibitors and the trade generally. No small measure of its success is due to the excellent organisation, and the executive committee, together with the secretary (Mr. Walter Davenport), deserve to be specially congratulated upon the result. It remains to be seen how far this decision will apply to those who receive unsolicited Christmas presents from manufacturers.

Turbines.—The Cunard liner "Carmania," which, in place of reciprocating engines, is equipped with the most powerful installation of model turbines yet conceived, set out upon her maiden voyage last Tuesday week. She had been previously subjected to a six hours' trial run from Glasgow, in which she attained an average speed of 19½ knots with what, in the estimation of her builders and designers of the turbines, proved to be a satisfactory consumption of fuel. It is interesting to note the fact that on her trial trip she carried, among an influential company, special representatives of the Russian and Japanese navies, the former of whom (Major-General Poretchkin) is now in this country for the purpose of studying the problems suggested by the arrival of the turbine with a view to its adoption in the new war fleet which the Tsar is about to build.

Copper Wire.—In the discussion on Mr. Fowle's paper on railway telephone service read at the recent conference of the Association of Railway Telegraph Superintendents some interesting facts were brought to light concerning the life of copper wires. It was stated by one speaker that the copper wires laid along the Wabash Railroad had been in use for 15 to 18 years without any signs of deterioration being shown. Another speaker remarked that copper wire on a certain point on the Erie Railroad, in close proximity to a chemical works, served about 3½ years, while an example was shown of a case in Texas where 20 miles of copper wire in the Beaumont oil region had been badly impaired in two years by the sulphurous atmosphere. The iron wire in the same region was eaten up in about one year. In Beaumont lead-covered cable is used with good results, the lead apparently acting as a protection against the sulphur fumes. A test of aluminium wire on the Erie road was made at the point above mentioned. It worked well for about six months, when one day a circuit was broken, and investigation showed that three sections of the wire had "evaporated."

Electric Traction.—Engineers are beginning to perceive that in the not too far distant future the motive power for traction will be unlike that of the present, and that with the advance of electric science its wider application for traction purposes is inevitable. This is recognised by Mr. Donald A. Matheson, M.I.C.E., engineer-in-chief of the Caledonian Railway, who, in delivering his presidential address at the inauguration of the session of the Glasgow Association of Students of the Institution of Civil Engineers, remarked that "the steam locomotive was now shadowed, if not absolutely threatened, by the electric motor." This statement, emanating from so important a source, and supplemented by the utterances of other prominent railway officials, marks a significant change in the attitude of railway authorities. Dealing more particularly with the work of railway engineers in the future, Mr. Matheson indicated that the tendency, rather than in the construction of new railways, was in the direction of betterment by the widening of existing lines, the providing of additional accommodation, and the extension and improvement of the great terminal stations for goods and mineral traffic, as well as for passenger traffic, in the principal cities of Europe, as well as of the United States. Improvement in permanent way had also in recent years been most marked.

Rand Power Scheme.—In the *Times* engineering supplement Prof. W. E. Ayrton reverts to the proposed electric transmission scheme from the Victoria Falls to the Rand, and disputes the statements made in an interview with a contemporary by Mr. Wilson Fox, manager of the British South Africa Company, relative to the possibility of such a scheme being commercially successful. He condemns the comparisons made between the power schemes at Victoria and Niagara, as the latter only delivers electrical energy over a distance of 30 miles while the former proposes to deliver it over 745 miles. At present the Rand consumes about 150,000 h.p. at a cost of something like £20 per year per horse-power. Niagara sends 24,000 h.p. to Buffalo, 30 miles away, and sells it at 0·7d. per horse-power hour to an eight-hour consumer, which is equal to £25. 11s. per horse-power year. There is a plentiful supply of coal in the neighbourhood of Johannesburg. Estimates have been obtained and the accurate analysis made of about 20 different kinds of coal, giving the specific gravity and the percentages of carbon, ash, volatile matter, coke, as well as the evaporation factor, with the result that at a price of 10s. 5d. to 12s. a ton excellent coal can be delivered on the Rand itself. How is it possible, therefore, asks Prof. Ayrton, to "transmit electric energy 745 miles and sell it more cheaply than it can be obtained from coal on the spot." He also points out the dangers from native nterference with the line, and summarises his objections to the scheme in the sentence that "such lengthy transmissions, more than three times as long as have ever yet been made, because more than three times as long as even the enterprising Americans have ever yet considered commercially possible, could certainly never succeed in such an unsettled country as South Africa."

Birmingham Local Section.—The opening meeting was held in the large lecture theatre of the university on Nov. 23. The attendance numbered 86. Dr. Sumpner having taken the chair, congratulated the members on the success of the previous session's work, and pointed out that not only had all the papers been published in full in the Institution *Journal*, but that two of them had been awarded premiums. In cordially welcoming Prof. Kapp, who was present with them for the first time, he said that among his many great services rendered to the electrical engineering industry, perhaps none was greater than that rendered

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when in 1885 he pointed out, simultaneously with Dr. Hopkinson, the true theory of the magnetic circuit and made it clear to dynamo designers. Dr. Sumpner then vacated the chair in favour of Prof. Threlfall, after thanking the members for their support during his term of office. The new chairman proposed a vote of thanks to Dr. Sumpner for his services as chairman, which had been performed with such conspicuous ability. This was carried with acclamation, after which Prof. Threlfall delivered his address on "Some Problems in Electro and Electro-thermal Chemistry." Mr. R. A. Chattock proposed a vote of thanks to the chairman for his address, alluding to the importance of the introduction of new materials for making lamp filaments. All were interested in following up discoveries which were leading to an increase in the efficiency of incandescent lamps. The motion was seconded by Prof. Gisbert Kapp, who expressed admiration for the skill with which the chairman had dealt with a difficult subject, for electro-chemistry and metallurgy had been unfortunately too much neglected by electrical engineers. He thanked the audience for their kind reception of him as a member of the section.

Books Received.—We have received from Messrs. S. Rentell and Co., Limited, London, a third edition of "The Application of Electric Motors to Machine Driving," by Mr. Andrew Stewart, A.M.I.E.E. (2s.), which has been rewritten and enlarged so as to include the more recent developments in this system of electric driving.—The *Proceedings* of the Royal Society of Edinburgh (vol. xxv., No. 11) includes among its contents a "Note on Some Generally Accepted Views regarding Vision," by Dr. W. Peddie; a "Note on the Boiling Points of Aqueous Solutions," by the Rev. S. M. Johnston, B.A.; and "A Comparative Study of the Dominant Phanerogamic and Higher Crytogamic Flora of Aquatic Habit in Three Lake Areas of Scotland," by Mr. George West (with 55 plates).—The *Bulletin* of the Imperial Institute (vol. iii., No. 3) contains an article on rubbers from Burma, which gives the results of analyses made with products of the plant Ecdysanthera micrantha, and Parameria penduncolosa. The chemical examination of the dry material of the former plant gave the following results: caoutchouc, 84·1 per cent.; resin, 11·5 per cent.; insoluble matter, 4·4 per cent. (of which 1·3 per cent. was ash). The composition of the latter was revealed as follows: resin, 88·5 per cent.; caoutchouc, 10·7 per cent.; insoluble matter, 0·8 per cent. Material possessing such a very resinous composition as the latter product would have very little commercial value. It appears, however, that further investigations may be made in view of the favourable opinion expressed upon the product of this vine in Java and Sumatra. The *Bulletin* contains also a long article on the production and uses of asbestos, and an announcement that the Natal Government is offering to lease the rights of rubber collection of certain portions in the Ingwavuma district of Zululand.

Society of Arts.—The first of the series of four Cantor lectures for this year was delivered on Monday last by Dr. J. A. Fleming, F.R.S. The subject chosen was "The Measurement of High-Frequency Currents and Electric Waves." At the outset the lecturer said that the determinations of Cavendish were comparable with those made to-day, for the reason that he measured in the same units. The capacities of different bodies were best found experimentally, as was also the inductance. Those associated with large engineering schemes were apt to imagine that the measurement of these small inductances was of little importance, but, as he showed, in the case of high-frequency currents small inductances and capacity were of very real significance. A principal property of high-frequency currents was that they were entirely on the surface of the conductors. It was very important to study spark resistance. A method of spark counting which he had devised had proved of great service, and had thrown fresh light on certain investigations. Spark resistance was a very complex thing, depending upon many things, of which the chief were the capacity of the jar, the inductance of the circuit, the length of the spark, and the shape of the spark terminals. Spark resistance had been measured in another manner by Prof. Slaby, of Charlottenburg, and his experiments showed that with increase of spark length, and with increase of capacity, there was a rise in resistance. Dr. Fleming said that he had found that the material of which the spark balls were composed had a marked effect on spark resistance from giving a higher resistance than zinc or brass. It was also noticeable how great was the effect of length of spark upon resistance, as had also been demonstrated by Slaby. There were, however, many anomalies, and the work of various investigators did not show agreement; but the results were not necessarily contradictory, being rather due to the different kind of spark employed. This referred particularly to the experiments of Rempp. Numerous diagrams and experiments were introduced to illustrate the lecture.

Three-Phase Railways.—An inspection of the Valtellina three-phase railway, which connects the towns of Lecco, Sondrio, and Chiavenna, and skirts the picturesque borders of Lake Como, was recently held, and in the *Electrical World and Engineer* is given particulars of the results achieved, together with a description of the general equipment. According to the official time-table the daily train miles are 1,400, and the ton-miles about 268,000, allowing 134 tons for passenger trains and 313 tons for frieght The total energy developed at the generators is 10,000 kilowatt-hours per day, including that required for lighting and for the workshops. The energy generated per ton-mile would, therefore, be about 37 watt-hours, but as this is measured at the generators, the actual average required for propulsion per ton-mile would be less, corresponding to a very economical result. The three 2,000-kw. generators in the power-house, of which one is held in reserve, are tended by 12 men, and for the maintenance of the 65 miles of double overhead line 26 men are employed, while 45 men supervise and maintain the sub-stations and rolling-stock. Twelve motormen in addition complete the staff. The total expenditure per annum amounts to £4,780, or 11·7d. for the working cost per 1,000 ton-miles. Of this total, £889 is spent in the power-house, £1,438 is required for the maintenance of the overhead equipment, £1,368 for the electrical equipment of cars and locomotives, and £1,085 for motormen. In contrasting these figures with the cost of operating steam locomotives it is stated that, on the basis of 1,400 locomotive miles per day, the corresponding cost of steam traction would be £23,250, or nearly five times as much as with electric. The plant is driven by water power from an exceptionally fine source, the turbines operating under a head of about 100ft. As this line, forming part of the Adriatic Railway system, was formerly operated by steam, the comparison quoted was doubtless based upon actual performance, but as cheap coal cannot be obtained in the district, the great difference between the figures would be accounted for to a large extent by the entire elimination of the cost of fuel for the electric system.

Power in Sweden.—Formerly industries in Sweden were largely dependent upon outside sources for the means wherewith to obtain energy for power or lighting purposes. The coal production of the country is very small, and her requirements were met from supplies from abroad. Now, however, she is turning her attention to the rich resources

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which she herself possesses, and bringing energy to bear in their development. The enormous peat fields are being worked for their product, which is largely substituting foreign coal on the goods wagons in the service of the State railways, and the *Elektrotechniker* announces that the waterfalls in the country are being utilised for the supply of electric power. This journal states that a company has been formed in Halmstad—the Sydsvenska Elektriska Aktiebolaget—for the purpose of working the supply from the Laga in Southern Sweden, which flows from Bolmsee in Kronoberg into Laholms Bay on the south-west coast. Seven power stations will be erected on its banks, the first at Bolmsee, whilst the others will be placed at various points on the route, all connected with one another. Power will be transmitted south as far as Eslöf and north to Halenstadt. In addition, there will be a number of branch stations, and the total length over which the power will be transmitted will be 300 km. With the completion of the first portion of the system a total of 13,000 h.p. will be ready for use, whilst the final completion of the works will almost double the amount of power for disposal. The cost of construction of the stations and equipments is estimated at 14 million kronen (about £771,457), of which 1½ million kronen (£82,656) will be expended on the plant and machinery. It is anticipated that the price of power will be sufficiently low to enable it to compete with the cheapest of its rival methods. A definite demand in the locality is already guaranteed, so that the profitableness of the undertaking is assured. Furthermore, it is understood that current will be utilised on some of the railways and in collieries for power and lighting purposes. The erection of stations and equipments is being undertaken forthwith, so that it will be possible to supply current in two years.

Electrical Engineers (R.E.V.).—Notwithstanding the fact that this corps has only been in existence for nine or ten years, the record which already stands to its credit is one of which the officers and men may well be proud. From humble beginnings they have worked their way up to the position which they at present hold, one unique among branches of the volunteer service, and the number of men enrolled in their ranks now amounts to 800. This success is in a large measure due to the fact that in their case intellect goes together with strenuous work and a sense of military discipline. The Government have recognised that in them the nation has a valuable accession to its defensive forces, and in the matter of camping have not failed to accord special facilities to suit the convenience of the men. On Saturday evening last a good muster of officers and men met a number of guests (including officers from the regular army) at the Café Monico on the occasion of their annual regimental dinner. The chair was taken by Colonel R. E. B. Crompton, who took a leading part in founding the regiment. The toast-list was discreetly brief, and, after the loyal toasts were duly honoured, the Chairman proposed "The Army," which was responded to by Colonel W. Pitt, R.E. (Eastern Command), who referred to the close connection between the Electrical Engineers section of the Royal Engineers and the army, and incidentally mentioned that the 350 men who went out to South Africa during the late campaign had greatly distinguished themselves. Colonel N. M. Lake, C.R.E., proposed "The Corps of Electrical Engineers," and in so doing took occasion to remark that the Electrical Engineers were engaged in duties such as they would be in war, and, therefore, the value of their services was greatly enhanced. Colonel Crompton replied to this toast, and pointed out that the efficiency of the men as volunteers depended upon their efficiency as electrical engineers, and that the training given in the corps was to the end of the men gaining a livelihood. The toast of "The Guests" was proposed by Major B. Hopkinson, and responded to by Lieutenant-Colonel Sir E. P. C. Girourard and Prof. John Perry. The toast-list was interspersed by an excellent programme of vocal selections.

Yorkshire Local Section.—An ordinary meeting of the Local Section of the Institution of Electrical Engineers was held on the 23rd ult. at the University of Leeds, when a paper was read on destructors and their by-products by Mr. F. L. Watson. After describing the progress which had been made in destructor design, Mr. Watson proceeded to a consideration of the financial side, and indicated the manner in which economies could be effected by the utilisation of by-products. He then went on to explain the details of various types of destructors, and afterwards discussed the allocation of cost and returns as between the destructor and the electricity works, and the management of the joint undertaking. If the cleansing department ran the destructor and sold steam to the electricity department, it would be run for sanitary purpose, and might not give its maximum results when the electricity department wanted them; if by the electricity department, it might be run for steam regardless of sanitary considerations. Again, if the sanitary department was to be paid for steam, how was the quantity to be ascertained? Mr. Watson said he knew of no satisfactory method, since the quantity used in the destructor itself was generally more or less uncertain. The value of the steam per ton could be easily ascertained from the cost of raising the same quantity by means of coal. The ideal method would appear to be to drive an independent generating set from the destructor, and to work this set as near as possible at a constant load, crediting the destructor with the actual output. If the generating set could also be retained in the control of the cleansing department, and the current delivered by meter to the electricity department, it was better still. A well-known surveyor said recently that most of the electricity generated by destructors was produced by friction between the two departments, and if that was so, it was deplorable that the ratepayers' money should be so wasted. Mr. Watson thought that these questions might find a solution in the increasing responsibilities undertaken by cleansing departments, such, for example, as the combination of a works department for the whole corporation, the manufacture of clinker products, and the lighting of stables, workshops, and staff dwellings, and streets in the vicinity of the plant, or the sale of power to neighbouring manufacturers.

Ramsgate Tramway Accident.—The report of Lieut.-Colonel P. G. von Donop, R.E., upon the accident on Aug. 3, when a car running down Madeira-hill got out of control and fell over a cliff, a height of about 32ft., has just been issued. The responsibility for the accident is placed upon the motorman, who did not apply his brakes judiciously when travelling on a steep gradient. Madeira-hill is about 230ft. in length, and opposite Albion House, where the accident occurred, according to Board of Trade regulations a stop has to be made by all cars before descending the hill. From this point down to the end of Madeira-hill the gradient is a continuously falling one, varying from 1 in 13 to 1 in 16. In addition, there are a number of sharp curves in Madeira-hill; the only one, however, concerned in this accident is a reverse curve, which commences at a point about 35 yards below Albion House. At this point there commences a left-handed curve of 66ft. radius, and about 30 yards in length. Almost immediately at the termination of this curve there commences a right-handed curve of 73ft. radius. There is practically no straight at all between the two portions of this reverse curve. Owing to the gradient and curves, speed down Madeira-hill is restricted to

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three miles an hour. In this case the front wheels of the car ran round the above-mentioned left-handed curve successfully, but immediately that they met the commencement of the right-handed curve they were derailed towards the left of the line, and the accident occurred. The superelevation at the point where the wheels left the line was ½in. in the wrong direction—that is to say, the rail on the inside of the curve was ½in. higher than the outer one instead of the outer one being the higher of the two. With the authorised speed of three miles an hour this want of superelevation would, however, have been immaterial. The inspector reports that the actual derailment was due to the sharpness of the curve and the high rate of speed at which the car ran round it; and with this high speed, the derailment was further facilitated by want of superelevation at the point where the wheels left the line. The gradients on Madeira-hill are not considered excessive provided the brakes be in good order, but, owing to the car becoming a total wreck, it was not possible to ascertain this. Colonel von Donop reports that the arrangement of the lines on Madeira-hill where this accident occurred is susceptible of improvement, but it is understood that the company intend to take steps at an early date to carry out certain alterations with that object. The only other point to which attention is drawn is the method of applying the slipper brake, and the inspector considers that the arrangement was not satisfactory, though it did not appear to have contributed to the accident in any way.

Commercial Progress.—For two or three years past, adherents to a certain school of economic thought have gone about the country pointing out to us that trade is declining, that our commercial supremacy is threatened, and that the break-up of the Empire is inevitable. To revive our declining industries and to avoid the terrible catastrophies which lie ahead, we are urged to accept and apply certain changes which are advocated by those disciples. Whether their diagnosis of the case is the correct one or not, or whether the measures prescribed are likely to be remedial, it is not our purpose here to discuss. Certain it is, however, that the fears which they convey have disturbed the mental calm of a great number of individuals to such an extent that an impartial examination of the question is not attempted and underlying causes more and more obscured. It is consoling, therefore, to transcend this atmosphere of doubt and apprehension, and to inquire into other factors which bear upon our foreign commerce. Reference to all records—official and otherwise—which indicate the actual state of the nation's commerce, are sufficient to allay our misapprehensions about impending disasters. Nevertheless, there are matters which if properly attended to cannot but extend our foreign trade. And of these, the most important is the consular service. It is because this branch of the civil service is not too well organised and adequately controlled and remunerated that much valuable information as to the requirements of and possibilities in the world's markets is not available to our manufacturers and merchants. European and American consular services are placed by their respective Governments on a much higher status than are ours, and, consequently, are able to supply their people with more extensive information. Only the other week we called attention in these notes to an American consular report on the possibilities of a wider application of electricity to lighting and traction in China, and other reports which are constantly being brought to our notice convince us that one of the great defects in our foreign trade is that our manufacturers do not know the requirements of the world's markets, and that they are not aware of what is being offered there by their foreign rivals. This view is largely borne out by the speech delivered before the Liverpool Chamber of Commerce last week by the Marquis of Lansdowne, who said that if we were outclassed in different parts of the world it was not because of the inferiority of our goods, but because of the greater adaptability and resource shown by some of our rivals in different branches of trade It is satisfactory to learn, further, from the same source that treaties have been concluded with foreign countries whose markets are neutral whereby our goods are allowed to enter under the most-favoured-nation treatment, and that future prospects are by no means so gloomy as depicted by others.

Institution of Electrical Engineers.—There was a large company present at the meeting held on the 23rd ult., when Colonel H. C. L. Holden read his paper on the "Applications of Electricity in the Royal Gun Factory, Woolwich Arsenal." The President (Mr. John Gavey), in opening the meeting, referred to the sad loss of Mr. G. A. Grindle, who was one of the victims of the ss. "Hilda" disaster. Mr. Grindle had been a full member of the Institution since the early eighties, and a vote of condolence with his family was passed in silence. Colonel Holden then proceeded with his paper (which we are producing elsewhere), which gave a most interesting account of the electrical applications introduced into the Government workshops, and was followed with keen interest by the members. At the invitation of the chairman, Prof. Ayrton rose to open the discussion, and, in so doing, said that it was a matter for congratulation that mechanical power had been substituted by electrical power, and he emphasised the advantages accruing from the better light which was possible in the workshops following the substitution. As instancing the rapid development of the application of electricity in factories, he stated that while in South Africa he had noticed that in a large electrical works in Central Pretoria the machinery was driven electrically. There the equipment consisted of a line shaft driven by a single motor, and he wished for an expression of opinion from Colonel Holden as to whether it were more advantageous to employ a separate motor for each tool or lathe, or whether all tools should be attached to a line shaft driven by a single motor. Prof. Ayrton stated further that an idea which he found to be generally put into practice in America was that the machine and motor were complete—*i.e.*, the casting of a tool or lathe or other machine was made to receive the motor. The only serious objection which he had heard against that practice was on account of the greater vibration. Mr. Russell followed in the discussion, and said that, with regard to the use of worm gear described by Colonel Holden, the experience which he had had with that class of gear at Silvertown had clearly established its advantages. Though the initial cost is greater, the wear is so small that repair is not required, and smooth running is gained. He pointed out the wonderful way in which the electric cranes worked, and he thought that Colonel Holden had too modestly refrained from sufficiently emphasising this point. Mr. A. W. Marshall wound up the discussion by asking what precautions were taken at the factory, where so much electrical machinery was in operation, to prevent a sudden cutting off of current? Replying to Prof. Ayrton, Colonel Holden said it was difficult to draw a hard-and-fast line between driving machines with separate motors and line shafts, each particular case having to be decided upon its merits. He himself favoured the line shaft when such were possible, for it would be found that the cost of driving tools by separate motors and switches would form a serious objec-

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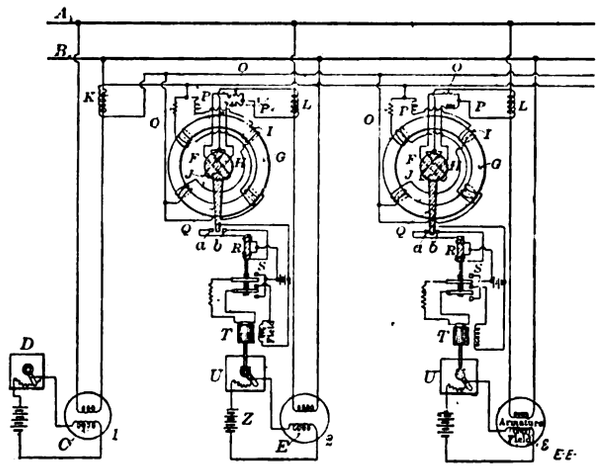
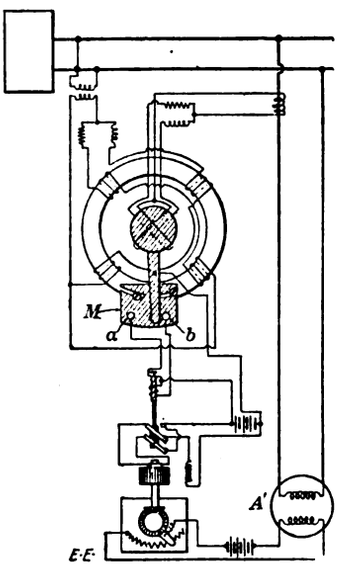
tion. With regard to practice of building the motor complete with the machine, Colonel Holden thought it advisable to do so in some cases, especially in those where there is no reduction of gear. A special department was appointed to control the supply of current to the Arsenal, but there were multiple mains and a good many generating sets in case of need. On the motion of the chairman, Colonel Holden was cordially thanked for his interesting discourse.

Phase Regulator.—The general principles of a proposed phase regulator are described by Mr. P. G. Watmough, jun., the designer, in the *Electrical World and Engineer*. Briefly speaking, the apparatus consists of a selective device, responsive only to phase displacement in combination with and actuating a relay mechanism, which controls or varies the field exciting current supplied to the generator or other alternating-current apparatus whose phase displacement it is desired to adjust through the medium of its field excitation. In the accompanying illustration the two magnetic field members of the indicator placed concentric with each other are marked G and H. The inner field is pivoted so that it can rotate through a considerable angle. Polyphase field windings, preferably arranged for diphase currents, are placed on each member, so that a rotating field flux may be obtained in each structure when the windings are suitably energised. In order that the instrument may be used as a phase regulator, a swinging index arm, mounted on H and arranged so that



it will swing over a graduated scale, is equipped with a contact device arranged to close one or other of two relay circuits, the energising of which sets in motion a motor that is suitably geared to the field rheostat of the machine whose field it is desired to control. One of the applications of the device is seen in Diagram 1. A B represent the 'bus bars or lines; C E, separate excited fields; D, field rheostat, hand control; F, phase regulator; G H, field members of regulator; I J, polyphase windings; K L, current transformers; O, resistance coil; P, inductance coil; Q, contact arm; R, relay, plunger, and coils; S, reversing switch; T, motor armature; U, field rheostat; Z, any source of excitation. The encircled windings, 1, 2, 3, represent single-phase alternating-current generators. Should any of the machines, say generator No. 2, have insufficient excitation, its current will be displaced in phase from the current flowing in generator No. 1, due to the lower terminal E.M.F.; this phase difference will cause the moving element and contact arm of the phase regulator connected between generators 1 and 2 to assume a certain position dependent upon the amount of phase displacement existing. If the contacts, *a* and *b*, are so adjusted that at zero phase displacement the contact arm just swings clear of both contacts, then the above phase displacement and resulting position of the arm will close one or other of the contact points; one of the local relay circuits is thus energised, which through the medium of relay coil, plunger, and reversing switch starts into action the small motor operating the field rheostat, connections being such that the direction of rotation will cut out resistance, thus strengthening the field of generator No. 2. A corrective force is thus applied to the existing phase displacement, which will be gradually diminished by the increasing field strength, until zero phase difference exists between generators 1 and 2. When this condition obtains, however, the regulator arm will assume its former position—wherein the contact arm swings clear of either contact—breaking the relay circuit, which thus allows the motor switch to fly open, and hence stops further movement of the rheostat motor. It has been found that in stations where there are many units operating together the above arrangement not only increases the efficiency of the plant—through the suppression of the wattless magnetising or demagnetising currents circulating between machines, which result is now approximately obtained by hand adjustment—but it also eliminates the time and attention now required of the switchboard operator in securing the above adjustment. Among its other applications is one for the automatic maintenance of a predetermined power factor between any machine and the circuit to which it is connected. This is effected by



but a slight modification of the arrangement, as shown in Diagram 2, where A' represents the armature of field circuits of the machine to be adjusted. Another application is for the automatic maintenance of constant voltage. Merely the relay and operating mechanism previously described are retained, the selective device or phase indicator being replaced by a voltmeter mechanism, the movable arm of which performs the same service as rendered by the contact arm in the phase regulator, closing one or other of the contact points, *a* or *b*, depending upon whether the voltage rises or falls below a predetermined value. The device may also be applied to the control of phase displacement due to speed variation. Actual operating conditions may require combinations of the above applications, thus it might be desirable to maintain a group of several rotary converters in phase unison with each other, utilising the connections illustrated in Fig. 1; the "master machine" of the group, however, if connected as in Fig. 2 would determine the power factor at which all the rotaries would tend to operate. Different methods have heretofore been suggested for meeting one or more of the above applications, but the author is of the opinion that the particular mechanism proposed embraces several points of novelty, especially the idea of utilising a "master machine" to which other machines on the circuit may be cophased.

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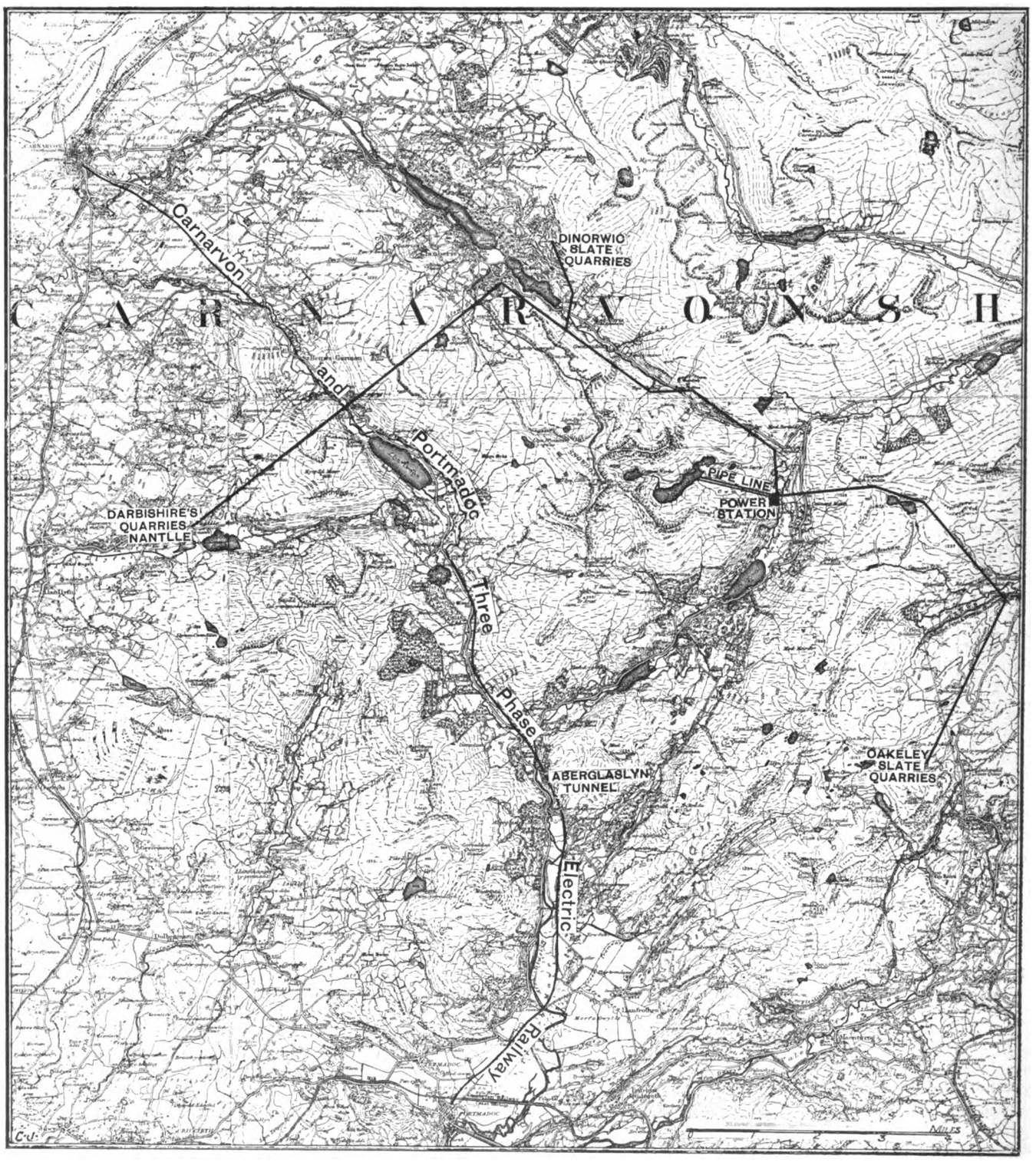
NORTH WALES ELECTRIC POWER SCHEME.

Contractors' Dinner.

Through the courtesy of the editor of the *Contract Journal*, we are able to reproduce an account of a dinner which he attended at the Victoria Hotel, Llanberis, on Saturday last, Nov. 25. We are also permitted by him to reproduce some photographs showing the class of contractors' work which this large power scheme involves. The editor of the *Daily Express* kindly lent us three of the photographs, but, unfortunately, we could not get in time for reproduction those photographs used in the excellent description of this scheme in the *Daily Express* for Nov. 23. We hope to give a technical description of the scheme when the plant is officially opened in the early part of next year.

The dinner given by Messrs. Bruce Peebles and Co. to celebrate the partial completement of their extensive contract for the North Wales Electric Power and Traction Company was held in the Victoria Hotel, Llanberis, on Nov. 25. The large hall of the hotel had never before seated so many guests, but the host proved quite equal to his task. Covers for 174 visitors were laid, and the hall, when the guests were seated, presented a gay appearance. The guests included local quarry owners, tenant farmers, and the large staff of men employed in the works. Dinner was served in good style, and everyone did full justice to the excellent viands set before them. The place of honour



Map of the Snowdon District, showing the Work of the North Wales Electric Power and Traction Co.

on the toast-list was, of course, given to "The King," and was proposed by the genial president, Mr. M. T. Pickstone, the able director of Bruce Peebles and Co., in his usual inimitable style.

The North Wales Electric Power and Traction Company were complimented in a few appropriate words by Mr. Brinkman on their enterprise in the huge undertaking they have in hand. Mr. Brinkman is the manager of the Dinorwic slate quarries, which are to be equipped for electric driving. Mr. Aitchison was put down in the

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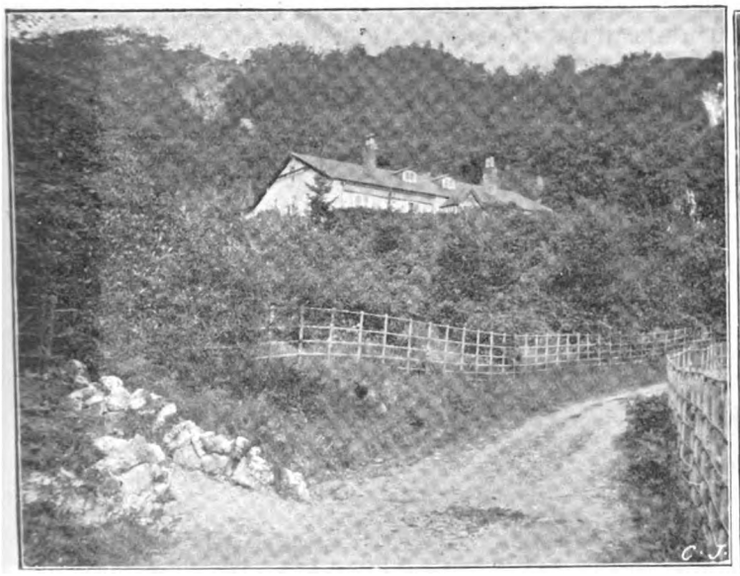
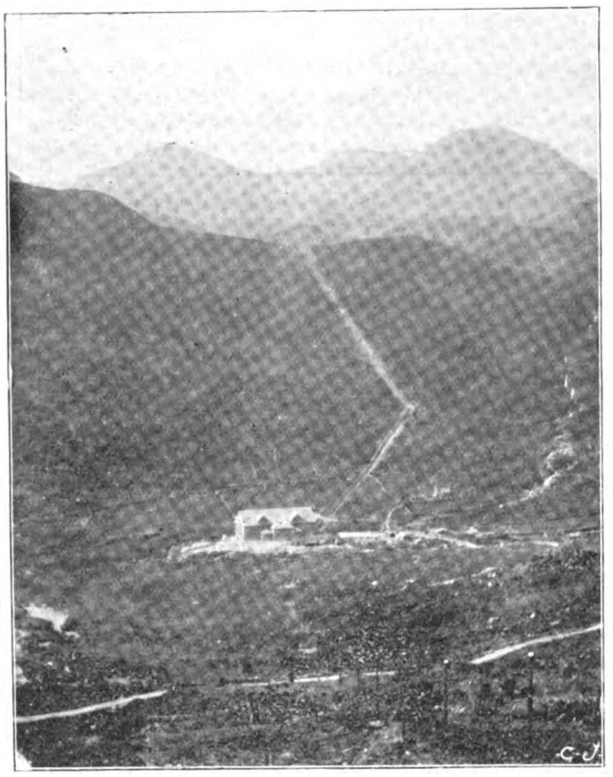
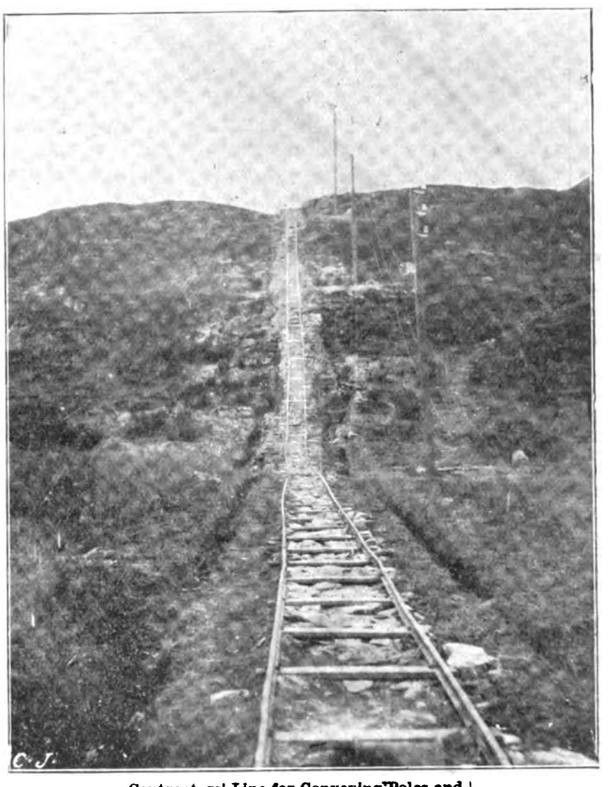


The Chalet Beddgelert (Headquarters of Messrs. Bruce Peebles and Co. in Wales.

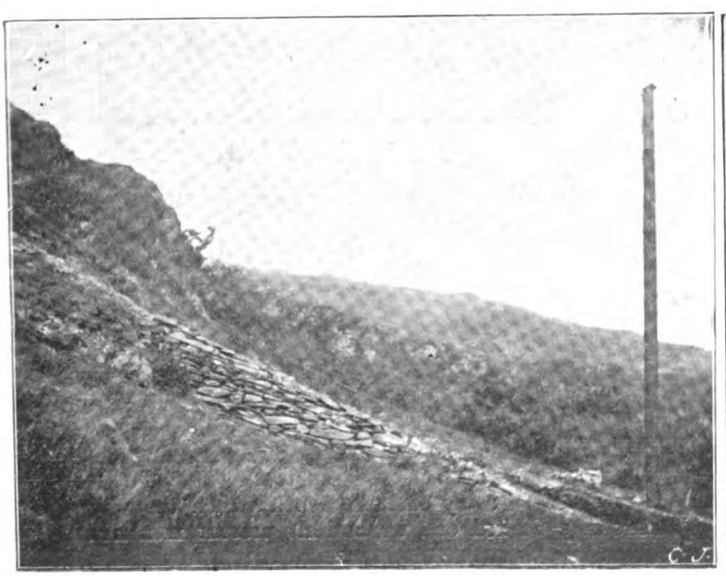
The Power Station.



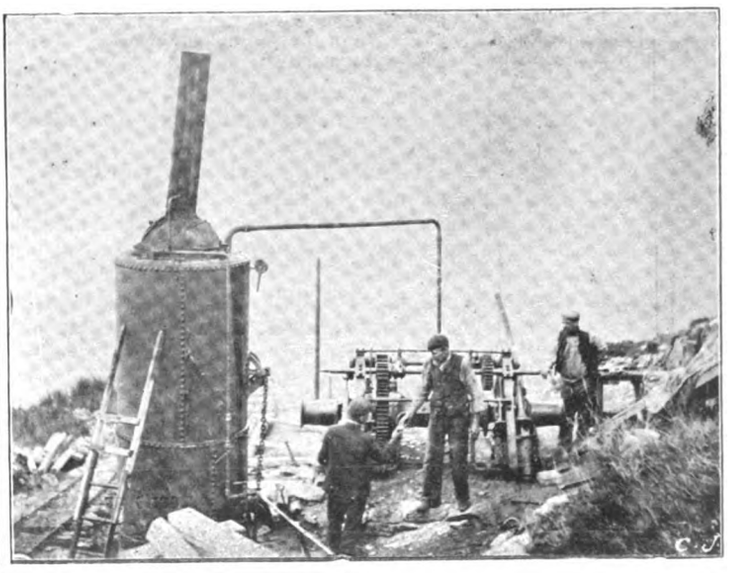
General View of Power Station and Pipe Line, with Snowdon in background.



Contractors' Line for Conveying Poles and Line Materials



Side View of Line, showing Grade.



Steam Haulage Gear for winding up heavy grade.

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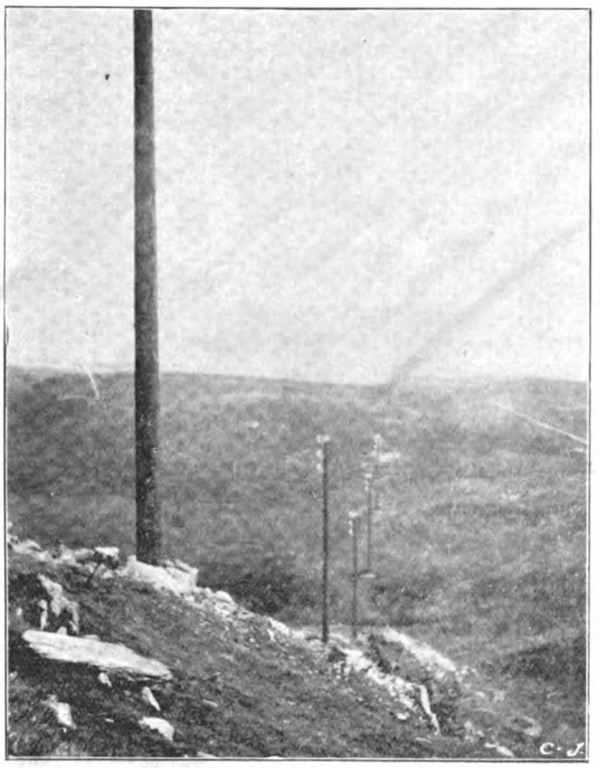
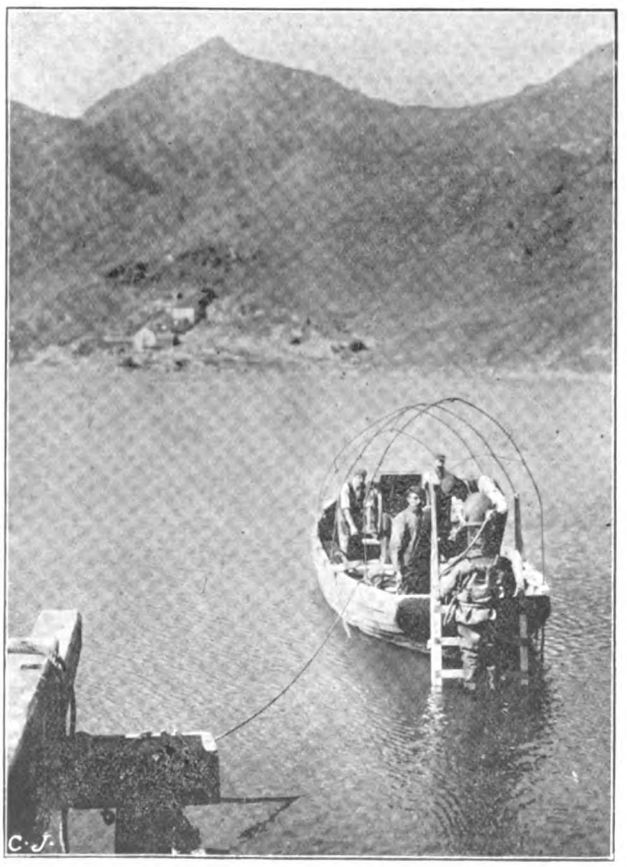
list for this toast, but had wired his great disappointment in being unable to be present that evening, and Mr. Taylor, the superintendent of the works for Messrs. Harper Bros.,



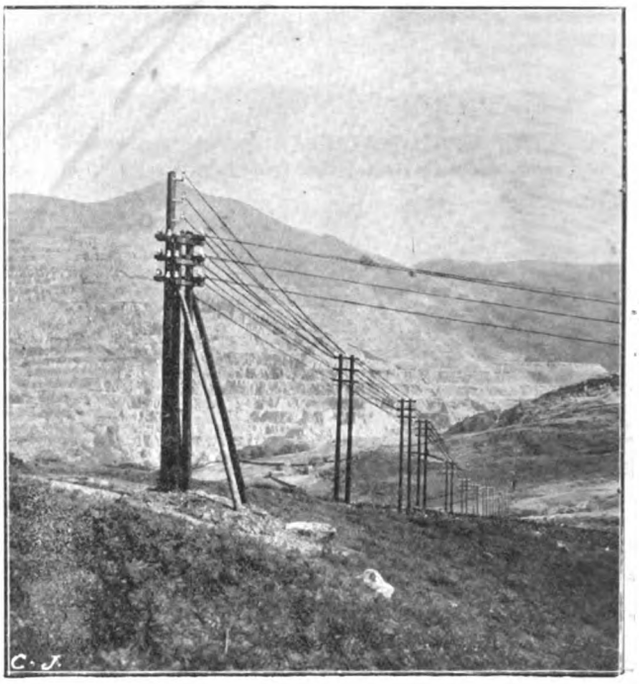
The Pole Line to Roman Bridge.

ably took his place. Between toasts a recitation was given by Mr. D. H. Jones on "Our Job," composed by one of the employés for the occasion, and hitting off



Divers on Llyn Llydaw, preparing Pipe Line Intake in bottom of Lake. (*Daily Express* Photograph.)

to a nicety the various personalities at present working in Messrs. Bruce Peebles' interests. The rendering received prolonged applause. Messrs. Bruce Peebles and Co. had a warm champion in Mr. T. C. Kerr, who had come all the way from London to speak of his admiration for the company. He sketched in a most interesting manner the growth and development of that firm from small beginnings up to its present great size, and how Mr. Pickstone had thrown his whole



A Turn in the Line near Llanberis, showing Slate Quarries in background. (*Daily Express* Photograph.)

energies into its development. He also gave a list of some of the new contracts the firm had lately obtained, and from that one judged how it would in future become a power, not only in the land, but through the British Empire spreading still more the impression that Britain is not by any means so backward in business as some people say and think.

Entrance to Aberglaslyn Tunnel. (*Daily Express* Photograph.)

Mr. M. T. Pickstone had certainly to take a meed of praise for himself in his reply to the toast, but said that the whole success of any business depended on the way one's assistants backed one up, and his present men had never given him a moment's disturbing thought in the way they had carried out instructions for this contract. Mr.

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W. V. Waite, the engineer in charge of the whole work, had given him great satisfaction doing work of sterling worth. Mr. A. W. Beutell, sent down from Edinburgh perfectly inexperienced in this new work, had, by his tact, commonsense, and keen interest in his work, made himself a name in that part of the world, and would, he felt sure, rise to still greater prominence in the future. This contract had proved a record in many respects, 30 miles of transmission lines having been erected in the course of five months, and much of this in almost inaccessible places. The scheme was also unique in character, being the first high-tension hydro-electric power scheme in this country with transmission by bare overhead conductors. Three-phase alternating current was generated by alternators direct driven by Pelton wheels, the head of water being 1,100ft., and the turbines being fed by duplicate pipe lines 1¼ miles long, with pipes 30in. in diameter. Each of the four sets of Pelton wheels and alternators already installed would develop 1,500 kilovolt-amperes. The power was to be used principally in the slate quarries situated within a radius of 15 miles. The power would also serve to supply current to the North Wales Narrow-Gauge Railway and its extensions, all of which were being carried out by the firm, the result being a complete narrow-gauge electric line from Carnarvon to Portmadoc. The line, when completed and electrified, would be 30 miles long, with nine transformer stations, the current being transformed to 600 volts for supply to the two overhead wires feeding the three-phase motors on the trains. He also referred to the many large contracts that the firm have at present on hand, not only in Great

A Camp on the Mountains.

MR. H. BEUTELL. MR. W. V. WAITE (RESIDENT ENGINEER).
DR. W. E. SUMPNER (VISITOR). MR. M. T. PICKSTONE (DIRECTOR)
MR. WALNOTHE. MR. WOOLRIDGE. MR. A. W. BEUTELL (CHIEF ASSISTANT ENGINEER).
THE GUARDIAN OF THE CASH.

The Erecting Staff of Messrs. Bruce Peebles and Co.

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Britain, but also in Canada, South Africa, China, South America—in fact, in all quarters of the globe. Mr. Pickstone then proposed the toast of "Mr. Aitchison, general manager of the North Wales Power Company, and of the North Wales Narrow-Gauge Railway, and the Portmadoc, Beddgellert, and South Snowdon Railway Company," all of which companies are directly interested in the scheme, the two latter about to be worked electrically. In the unavoidable absence of Mr. Aitchison, Mr. Wells, resident engineer at Beddgellert, replied.

Mr. W. V. Waite proposed "The Visitors," responded to by Dr. Mills Roberts.

Mr. H. T. Beutell proposed "The Tenants," responded to Mr. Close.

Mr. A. W. Beutell proposed "The Men," which was replied to by Mr. Ovenden and Mr. W. Owen, who said the firm and their representatives had taken a genuine interest in the men, and by their fair and even generous treatment of them had won not only their esteem, but the affection of both the staff and the rank and file. They would pardon almost any delinquency but "scamped work" or work not strictly in accordance with the book, with the result that they had secured sound and substantial work such as would for many years successfully resist the assaults of the tempests and hurricanes for which Snowdonia is notorious. The men, in expressing their high appreciation of the honourable treatment received, most cordially wished Messrs. Bruce Peebles and Co. the long and prosperous career which they so richly deserved.

The great feature of the evening's entertainment was the excellent musical interludes. One felt in listening to these worthy exponents of Welsh musical fame that here one was right in the centre of a world of music. The reception the performers got was most cordial, one encore not by any means being judged sufficient. One or two truly Welsh songs were sung, and Mr. Kerr, a man near to the Biblical limit of three score and ten, gave us in charming style a couple of Scottish national songs. When the time for parting came it was with extreme sorrow that such a unique evening should have any limit at all, but the near approach of the "Sawbath" compelled all to seek their various ways, after singing in true Welsh fashion "John Jones," etc.

We need only add that our photographs and the map will show the extent of the scheme and the difficulties overcome by Messrs. Bruce Peebles and Co. under the able guidance and to the plans of Sir Douglas Fox and Messrs. Harper Bros., the consulting engineers to the North Wales Power and Traction Company.

SHUNT-WOUND TRAMWAY MOTORS.

BY A. JOHNSTON, A.I E.E.

The adoption of shunt-wound motors for tramway work has caused a large number of engineers to shake their heads in doubt as to the result in practice of such experiments Usually, a shunt-wound motor designed for stock will have a much lower starting torque than a similar series-wound motor—in fact, the same calculations will be used, except, of course, the size of the field conductors, both motors being designed to run at normal load with the same field strength, and the field saturation at normal load will not be carried into the sloping part of the curve. As this practice has been carried on from the beginning, it has firmly established the idea that the starting torque of series motor is greater than a shunt motor. Users of the two have found it to be the case, and have taken it as a natural consequence.

Improvements in commutation have been made which allow considerable variation in the strength of field without serious sparking at a fixed position of the brushes, that reduce the difficulties standing in the way of varying the speed by varying the field strength. Commutation in the later series motors gave little trouble owing to the fact that a heavy current was never commutated in a weak field, the field being always strong when the armature current was great. If the field is excited independently of the armature current, it is, of course, possible to have a heavy current commutated in a weak field, and in constructing controllers for shunt-wound primary motors precautions are necessary to prevent this being carried to a point that will injure the motors.

The torque of any motor is approximately proportionate to the product of the field strength and the armature current, or

$$T \propto N\,C, \text{ then } T = k\,N\,C.$$

It makes no difference how N, the field strength, is maintained, whether by a shunted current or by C, the armature current; but it is evident if saturation is not carried beyond the bend of the curve, that in the series-wound motor

$$N \propto C, \text{ and } N = m\,C; \text{ therefore } T = k\,m\,C^2;$$

and in the shunt motor with the field excited by a constant current, N will be constant and $T \propto C$.

Still assuming that the saturation of the field is not carried beyond the straight portion of the curve, if the phrase is not contradictory, it is seen that, while the torque of a series motor varies as the square of the armature current, the torque of a shunt motor varies with the current simply; and these facts alone would indicate that the torque of a series motor when starting (at which time the armature current will probably be at its highest value) will be greater than that of the shunt motor, and if the field strength was not a factor of the torque in both cases, the truth of this indication would be clear. The fact remains, however, that N is a factor of the torque, and there is no reason why a shunt motor should not have as high a value for N as a series motor when starting. How long this high value of N can be maintained without injury to the field coils is quite another matter, for the winding space in tramway motors is very limited and the ventilation is bad; consequently, if the rate at which heat is generated is high, it cannot be continued for more than a brief period without endangering the insulation of the coils, and on this account the current in the shunt circuit must be reduced soon after starting by inserting external resistance in the circuit, which, of course, means some loss of energy and a lowering of the efficiency of the motor.

The curves in Fig. 1 are for two motors of exactly the same design and size except that one, A, is series wound and the other, B, is shunt wound The manner in which the tractive effort falls as the speed increases is very striking, but it must be remembered that this, in the case of B, the shunt-wound motor, depends on and is under the control of the operator. In making out these curves, the armature current in B is kept constant at full working value by varying the field strength, while the current in the armature and field of A is controlled only by the speed, unless field shunts are used. The two tractive effort curves show that the acceleration of B compared with A is less when starting and at slow speeds and greater at moderate and high speeds, and in this it holds a great advantage in that it lessens the strain on the gear and truck and the discomfort of the passengers. The same motor will, of course, give a different curve if differently operated—in fact, a great deal depends on the operator; and if cars fitted with shunt-wound motors are to be run on lines having long heavy gradients, he must be well trained and reliable, so that he will not injure the motors by allowing the car to travel too quickly and take too much current when ascending these heavy gradients. This, if it could not be overcome, would be a serious defect; a tramway motor that depends greatly on a reliable motorman would be scrapped at once by ninety-nine out of a hundred managers The trust, however, can be transferred from the motorman to the car circuit breaker by adjusting the latter to open when the current rises beyond a safe value, but as a circuit breaker, too, is inclined to err, one should be fixed on each end of the car and connected in series in place of the usual arrangement of a circuit breaker at one end and a switch at the other. The motorman will soon find out the correct position for his controller on each particular hill and will not go beyond it, for should he do so he will be put to the trouble of stopping the car, closing the circuit breakers, and starting again. This arrangement also prevents the motors being abused by the conductor holding the circuit breakers closed; he cannot hold both at the same time in

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his endeavour to assist the motorman to get home quickly on the last trip at night. Usually more harm is done during the last trips than at any other time.

Two shunt-wound motors with their armatures connected in series and their field coils similarly connected will work well and each will take a fair share of the load, but when connected in parallel difficulties arise. If the pair of wheels connected to one motor varies in diameter with the wheels coupled to the other, the load will not divide equally between the two motors—one will do more work than the other to some extent, small or great according to the difference in the sizes of the two pairs of wheels. Take, for example, the first pair of wheels to be 30·25in. in diameter and the second 30in.; this would only mean $\frac{1}{8}$in. all round the wheel, and is often exceeded in actual practice, accounted for by the quality of the wheels and brake blocks varying. The armature speed in revolutions per minute will be the speed of the car in miles per hour multiplied by 50 in the first instance, and in the second case the multiplier will be 50·42. If, at a speed of 10 miles per hour or 500 r.p.m., the first rotor takes 20 amperes, its counter E M F. will be:

Impressed voltage – armature current × armature resistance; or if the armature resistance is ·5 ohm,

$$500 - 20 \times \cdot 5 = 490 \text{ volts};$$

and if the field of the second motor is of the same strength, since it will revolve at 504·2 r.p.m., its counter E M.F. will be

$$\frac{504 \cdot 2}{500} \text{ of } 490 = 494 \text{ volts.}$$

Its armature current will then be

$$\frac{500 - 494}{\cdot 5} = 12 \text{ amperes};$$

thus showing that this slight difference in the wheels causes one motor to take only 60 per cent. of the current taken by the other.

Again, it may be shown that if the field of one motor is slightly stronger than the other, it will make a considerable difference in the current taken by the two motors when working in parallel. Suppose that the first motor takes, as before, 20 amperes, and that its counter E.M.F. is 490 volts, then if the second motor runs at the same speed but with its field, say, 1 per cent. weaker, its counter E.M.F. will be

$$\frac{99}{100} \text{ of } 490 = 485 \cdot 1 \text{ volts},$$

and its armature current will be

$$\frac{500 - 485 \cdot 1}{\cdot 5} = 29 \cdot 8 \text{ amperes},$$

or nearly 50 per cent. more than the first motor. This extra load would cause the motor to become hotter, which in turn would weaken the field still more, and so on. It may be concluded, therefore, that to run shunt-wound motors in parallel on a tramcar in the usual way is certain to lead to serious trouble. This difficulty with the field strengths may be overcome by leaving the field coils connected in series always, no matter how the armatures may be connected, which will keep the ampere-hours the same in each. The only variation which can then take place will be due to the magnetic circuits, and if care is taken to keep the material in these the same, it should not be serious.

If shunt-wound tramway motors are to be worked with economy, the shunt circuits must be broken every time the car is stopped in order to prevent waste of energy in them, and each time this is done a destructive arc will be produced at the contacts owing to the high self-induction of the coils. Seeing that it is necessary to stop a car about 1,000 times a day, these contacts which carry the shunt current will give considerable trouble, and should they fail to make connection at any time the safety of the armatures will depend on the working of the car circuit breakers. It is a very rare occurrence for the field coils of a series motor to become short-circuited owing to the small potential difference between the turns, and if a current is allowed to flow through the motor, it may be taken almost as a certainty that it will have its proper field.

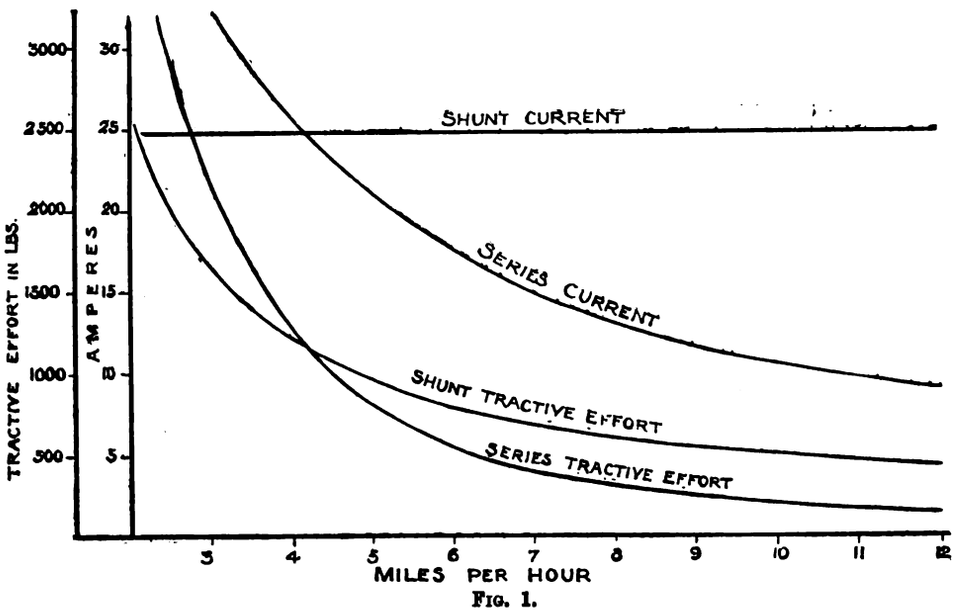

FIG. 1.

Shunt-wound motors can be used for controlling the speed of the car when running down hill or reducing it when on a level road, and when doing this they will return energy to the line, which can be used again by other cars. This action reduces the wear and wear on the wheels and brake blocks considerably, but puts more work on the motor armatures in just the same way as the rheostatic brake, except that in the latter the energy is wasted in resistances. It will take a fixed amount of energy to reduce the speed of the car a certain amount in a certain time that energy is taken from the car through the medium of the motors, and either returned to the line or absorbed in resistances. In either cases the strain on the motors will be the same. On most tramway systems the use of the rheostatic brake as a service brake is strictly prohibited, owing to its destructive effect on the motors. If shunt-wound motors are to be successfully employed to control the speed of the car in both positive and negative acceleration, their dimensions must be carefully worked out, and the size of the cars and steepness of the gradients on which they are to work taken into consideration. It is unreasonable to expect motors that have been converted from the series to the shunt type by simply altering the field coils to work as well on the same cars as before this alteration was made; the conditions are so different. If the motors were only just large enough to deal with the positive acceleration of the cars, it is certain that if they are used to retard the speed as well, their life will be short. There is a difference in the braking action of series

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and shunt wound motors when generating, in that the former will bring a car to almost a dead stop, while the latter will only reduce the speed to three or four miles per hour. This difference, however, is not so great as it might appear at first sight, for if, before the braking action is started, the car is travelling at, say, eight miles per hour, it will not retain half its kinetic energy at four miles per hour, but a much less quantity, since the store of energy in the car varies not with the speed simply, but with the square of the speed—that is,

$$E_k \propto v^2 \text{ and } E_k = a\,v^2,$$

and at a speed of four miles per hour

$$E_k = 16 \times a.$$

At a speed of eight miles per hour

$$E_k = 64 \times a.$$

Thus it will be seen that, while series motors can convert all the kinetic energy stored in the moving car, shunt motors can convert only 66 per cent. of it, assuming these speeds. In retarding a car from travelling beyond a certain speed when descending a gradient, the same amount of energy must be converted whichever type of motor is employed.

When a short-circuit occurs on a section of tramway on which shunt motors are running, it will be more violent, owing to the motor acting as generator and the car circuit breakers having to open in addition to the station circuit breaker.

THE APPLICATIONS OF ELECTRICITY IN THE ROYAL GUN FACTORY, WOOLWICH ARSENAL.*

BY COLONEL H. C. L. HOLDEN, R.A., F.R.S., MEMBER OF COUNCIL

(*Continued from page 737.*)

Grindery.—As in most modern workshops, it is the custom to grind the workmen's tools for them, and not to allow them to do this for themselves in the old-fashioned haphazard way on a grindstone. In the grindery devoted to this work some 12 Gisholt tool-grinders are continuously in use, and the problem to be solved was to drive them in the most economical and efficient manner. The grinders were arranged half on either side of the shop, and driven by belting (Fig. 8) from a shaft running at very nearly the same speed as the wheels, and coupled direct through a flexible coupling to a 6-h.p. shunt motor standing on a bracket fixed to the wall. The speed of the shaft is 1,400 r.p.m. Besides the tool-grinders there are also two small cutter grinders, and in order to drive these latter, which are placed across the shop, it was necessary to have a shaft running at right angles to the other two. As the power required was small, this motion was transmitted by a friction disc and wheel, the wheel being advanced so as to be in contact with the disc when it is required to rotate the shaft, which consists of a thin steel tube, and runs at 2,500 r.p.m. Some doubt was expressed as to the life of these high-speed shafts and bearings when they were first erected, but as they have been working for the last three years with practically no wear, it is evident there is no need for apprehension that they will not last. The economy in transmission here is considerable, owing to there being none of the usual countershafting; it is not uncommon to see machines of this sort driven from a high-speed motor, which, from a small belt pulley on its own shaft, drives a large one on a countershaft, which again drives by means of another large pulley the small pulley of the grinder. The best wheels for use on these grinders for high-speed tool steel have been found to be carborundum ones. Carborundum, as we know, is itself electrically produced at Niagara Falls.

Rifling Machine.—The method of driving of a large rifling machine for 12in. guns is shown in Fig. 9. The term "rifling," of course, is applied to the operation of cutting the grooves which run spirally along the bore of a gun. In order to do this, a bar carrying one or more tools to cut the grooves is drawn through the gun, and turned as it is moving to give the required twist. The saddles which guide the bar are carried on a bed, within which is the screw for actuating the bar; as this screw revolves in one direction or the other, so the bar is moved in or out of the gun—cutting is always done by pulling the bar through, not pushing it, and, indeed, I may remark that in boring operations it is always better to have the cutter bar in tension than in compression—the end of this screw is coupled to a shaft passing right through the gear box, and

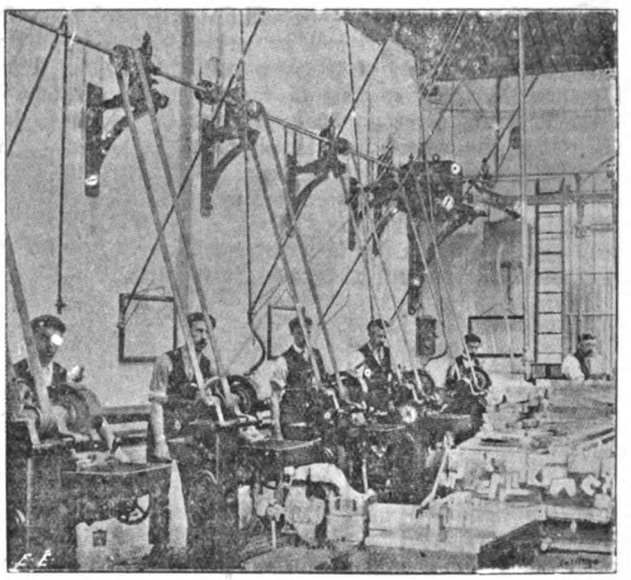

FIG. 8.

supported in the bearing shown on the left of it in the picture. This shaft carries two magnetic clutches (Fig. 9), one on either side of the gear box. The motor of 30 h.p. drives a pinion which is always in gear with the teeth of the large internally geared wheel, and also with a small spur wheel, running on the same centre as the former, but, of course, in the opposite direction. A clutch on the left connects the screw shaft to this latter wheel, whereas the clutch on the right attaches it to the internally geared wheel. It will be obvious that the direction of rotation of the screw shaft will be different according as one clutch is in action or the other, and owing to the different ratio of the gears a quick return motion when not cutting is obtained. The motor and the gears run continuously in one direction, and, therefore, there is only the momentum of the screw shaft and inertia of the screw and saddles with the rifling bar to overcome on reversal of its motion. The action of reversing is entirely automatic, and worked by the movement of the rifling bar saddle. This drive works very smoothly and well—it enables the rifling

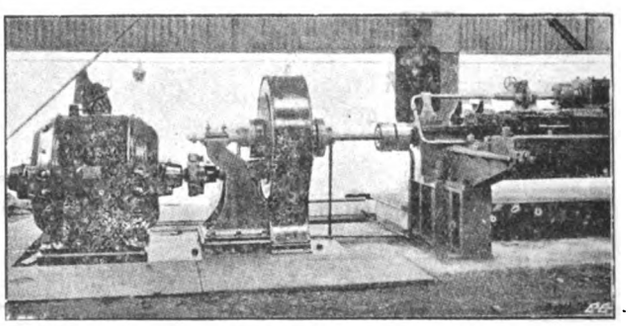

FIG. 9.

of a 12in. gun to be carried out in 40 hours, six grooves being cut simultaneously, whereas only a few years ago the same operation, with one tool only cutting, took more than three weeks, working day and night; no less than 26 cuts have to be taken to finish each set of grooves, and I am able to show specimens of the shavings taken. In contrast to this machine, I have an illustration of another driven by the older method of crossed belts, which go through the usual shrieking performance whenever the drive is reversed. Within the last few weeks, however, this latter machine has been dismantled in order to lengthen

* Paper read before the Institution of Electrical Engineers.

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it, and fit it with a driving gear similar to the one already described.

For lapping the bores of guns, an operation which has to be done in order to get the extreme uniformity of diameter that is necessary in the bore, both during manufacture and sometimes after the gun has been in use, there are three machines in the factory for dealing with various sizes of guns. Two of these were designed to be driven by separate motors, and the third was converted to an electric drive. I may remind you that the operation of lapping is performed by means of an expansible lead-covered block or head

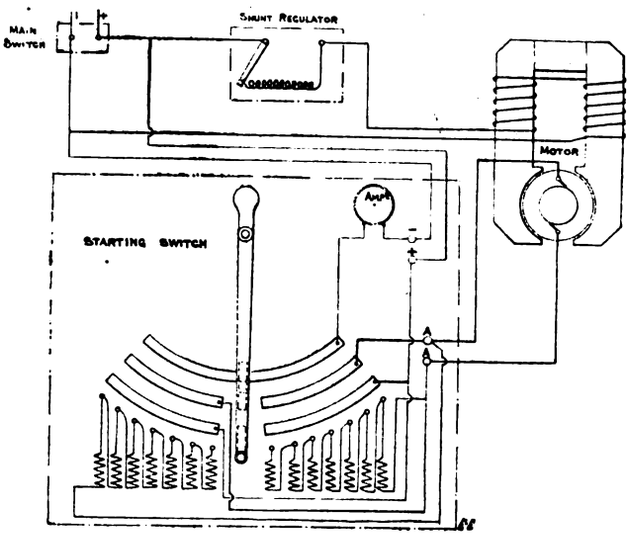

FIG. 10.

charged with abrasive material, such as emery or corundum, which is attached to the end of a rapidly revolving shaft, and is capable, whilst revolving, of being moved from one portion of the bore to the other. A short and rapid to-and-fro motion should preferably be given to this head, so as to prevent the cutting of rings in the bore. The largest of the three machines is devoted to the larger guns, such as the 9·2in. and the 12in., and the motor is mounted above the saddle which carries the lapping shaft, and drives the latter by means of a short link belt. The large pulley is attached to the shaft by a feather sliding in a feather-way cut the whole length of it, and in this manner rotates the lapping head. The saddle is traversed backwards and forwards along the bed by a screw extending the whole length of the bed and similar to the leading screw of a lathe. This screw, however, is stationary, and the traversing motion of the saddle is produced by means of a revolving nut, which is driven also by a linked belt and through reducing gear from a pulley carried on the other end of the motor shaft. The quick to-and-fro motion is given to the bar by the sleeve, which is clamped on to the bar between the two cheeks of the saddle, and has cam grooves around it in which guide blocks fixed to the saddle are made to engage when required. The liquid reverser, worked either automatically or by hand, is in front of the starting switch. The tightening of the belt is accomplished by sliding the motor across the saddle, and can be done by the hand-wheel when the machine is running. The next size of machine is somewhat similar in design, but the motor is underneath the bed, and drives by gear entirely; the motor is not easily accessible, and is more liable to damage from emery and oil, and is mentioned more as an example of how not to do it. I must add, however, that it works very well. A diagram of the switch connections is shown in Fig. 10.

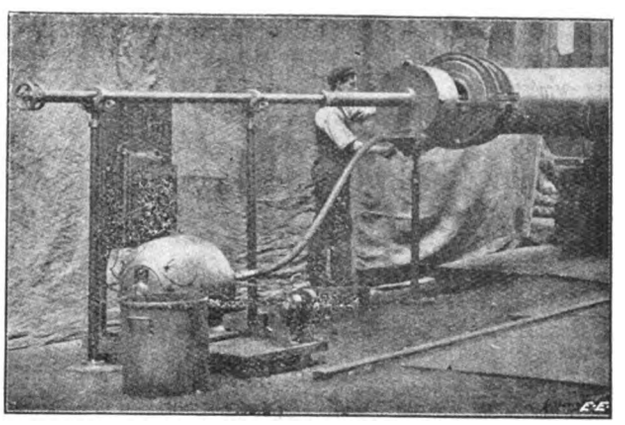

FIG. 11.

The smallest machine, situated in the north-east shop, is really a converted lathe, and is devoted to the smaller size of guns up to 4·7in. I mention this as a practical example of the advantages possessed by magnetic clutches over the old system of reversing by a shifting belt. The machine originally had two shifting belts with loose pulleys and a fast pulley between them, on to which the belts were shifted in turn for reversing the direction of motion of the screw actuating the saddle. The central pulley was done away with, and magnetic clutches were applied to the other two either one of these can be energised by a rocking switch actuated by hand or automatically. The result of this change was to enable the saddle screw to be run much quicker than before, the reducing gear between the pulleys and the screw being removed, and the latter driven direct, while the motion is reversed silently, instead of with a screeching of belts and clashing of gear. Altogether four magnetic clutches are used with this machine, two on the main shaft, one to drive the headstock which rotates the gun and another to drive the open and crossed belts, and

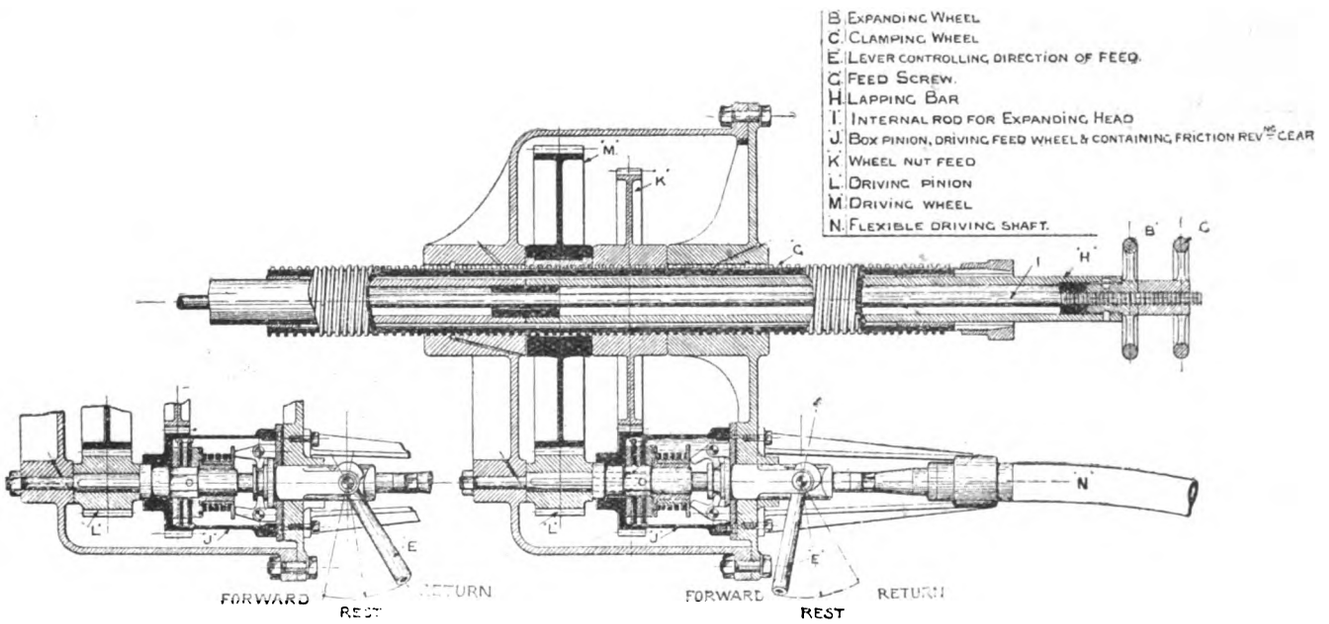

FIG. 12.

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then there are the two already described. This may seem a somewhat extravagant number to employ on one machine, but it is justified because the machine is not one that is in constant use, and the power absorbed by running three belts idle is very considerable, and quite a large figure when compared even with the total capital cost of the clutches, instead of the interest thereon and depreciation.

An illustration is also given of a portable electric lapping machine (Fig. 11) for use on board a ship or elsewhere. The machine itself, which embodies most of the features of the large machine, is here attached to the muzzle of the gun, and rotation is imparted from the motor to the machine by a flexible shaft (Fig. 12). The forward and

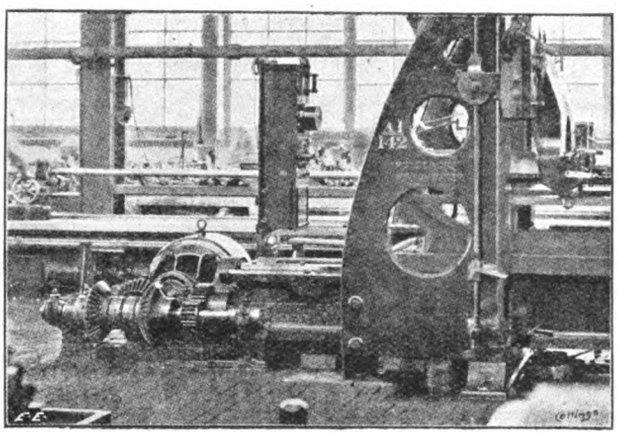

Fig. 13.

backward feed of the lapping head is obtained by means of a friction clutch, controlled by a small lever, which regulates the movement of the nut through which the screw feed bar passes. If the nut is held still, the bar advances at the highest speed; if the nut is allowed to revolve at the same speed as the bar, no forward or backward movement takes place; and if the nut is driven faster than the bar, the motion of the latter is a backward one. In the first case the friction clutch is out and the nut held; in the second case the nut is free to revolve; and in the third case, the friction clutch being in, the nut is revolved at a higher speed than the bar, and so the bar is withdrawn. The power required for a lapping machine is always out of all proportion to the weight of metal removed, and in this case a motor of 6·5 h.p. is necessary.

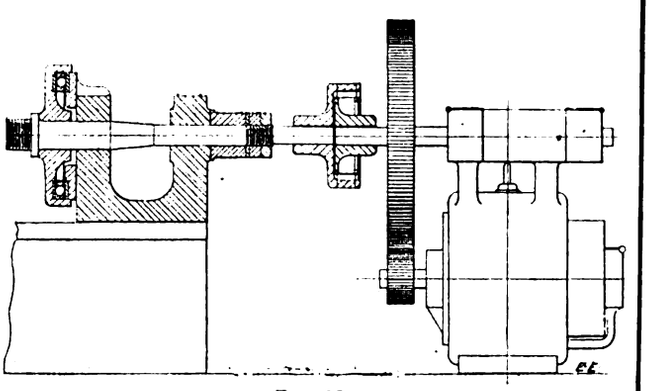

Fig. 14.

We now pass to the electrically-driven planing machines, and I may here say that, so far as planing machines generally are concerned, I am in favour of cutting in both directions with two separate tools whenever and wherever it is possible, the economy in power, time, and labour being greater than having a quick return stroke, for it is obvious that, however rapid the return stroke may be, time is lost, and no useful work is done. This will explain why the gear is so designed that the speed of the table in either direction is the same. In the case of planing machines, as in the case of the boring machines, I hold a strong brief for the screw drive as against the rack and pinion drive. The former undoubtedly does the better work. The planing machines are driven by a shunt-wound variable-speed motor, which runs continuously in one direction, and drives, by means of a bevel pinion, two bevel wheels revolving in opposite directions (Fig. 13); these two bevel wheels are concentric with the shaft which drives the screw of the planing machine, and are each furnished with a magnetic clutch, by which they can be attached to the shaft; the clutches are alternately energised by a rocking switch, actuated by adjustable tappets on the bed of the planer. The reversing action of these machines is very quick and silent. No check or change of speed is discernible in the motor, though, of course, the ammeter shows a momentary rise of about 25 per cent. on the reverse. The special shaping machines used for interrupting the screw threads in the breech openings of guns seem very well adapted to driving in pairs, and this arrangement has, therefore, been adopted. The motor drives a countershaft placed above it, and the two machines are driven each by

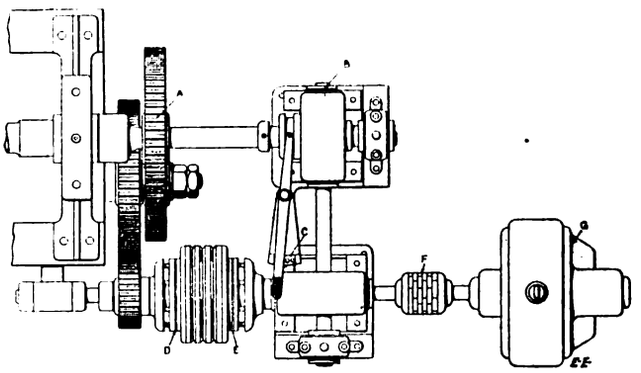

Fig. 15.

its own magnetic clutch from this countershaft by belting. Mention may also be made of a heavy vertical milling machine, which was not originally designed for electric driving, but had to be converted. Though I am not in favour of very short belt drives when there is a difference of diameter between the driven and the driver, yet in this case it was almost the only arrangement possible, and, in point of fact, it has been very successful, the motor being supported on a Γ-shaped bracket attached to the upright of the machine, and to the portion of the frame carrying the driving shaft.

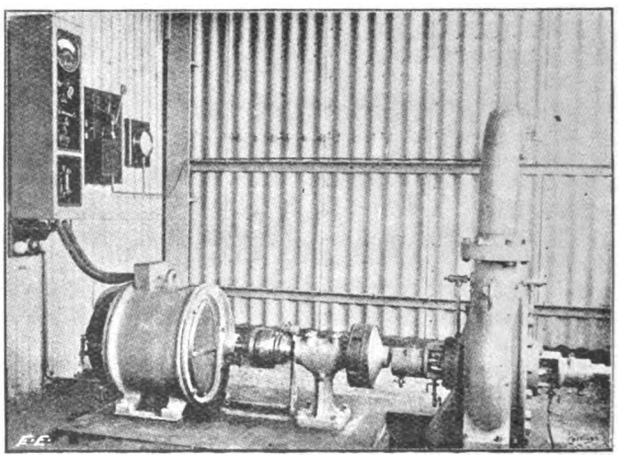

Fig. 16.

Earlier in the paper I described a separate feed arrangement for a large boring machine, and I now propose to illustrate a smaller one for high-speed solid boring fitted with a somewhat similar arrangement. The machine itself has a mandrel, which is driven by a motor through a single-reduction gear, for the reason that, although it would have been preferable to drive it direct from the motor shaft, this was not practicable owing to the comparatively low speed required The thrust of the boring tool (which is very considerable) is taken by a ball bearing of large diameter forming the back of the face plate (Fig. 14), a device which has been very effective. The feed gear is shown in Fig. 15. This, as in the other example, fulfils two functions—viz., that of the actual feed of the tool into the work, and also the quick withdrawal and

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advance of the same. In this instance two clutches are used in conjunction with a claw clutch, and besides the safety arrangement provided to prevent the feed gear running after the headstock is stopped, or being started before the other is in motion, there is also a switch worked by the lever actuating the claw clutch, which prevents the two clutches being operated simultaneously, or even the wrong one being operated. When the feed is in operation the motor is clutched to the first worm-shaft and turns the first worm-wheel, which in turn drives the worm of the second worm-wheel, and the claw clutch being engaged, the screw is driven, and the saddle carrying the boring bar advanced. If now it is desired to withdraw the bar rapidly, the claw clutch is withdrawn, and the motion of the lever effecting this allows the second magnetic clutch to be rendered active, and this clutches the pinion to the motor shaft, and drives the spur wheel through the intermediate wheels. The speed of the carriage when feeding varies from 33in. to 115in. per hour, whilst the quick return is from 7in. to 24in. per minute, or nearly 13 times faster.

In the south boring mill it used to be the custom, as elsewhere, to have each large boring machine supplied with cutting lubricant by a small and separate plunger pump, but a short time since it occurred to me that it would be preferable to have a constant and general supply from one

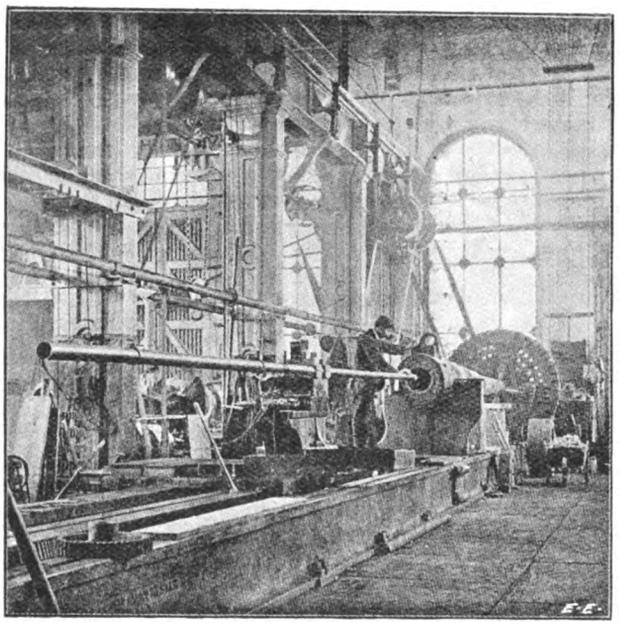

FIG. 17.

source, and to do away with the small separate pumps. A high-lift centrifugal pump, driven direct from a motor, appeared to be the most suitable pump for the purpose, and the pressure required being only 30lb. per square inch, an old boiler was utilised as an accumulator and air-vessel to maintain the pressure. The motor is coupled to the pump (Fig. 16) through a magnetic clutch and flexible coupling, and runs at 1,200 r.p.m., the clutch being used to connect or disconnect the two when the pressure falls below or rises above the amount that the automatic switch is set for. It is somewhat remarkable to see the extremely quick, and yet, as it must be, gradual action of the clutch in starting the pump, which is, of course, started from rest with a full head—there being no appreciable delay or shock in so doing. This installation has proved so successful that a second set is being obtained, to enable the whole shop to be supplied. The motor of the second set will be so arranged that it will only be started when the first set cannot meet the requirements. The pump takes 14 s.h.p., and lifts 300 gallons per minute. Once having introduced magnetic clutches into the workshop, it is astonishing how quickly their applications seem to spread, and I propose to devote a few minutes to describing one or two special examples.

In the testing-room there is a small piece of apparatus which is used for compressing to a predetermined amount the copper cylinders employed in guns for ascertaining the pressures developed by the explosive; for instance, if a 15-ton per square inch pressure were anticipated, a copper pressed to 12 tons per square inch might be used. The pressure required is obtained by the weight of a column of mercury, the height of the column being varied by the displacement of the mercury by a piston of considerable area in a cylinder connected with the column. The piston is moved by a vertical screw, driven through gearing by an electromotor, the copper cylinder being between two flat and hard steel surfaces interposed between the end of the screw and the piston. Means are provided for starting, stopping, and reversing the motor, but in order to get the practically instantaneous stoppage of the screw when the mercury has reached the correct height on the scale for the pressure required, a magnetic clutch is fitted as close to the screw as practicable, and is found to answer the purpose admirably, the switch controlling it being operated by the man's foot. The motor can then be stopped, reversed, clutched in, and the pressed copper removed and replaced by another, and so on, the whole process taking longer to describe than to carry out in reality.

Electricity has been of assistance to us in enabling the amount of eccentricity of the bore of a gun which, as sometimes happens, has from one cause or another become bent, to be readily ascertained. You will, I am sure, appreciate the difficulty in first of all ascertaining, and secondly actually measuring, the want of truth in the bore of a gun 20ft. to 30ft. from the breech end, which distance it may easily be, as the 12in. gun is 45ft. in length. The means adopted, however, are, thanks to electricity, quite simple (Fig. 17).

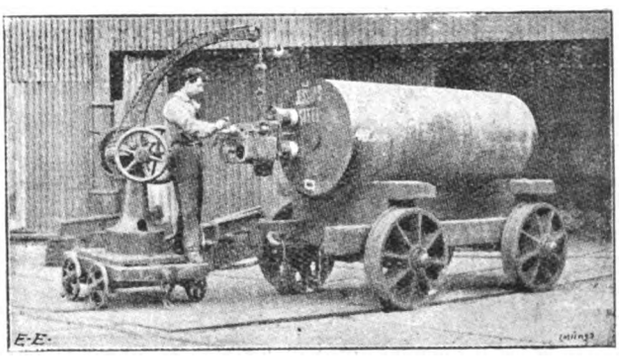

FIG. 18.

A tapered steel tube, stayed and tied with a single gun wire so as to bring both ends of the tube to the same level, carries at one end a knife-edged contact wheel about 2in. in diameter, this wheel being insulated from the tube, but connected to a flexible conductor passing down the interior of it to the other end of the tube, which is fixed in the slide rest; a dead-beat galvanometer and a couple of dry cells complete the equipment. When the wheel touches the metal of the gun, the circuit is completed through the galvanometer, which indicates accordingly. The movement of the slide rest, necessary to make contact, reveals the amount of eccentricity. When any billet of steel arrives in the factory, the first thing to be done is to obtain a small quantity for chemical analysis. This is generally taken in the form of fine drillings from a point midway between the centre and exterior of the billet (Fig. 18) and at both ends. Until current was generally available throughout the factory, this was quite a lengthy operation, involving the loss of time taken to fix a ratchet brace, and then the time to drill the hole in order to obtain the shavings; by the aid of the electric drill the time lost in fixing is eliminated entirely, and the drilling by power is quite a short operation.

I feel that my list of applications would not be complete if I omitted to refer to the use of the electromagnet for lifting projectiles (Fig. 19), which was introduced by me many years ago when the 110-ton gun was in use. The cast-iron projectiles for proof were exceedingly awkward things to remove from the pile and sling for the crane to lift; this was made delightfully easy by substituting an electromagnet for the sling. The magnet used consisted of one piece of mild steel of ⌐¬ section, and 10in. in length, with a single-coil wound round it longitudinally—the sur-

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face magnetised was 30 square inches, and the maximum weight it had to support 1,800lb., the weight of the projectile of the 110-ton gun, though, as you will see, there was ample power to spare. The weight of this magnet, complete with the shackles for attaching it to the crane hook, was under 56lb., and the electrical energy required for the maximum lifting power was 120 watts. In any large gun factory, or, indeed, in any factory where large makes of steel are heated, forged, and tempered, or otherwise treated, it has long appeared to be absolutely essential that some means should be provided of measuring temperatures. This is

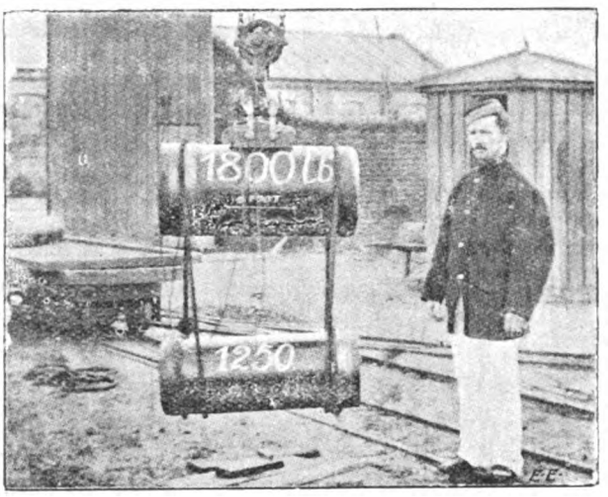

FIG. 19.

most conveniently done by electrical means, and without going into the history of the matter and a description of the various instruments that are available for the purpose of measuring temperature electrically, I will merely say that, for our purpose, the measurement by means of the E M.F. generated by a thermo-couple has been found to be the best adapted.

The thermo-junction we use is a platinum and iridio-platinum one, in conjunction with a modified form of d'Arsonval galvanometer to measure the E M.F. which indicates the temperature. The instruments are fixed in

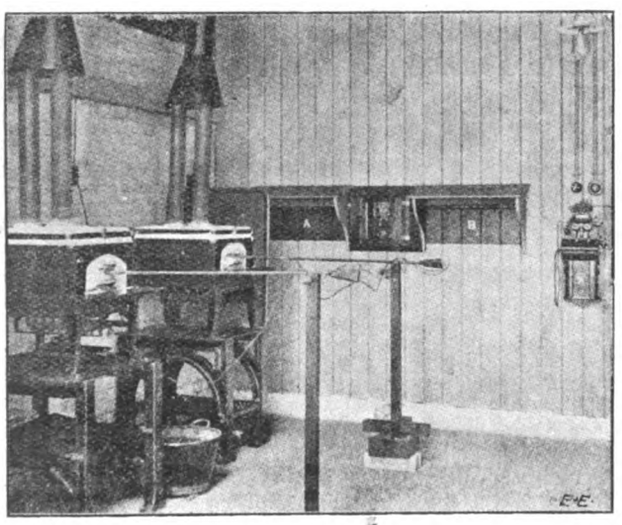

FIG. 20.

various parts of the factory, and connected up to the re-heating, annealing, and tempering, etc., furnaces, as also to the lead baths (Fig. 20) for tempering steel specimens in such a manner that the temperature of any one of them can be immediately ascertained by those in charge, and regulated accordingly; but this is not all. From each of these centres, so to speak, line wires are led to the metallurgical laboratory, where there is a standard recording instrument, and by this means not only can a continuous record be taken of any operation desired, but the individual instruments can be, and are, constantly checked to ensure accuracy and uniformity with the standard, for which purpose the points are connected by telephone. The standard itself is checked by the usual method of observing the freezing points of pure metals at various points of the scale. The zero of all the instrument scales is the temperature of boiling water, which, where steam is always available, as in our case, is readily arranged for, and is in itself a check on the accuracy of the instrument.

Automatic Water Clutch.—A difficulty arose in connection with the starting into motion of the heavy saddles of some double-ended boring lathes, by the 1½-h.p. motors that had been supplied with them, and after some trouble with burnt armatures and fuses the following arrangement was tried with complete success. The solid coupling was removed

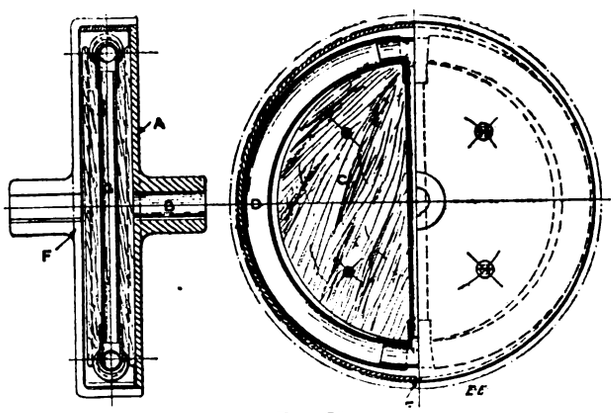

FIG. 21

and a disc of cast iron, A, was keyed to the motor spindle, B (Fig. 21). This disc carries a block of hard wood, C, on its face, the periphery being prepared with a semicircular groove to carry an indiarubber tube, D. This indiarubber tube is in halves, which are joined by a metal tube, G, let in across the diameter of the wooden disc. Outside the indiarubber tube is a split cast-iron ring, E, similar to a piston ring, attached loosely to the iron disc so that it is free to expand. The tubes are then filled with water, and the whole arrangement is fitted into a cupped disc, F, keyed to the shaft to be driven When the motor is at rest the two portions of the clutch do not touch each other, but when the motor is started, and as it gains speed, the water, acted on by centrifugal force, expands the rubber tube, and this in turn expands the split ring, which eventually rubs against and then grips and drives the other half of the clutch.

To sum up, there are at work at the present time in the Royal Gun Factory 134 motors of an aggregated rated horse-power of 1,903, whilst there are 61, either connected or ready to be connected to the supply mains when current is available, of an aggregate rated power of 840 h.p. more. They consist of one motor of 100 h.p, one of 50 h.p, six of 40 h.p., thirty of 30 h.p., two of 25 h.p., eleven of 20 h.p, twenty-nine of 15 h.p, and thirty-nine of 10 h.p, the remainder being under 10 h.p., and ranging down to 1 h.p. The largest motors—viz., 100, 50, and 40 h.p.—are all connected to individual machines. The number of magnetic clutches in use is 117, thirty-one rated at 25 h.p. and eighty-six at 6 h.p. Of magnetic chucks and holders there are 16 in use, but fresh fields of application are continually being found for them, and their numbers are, therefore, constantly on the increase. Magnetic holders are of the greatest service in connection with surface-grinding machines, and enable small steelwork to be turned out with the greatest accuracy and rapidity. One instance may be given of the utility of the magnetic lathe clutch, and that is in turning obturator rings. These rings are made from extremely hard-tempered steel—so hard, indeed, that they can only be cut at a very low speed with specially hard tools—yet it is found that in spite of the small surface area they afford for the magnetic attraction, and also of their somewhat low permeability, the magnetic chuck is the most effective method of holding them whilst being turned that we have yet been able to devise. There is nothing very special in the construction of these magnetic devices; they are designed with a view of taking the standard size of bobbins used in the clutches, and by filling the air-gap

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with brass are so made that they cannot be damaged in any way by being used in oil or water.

TABLE A.

	B.H.P. of Motor.	No. of Tools.	Cut. Inches.	Feed. Inches.	Weight of Material removed per hour.	Lbs. per E.H.P. per Minute.
					Lbs.	
Fine boring machine	30	1	1·4	0·04	118·86	0·082
Rough boring machine	30	1	2·0	0·033	288·3	0·289
Experimental lathe	70	1	1·0	0·5	1652·0	0·38
" "	—	2 each	0·5	0·5	1052·0	0·417
" "	—	1	0·5	0·5	826·0	0·375
Medium boring machine, 5·75 hole from solid	15	—	—	—	132·6	0·142
Double-ended boring machine, 4-in. hole from solid ... ... One end only working	15	—	—	—	70·0 140·0	0·0956 0·147
Heavy single-spindle milling machine	15	—	—	—	14·0	0·049
Heavy double-spindle milling machine	15	—	—	—	85·0	0·109
Radial drill, ⅝ in. high-speed twist drill	10	—	—	—	—	0·115
" 1¼ in high-speed twist drill	—	—	—	—	—	0·180
" ⅝ in. ordinary twist drill	—	—	—	—	—	0·04
" 1¼ in. ordinary twist drill		—	—	—	—	0·056

It may be of interest, I feel, if I add a few data as regards the amount of material removed per electrical horse-power per minute on various machines—the electrical horse-power is the gross amount required not only to drive the motor and machine but also to do the work (Table A)

BOILER-HOUSE ECONOMY.

An interesting paper on the subject of "Boiler-House Economy" was read by Mr. A. W. Bennis, M.I.M.E., A.I.E.E., before the Huddersfield Society of Engineers, on the evening of the 22nd ult., Mr. W. M. Carnock, M.Sc., B.Eng., in the chair. A short digest of the paper may be given as follows: The lecturer started with some observations on wasteful coal consumption, and proceeded to point out where unnoticed losses may creep in. He then described an ideal chimney, flue, economiser, and boiler installation. He pointed out that the chemistry of combustion is included in practice, and described and advocated the calorimetry of fuel. Instructive data were supplied which showed incontrovertibly that by the use of mechanical stokers, small sized fuels, at low cost, may be burned with advantage. He then dealt with the question of heat transmission through boiler plates, and brought out clearly the advantages of complete combustion and high furnace temperatures. In considering the chemical composition of the waste gases of combustion, a table of the percentage losses through excess of air in combustion was shown. Mr. Bennis then dealt briefly with mechanical stoking, detailing its advantages and describing the different types of stokers. He subsequently passed on to consider the subject of elevating and conveying systems, and their relative merits and the savings effected by their use. The lecture was brought to a finale by a description of an installation of elevating, conveying, and machine stoking plant at Messrs. Martin, Sons, and Co., Limited, Lindley, Huddersfield. Several lantern views were shown, among them being the plant at Messrs. Martin's, which included the electric coal truck now so well known to readers of the leading technical papers and those interested in boiler-house labour-saving appliances.

EDINBURGH ELECTRICITY ACCOUNTS.

In the accounts of the Edinburgh electricity department for the year ended May 15, 1905, the total expenditure on capital account is given as £897,298. The following are abstracts of the revenue account, balance-sheet, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	25,367	6	5
Distribution of electricity	4,341	6	2
Attending and repairs to public lamps	3,959	18	0
Rents, rates, and taxes	8,018	3	5
Management expenses, salaries, etc.	5,053	15	3
Miscellaneous expenses	658	7	2
	47,398	16	5
Surplus carried to net revenue account	71,471	18	8
	£118,870	15	1

Cr. Income.	£	s.	d.
By sale of current for lighting and power	107,792	8	5
Public lighting	11,000	16	5
Meter rents	53	7	5
Rents of properties	8	3	1
Miscellaneous receipts	15	19	9
	£118,870	15	1

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Sundry creditors for outstanding accounts	1,785	11	9
Reserve fund	252,728	6	6
	£254,513	18	3

Cr. Assets.	£	s.	d.
Balance at debit of capital account	172,713	6	8
Bank balance	3,657	2	4
Stores on hand	3,350	1	2
Advance to resident engineer	50	0	0
Sundry debtors	15,871	6	6
Reserve fund investment	58,872	1	7
	£254,513	18	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		12,845,465
Quantity sold: Private lighting	7,543,739	
Motor power	2,705,259	11,648,501
Arc lamps	1,400,503	
Quantity used on works		559,963
Quantity unaccounted for		637,001

BERMONDSEY ELECTRICITY ACCOUNTS.

The accounts of the Bermondsey electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £106,668. Appended are abstracts of the revenue account, balance-sheet, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	3,177	10	1
Repairs, etc., of buildings and plant	507	18	3
Repairs to artesian well	347	6	1
Distribution of electricity	464	15	3
Attending and repairs to public lamps	1,244	0	2
Rents, rates, taxes, and insurances	473	18	3
Management expenses, salaries, etc.	1,128	0	2
Law and parliamentary charges	7	3	2
Special charges	375	15	7
	7,726	7	0
Amount carried to net revenue account	4,276	17	3
Balance to provide for bad debts	25	15	7
	£12,029	19	10

Cr. Income.	£	s.	d.
By sale of current per meter, less rebates	7,052	2	8
Charging batteries	0	7	6
Rental of meters and other apparatus	137	3	2
Public lighting	4,747	13	8
Sale and repairs of lamps, etc.	37	11	6
Water supplied to baths and destructor	54	19	4
Miscellaneous receipts	0	2	0
	£12,029	19	10

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—outstanding on loan account	97,542	14	10
Sundry creditors	1,716	8	11
Balance at credit of net revenue account	1,000	0	0
Balance to provide for bad debts	26	15	7
Reserve fund account	503	0	10
Sale of materials and laying and altering mains	1,112	10	1
Treasurer—balance overdrawn	9,274	7	1
	£111,175	17	4

Cr. Assets.	£	s.	d.
Capital account—amount expended less depreciation	106,181	10	7
Stores on hand	1,586	0	1
Sundry debtors for current supplied, etc.	2,909	1	2
Securities held (cost price)	499	5	6
	£111,175	17	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		1,039,505
Quantity sold: Private consumers by meter	649,918	
Public lamps	282,185	932,103
Quantity used on works		69,939
Total quantity accounted for		1,002,042
Quantity unaccounted for		37,460
Maximum supply demanded (kilowatts)		538

Number of public lamps: 168 arcs, 336 arc-incandescents, 200 side street.

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WOOD PAVING.

No, there is no idea at this time of day of dealing with wood as against stone, or soft wood as against hard wood. These things have been treated *ad nauseam*. Mr. Green, however, has, by his paper read before the Tramways and Light Railways Association, brought the matter of material for roadways again into notice. Mr. Green, of course, knows his subject—that is his business—hence whatever he may say upon the question of the use of various materials, and of hard woods especially, is worth considering in the connection of their use for the making of roadway surfaces. We may, however, quote one paragraph of Mr. Green's paper, even though it be lengthy, and with his remarks we agree:

Essentials of Good Paving for Cities.—The essentials of a perfect paving may be summed up as follows: it must have a perfectly sound foundation; it must be non-absorbent; it must have a smooth and even surface, offering the least resistance to traction; non-slippery, noiseless, durable; not subject to expansion or contraction; easily cleaned and repaired; and, lastly, we may say it should have a pleasing appearance. This is, of course, an ideal which has never yet been attained, and I do not suppose ever will be. Paving may be said to be "what it is—where it is"; by which I mean that the value of any form of paving is according to its suitability to the locality in which it is used, and to the traffic which has to pass over it. It would be entirely out of place, for instance, to lay down a road of soft-wood paving in the vicinity of docks where a very heavy and continuous traffic has to pass over it, and to condemn it as a bad form of paving because it wore out so rapidly. In the selection of a paving material every condition to which it has to be subjected must be thoroughly considered. There are few, if any, materials which are adaptable to every purpose, and there is no standardisation of paving materials by which one can make a selection for a special set of conditions; choice must be decided by experience. I shall hope to be able to do something in this paper towards simplifying the problem which every surveyor is confronted with, and, as an appendix to the list of essentials of a paving already given, a table is given below which shows the comparative qualifications of different paving materials now on the market. This table appeared in an official publication issued from the office of the Agent-General for Western Australia some three years ago:

	First.	Second.	Third.
Durability	Hard wood	Asphalt	Soft wood
Economy	Hard wood	Asphalt	Soft wood
Hygiene	Asphalt	Hard wood	Soft wood
Quietness	Soft wood	Hard wood	Asphalt
Safety	Wood	Asphalt	—
Traction resistance	Asphalt	Wood	—
Ease of cleansing	Asphalt	Hard wood	Soft wood
Ease of repair	Asphalt	Wood	—

In the consideration of the question of noise, it seems to have escaped most writers that noise is caused by at least two factors: (1) the street surface, (2) the traffic on that surface. Now, the various surveyors have done something for the street surfaces, but who has agitated against the infernal rap, rap of iron-shod hoofs, or the rattle, rumble of vehicles of antiquated descriptions and haphazard make Is noise bad for health or business and quietude an advantage? If so, work upon a modification of both factors till the minimum noise is obtained. Why expect everything from the use of a certain material for the road wearable surface? The idea is really preposterous, but hitherto criticism has been concentrated on the roadmakers, the roadmaking, and the materials used. Our point in referring to this question just now is quite a different one. For some years a solitary few have been advocating a different method of laying the wood blocks. With one exception the views expressed found no favour in this country, but singular to say, they have largely been followed abroad·

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Take one example: with tramways it is always the case that ruts wear in the road alongside the rails. Our method of paving is by parallel series of header courses abutting on the rail and kerb, with, of course, the necessary arrangement for breaking joint. When a rut along the rail sides becomes troublesome, repair is expensive and also troublesome. As we have long advocated, and as followed of late abroad, a stretcher course of blocks is laid alongside the rails, with parallel header courses abutting on these. We have in some cases seen two stretcher courses parallel to the rails, with header courses between. Another innovation to our ordinary system now becoming almost universal in certain districts in Germany is that the header courses are not at right angles to the kerb, but at an angle of forty-five, the apex being in the centre of the road. These innovations may have no value in practice. We think they are an improvement upon our ordinary methods, and, so thinking, call attention to them, knowing that if they are not advocated by the more eminent consulting engineers and insisted upon in their works it will be long, very long, before the ordinary councillor is brought to vote for change.

FORTHCOMING EVENTS

FRIDAY, DEC. 1.

Institution of Civil Engineers (Students' Section).—A 8 p.m., "An Installation for the Bacterial Treatment of Sewage at Neath," by Mr. W. L. Jenkins.

North-East Coast Institution of Engineers and Shipbuilders.—At 7 p.m., annual dinner.

MONDAY, DEC. 4.

Society of Arts.—At 8 p.m., "The Measurement of High-Frequency Currents and Electric Waves," by Dr. J. A. Fleming, D.Sc., F.R.S. (in continuation of previous courses on "Electric Oscillations and Electric Waves" and on "Hertzian Wave Telegraphy"). (Lecture II.)

TUESDAY, DEC. 5.

Institution of Civil Engineers.—At 8 p.m., "The Steam-Turbine," by the Right Hon. C. A. Parsons and Mr. G. G. Stonier.

WEDNESDAY, DEC. 6.

Society of Arts.—At 8 p.m., "The Manufacture of Sugar from British-Grown Beet," by Mr. Sigmund Stein.

Institution of Civil Engineers.—Students' visit to the Erith slipway of Messrs. W. Cory and Son. (Train from Charing Cross Station to Erith, 1.16 p.m.)

Automobile Club.—At 7.30 p.m., founders' dinner (at 119, Piccadilly).

THURSDAY, DEC. 7.

Society of Arts.—At 4.30 p.m., "The Partition of Bengal," by Sir James Bourdillon, K.C.S.I.

Rontgen Society.—At 8.15 p.m., "The Spontaneous Action of Radium and other Bodies on Gelatine Media," by Mr. J. Butler Burke, M.A.

Institution of Electrical Engineers.—At 8 p.m., "The Charing Cross Co.'s City of London Works," by Mr. W. H. Patchell.

Civil and Mechanical Engineers' Society.—At 8 p.m., "Concrete Mixers," by Dr. J. S. Owens.

FRIDAY, DEC. 8.

Institution of Electrical Engineers (Manchester Local Section).—At 7.30 p.m., "Electrification of Existing Steam Railways," by Mr. W. H. M. Parr.

Northampton Institute.—At 8 p.m., Sir William Preece, K.C.B., F.R.S., delivers the prizes at the annual prize distribution and conversazione.

Institution of Electrical Engineers.—At. 7 p.m., annual dinner at Hotel Cecil.

Institution of Electrical Engineers (Manchester Local Section).—Dec. 12, at 7.30 p.m., "Street-Lighting," by Mr. Haydn Harrison.

Association of Engineers-in-Charge.—Dec. 13, at 8 p.m., "High-Pressure Gas Illumination," by Mr. J. W. Blakey (at St. Bride's Institute).

Tramways and Light Railways Association.—Dec. 14, at 3 p.m., visit to Lots-road Power station. At 8 p.m., "Improvements in Trucks," by Mr. E. Cook.

Physical Society.—Dec. 15, from 7 till 10 p.m., exhibition of electrical, optical, and other physical apparatus at South Kensington Museum.

Junior Institution of Engineers.—Dec. 16, visit to Messrs. Johnson and Phillips's works at Charlton.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COMPENSATION.

SIR,—About six months ago we had rather a serious accident to a pedestrian, caused by a broken wire, and which is now causing some trouble to the Council in the matter of compensation. A bare wire had been run for about one mile carrying 1,000 volts to a transformer, and was protected by double-pole fuse where it branched off the insulated wire. In a very heavy wind and rain storm the wire broke, the live end coming to the ground and blowing the fuse, which in ordinary cases would have made it safe for anybody to catch hold of. But, owing to the dead end having blown over the top of a series circuit and hanging down in a loop, the current was directed to earth with a live wire, and this person caught hold of it with both hands and was thrown to the ground, where he laid for about five minutes still holding on to the bare wires till released by chopping the wire with an axe. Of course, the man was very severely burnt, and had received such a shock that he was removed to the hospital in almost a state of collapse. The contention is that the Council is liable for having bare wires running overhead carrying a dangerous voltage. The Council contend that as the wires were protected by safety fuses, and it was an act of God that caused the dead wire to blow over the live wire and again become alive itself, they are not responsible for the accident, and that there is no law existing that prohibits bare wires to be run. I shall be glad if you will find room for this in your valuable paper, so that others may give their experiences of like accidents—if, indeed, such a one has ever occurred before.—Yours, etc., D. H. S.

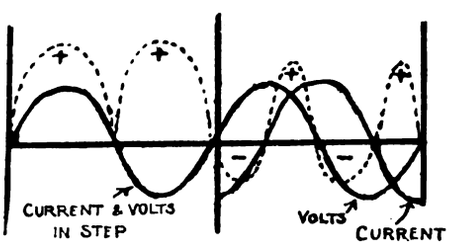
Penrith, N.S.W., Oct. 23, 1905.

ANSWER TO QUESTION No. 820.

SIR,—There are two errors in the answer to Question No. 820 in the supplement to the *Electrical Engineer* of Nov. 10, both evidently being slips made by the authors. May I point these out, as they are likely to prove confusing to the writer of Question No. 820?

1. In Mr. E. R. Alexander's answer the assumption at the end, "if two motors can be found to do the same work, taking the same current at the same pressure, one having a lower power factor than the other," is, of course, impossible.

2. The diagram in the answer of "F. B. M."—the total power in both cases as shown is zero. The diagram should be thus:



The (+) and (−) signs refer to the power as shown by dotted curves.—Yours, etc., P. WEIL.

85, South-side, Clapham Common, S.W.,
Nov. 12, 1905.

BELFAST ELECTRIC TRAMWAYS.

The inauguration of the new electric tramway system in Belfast took place on Wednesday, the 29th inst., Belfast being practically the last of the large provincial towns in the kingdom to adopt electric traction. The contract for the whole equipment was given to Messrs. J. G. White and Co., London, who commenced operations in February last, and were required to have the whole system completed in seven months. Thus it was expected that the inauguration would take place in September, but various causes have delayed it. During the first few weeks of work strikes

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occurred of the labourers on the permanent-way work, and when September arrived it was found that the pump-house could not be completed in time. This is a portion of the work outside the contract. For some reason, delivery of the condensing plant has not yet been completed, otherwise the whole equipment is practically completed. There are three 1,000-kw. units in the generating station, two of which are sufficient for the work, so that one unit is available as a stand-by.

On Tuesday, the 28th inst, the representatives of the Board of Trade (Major Pringle, R.E, and Mr. A. P. Trotter) commenced their official inspection of the new system. Mr. Trotter, who had to deal with the electrical equipment, completed his inspection, travelling along the various routes in one of the cars which had been previously used in the horse traction service, and was locally converted and equipped for the new electric service. It is understood that the whole of the overhead equipment is satisfactory; as a matter of fact, nearly all the telephone wires contiguous to the track have been removed or disposed underground, so that there is almost an entire absence of guard wire in the overhead equipment. Major Pringle hopes to finish his inspection on Friday, Dec. 1, and in the meantime is so far satisfied that the inauguration of the electric service was possible on the 29th inst. on some of the principal routes.

The inauguration took place at noon. Six of the new cars were held in readiness on the west side of Donegall-square, the first and last cars being elaborately decorated with wreaths and festoons of flowers, trailing smilax, and potted plants. The Lord Mayor of Belfast (Sir Daniel Dixon, Bart, who is also member of Parliament for one of the divisions of the city, and is chairman of the Tramways Committee) was in the first car, and it, together with the other five, were filled by the members of the Council of the county borough, many influential citizens, and the representatives of the contractors. Punctually to the hour named, the cars started amid the cheers of thousands of spectators who had crowded the ample accommodation of Donegall-square and its immediate vicinity.

The first journey taken was over the Malone-road route as far as Cranmore Park and back, then in quick succession journeys were made over the routes of the Ormeau and Lisburn roads, the trips concluding in front of the Ulster Hall at 1.10 p.m. The six cars ran about 50 yards apart, and their speed was a revelation to the many spectators who lined the routes, and who were for the most part only familiar with the speeds of the old horse-car service. The journey along the Lisburn-road was timed at exactly seven minutes, a figure which compares very favourably with the 20 minutes taken by the horse cars.

The entire journey was absolutely devoid of untoward incident—a fact which is much to the credit of the various contractors and all others concerned. There was an entire absence of vibration or pitching of the cars even at the highest speeds, which must have been over 16 miles an hour, and the smoothness of running was unbroken by any jar or other evidence of unsatisfactory permanent-way construction. No attempt was made to set the overhead points by means of the trolley pole, as the necessary construction for this purpose is not yet completed; but apart from this, the overhead portion of the system worked perfectly, and on the whole journey of the six cars only once was the trolley wheel seen to leave the wire, though high speeds were attained.

When the trips were completed, the passengers were entertained with light refreshments in the Ulster Hall by the Lord Mayor. The toast of the "The King" was first given by the Lord Mayor, Sir Daniel Dixon, who then proposed "Success to the New Electric Tramways." In a very few words he drew attention to the fact that the whole of the new system had been undertaken and completed by the contractors in 10 months, and that during that time the horse traction had been but little disorganised. To provide the Belfast people with such a splendid and successful system of electric tramways in that short time reflected the greatest credit on Messrs. J. G. White and the sub-contractors, while it was evidence of the whole-hearted efforts of Mr. M'Cowen (the borough electrical engineer) and his able assistants. This toast was followed by that of "The Health of the Lord Mayor," proposed by Councillor Wm. Harper, vice-chairman of the Tramways Committee. Councillor Harper spoke in felicitous terms of the zeal of the Lord Mayor as chairman of the Tramways Committee, and said that the people of Belfast, so long denied the conveniences of electric traction, would still be without them in 1905 had it not been for the efforts of Sir Daniel Dixon and the diplomatic methods he adopted with all parties to bring the electric tramway system to a successful issue.

The toast being received with applause, the proceedings then terminated.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Chairman's Address.

BY S. L. PEARCE, M I E E.

(Continued from page 745.)

Turning to the application of electrical power for industrial purposes, we find that very considerable progress has been made during the last year. A cheap supply of electrical energy for London, to which reference will be made later, has been one of the most striking events in electrical circles, and in other parts of the country four power companies—viz., the Yorkshire Electric Power Company, the Lancashire Electric Power Company, the Clyde Valley Electric Power Company, and the Fife Electric Power Company—have commenced operations, and others will shortly follow. It is noteworthy that of the four new companies the three former are employing three-phase systems operating at 10 000 and 11,000 volts, and the latter a two-phase system at 3,000 volts. Nor have the larger municipalities been behind-hand in the development of a power load at cheap rates, assisted by such means as the hiring-out system of motors and the "restricted hours' supply" system at very low rates. It may, perhaps, be of some interest to state that in this city at the present time there is in use some 11,000 h.p. in motors, and the power sales for last year show an increase of 75 per cent. over the preceding year. Industrial establishments possessing their own independent steam installations are naturally chary of making changes, but records go to show that as the more economical advantages of electrical driving are appreciated, so will the gradual supplanting of steam plant be accomplished. This is more particularly noticeable in the case of the iron, steel, and shipbuilding industries, and for colliery and mining work, all of which show a marked partiality for electrical power, which is evidenced by its extensive adoption at the many centres of the North-East Coast, on the Clyde, in South Wales, and in the counties of Lancashire and Yorkshire.

The adoption of electrical transmission of power for textile factories is a problem that more clearly concerns us in this part of the country, but on account of the more favourable conditions for operating with steam plants little progress has been made. This is certainly a matter for some considerable surprise in the light of data obtainable from the States and the Continent, where textile factories have adopted electrical driving extensively. On the other hand, it must be admitted that if it be possible for a cotton mill equipped with steam plant to operate at a total cost not exceeding £2. 10s. per indicated horse-power per annum, it would be difficult from the point of view of economy to show much better figures than these, and some very cogent reasons in favour of electrical driving must be advanced before millowners can be expected to adopt it. Competition in the production of marketable articles is already keen, and, realising that the advantage will be to those who can produce at the lowest cost, we see how important is the question of cheap power to the British manufacturers, and how necessary it is that by every means the production and transmission of electrical power should be cheapened. For large industrial installations there is a tendency to adopt three-phase motors where a three-phase supply is available, and where a variable speed is not required. A comparison between direct-current and three-phase induction motors shows that, so far as efficiency is concerned, there is little to choose between the two types; for motors up to 40 h.p. the advantage rests with the three-phase induction motor, and above this output with the direct-current type. The difference in weight is, however, very marked in favour of the former, and the low maintenance costs and general freedom from running troubles are also strong points in favour of its adoption.

Hauling gears up to 500 h.p. by induction motors are now becoming common in collieries. Continental practice has done much to perfect winding gears, and there is little doubt that

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the displacement of older steam plants by motors is gradually being brought about. Electric cranes of high lifting capacity are being built in increasing numbers, a notable instance of this class of work being the 150-ton revolving pillar crane at the Dublin Docks. The past year has evidenced a testimony on the part of manufacturers to produce variable-speed motors without double-wound armatures, and without the need for multiple voltage winding. The development of this class of motor for continuous currents will, doubtless, popularise the use of motors for individual drive of machine tools where wide ranges of speed are desired and where complicated gearing is to be avoided.

The question of furnishing energy for large consumers from a public supply or from isolated independent plants is one to which considerable attention has been given. Broadly speaking, it may be stated that unless an exceptional load factor can be shown—viz., something in the neighbourhood of 40 to 50 per cent.—it will be more advantageous for the consumer to obtain energy from supply mains. Capital cost of plant will be saved, space that would be occupied by generating plant can be otherwise utilised, a supply is always available, thereby facilitating overtime arrangements, and antiquation and depreciation of plant become minor considerations. For transmission lines the use of bare copper wires has been sanctioned in the case of three or four of the power companies, and incidentally it may be stated in passing that one of these—viz., the North Wales—avails itself of the use of water power, and will, therefore, form one of the very few examples of hydro-electric installations in this country. It is also of interest to note that this company, together with the Gloucestershire Power Company, were the first to obtain parliamentary powers to use overhead bare conductors. We see very few overhead mains in this country, and until recently the Board of Trade would only sanction their use for special purposes at comparatively low pressures; now, however, they permit bare overhead work for high-pressure transmission lines. Taking a 6,000-volt transmission line, the cost of running three-phase mains of any given section overhead would be approximately one-half of an underground main of the same section. For a 12,000-volt transmission line the proportion would be, roughly, one-third only. It is evident, therefore, that this factor will have an important bearing on capital costs and the question of cheap supply of power. Long-distance power transmission work with its corollary of extra high voltages has not made much advance in this country, up to the present the highest pressure employed being 11,000 volts. Although hard-drawn copper is still most generally used for bare conductors, the recent rise and maintenance of very high prices for raw copper due to restricted sources of supply and the financial operation of capitalists will undoubtedly help to advance the claims of aluminium. For a given conductivity the weight of the latter is only half that of copper, and its tensile strength for a given conductivity is about 75 per cent. of a copper line. Owing to the weight per foot of wire being reduced some 50 per cent. in the case of aluminium, it is possible to use much longer spans. At present prices of copper the above considerations mean that it would be cheaper to use aluminium.

Although the last two or three years have witnessed a considerable reduction in the cost of production of electrical power on a large scale, electrical engineers should not be unmindful of the fact that there is at the present time an increasing competition for the cheap supply of power for smaller or isolated plants. For plants using up to 200 b.h.p. to 300 b.h.p. suction-gas producers and Diesel engines will prove keen rivals owing to their low fuel consumption. The cost of the latter per brake horse-power hour in the case of a suction producer has been stated to be only one-half that of Mond gas at, say, 2d. per 1,000 cubic feet. This saving will, however, be discounted in the cost of the producers if the plant is subject to a variable load or run for considerable periods much below full load. The difficulty is to obtain reliable and accurate data with respect to this latter point, makers invariably giving the full-load results only. It will be conceded that where it is necessary and convenient to transmit all the power required from one point in any works, and under conditions that call for a steady load, the suction-gas plant may be the more economical. But do conditions such as these generally obtain in modern factories, and can any fair comparison be drawn in this form between electrical driving and gas plants? Modern users of electrical power find it more economical and convenient to dispose of their power at certain specified points so as to eliminate transmission losses and secure independent running for the various parts of their factories. If this be granted, then the only fair comparison to be made is between a motor-driven factory taking a public supply of energy and a similarly equipped motor-driven factory taking a supply from its own private gas plant, and it can be shown then that the costs of production do not widely differ. But these are not the only considerations to be taken into account. There are the questions of ground space for the private plant, the expenditure of relatively large sums on same, the ability to run any particular portion of a works on overtime without running the whole generating station, which, in the case of a suction plant running at anything under half load, would certainly be the reverse of economical. These and other points are worthy of consideration, and whilst there may be particular conditions under which the gas plant will prove the most economical, the many advantages of electrical power, coupled with the low rates at which it can now be obtained, should continue to attract all the largest power users.

A steady growth in electric traction work can still be chronicled. For tramways, extensions are proceeding on pretty well defined lines. The trolley wire system is still by far the most extensively used. Conduits are confined more or less to portions of London and Bournemouth, and the Lorain surface-contact system to Wolverhampton. Examples of the "Dolter" and "G. B." systems of surface contacts are, however, being installed at Torquay and Lincoln respectively. Some idea of the extent to which electric tramways and light railways have developed may be gathered from recent published returns, which go to show that the increase in capital invested in these undertakings for the last recorded 12 months over the preceding period is represented by no less a sum than £25,000,000, and the total capital invested in electric traction stood at the end of 1904 at the figure of £107,000,000. The series-parallel system of control up to recently was the only one adopted successfully, but considerable developments have taken place of late in the introduction of systems embodying the principle of "regenerative control." With the series motor, the maintenance of a constant speed over varying grades is attained by the controller with the expenditure of a certain waste of energy in resistances. To obtain an electrical braking effect, the motor is cut off from the line and short-circuited through resistances. The property possessed by a shunt motor of automatically producing a regenerative braking action whenever the normal speed was exceeded, together with that of automatic speed regulation, enabling the car to maintain a fairly constant speed without the use of the controller, would appear as strong points in favour of the adoption of shunt motors for traction work. The most serious objection to their use was the difficulty of insulating the field coils, which had to bear the full line pressure, and in getting on the desired number of turns of fine wire with good insulation. Other objections were the possibility of sudden rises in pressure should the load be suddenly removed when running at full speed with a constant field excitation, the greater liability to sparking, and the danger of a disruption of the field circuit. These objections to the use of simple shunt motors appear to have been largely surmounted in the types adopted in the systems of regenerative control now being introduced. The chief claims of the latter may be briefly stated to be as follows as far as the cars are concerned: economy of power consumption, varying from 7½ per cent. to 40 per cent., dependent on the nature of the route, or on an average 25 per cent. due to the motors returning energy to the line; automatic braking, due to the regenerative action of the motors. The whole of the speed regulation is effected on the shunt field between minimum and maximum speeds. Series field windings are also introduced as a means of further control in cases of emergency. Another system in introducing this principle of regenerative control adopts series motors when running and accelerating, and compound generators when regenerating. To accomplish this without having idle copper in the form of the series windings on the fields at any time, the shunt windings are arranged to be sub-divided and grouped in parallel and used as series windings.

It may be taken that the possibility of economising expenditure both upon energy and upon wheels and brakes by the use of the "regenerative principle" has been fairly clearly demonstrated, these savings being proportionate according to the undulations of the routes served. Further, the variations in the power taken by each car are not so great as with the series-parallel system, and, therefore, a better load factor will be obtained at the power station from a system operated "regeneratively." The outstanding matters on which engineers do not appear at present to be agreed are reliability, maintenance, and whether such systems are as favourable for "acceleration" or hill-climbing capabilities as the "series-parallel." To these questions, the obtaining of accurate and, as far as possible, independent data from repeated trials under strict commercial conditions will alone supply the answer. For existing tramway undertakings to adopt the regenerative system would entail very considerable capital expenditure, and if, in addition to the modified form of controllers new motors were also required, the cost would seriously offset the economies to be gained. For new undertakings, especially where the gradients are severe, it would appear that it has paramount claims for recognition.

It may be noted, in passing, that the principle of regenerative control is more easily capable of application to the induction motor, and most of the three-phase mountain railways on the Continent are so arranged that the energy of the trains on descending should be returned to the line. The practical application of the old principle of regenerative action to the direct-current motor, however, marks a new departure in the tramway world, and as such is of interest to all electrical engineers. The conversion to electric traction of the Metropolitan

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Underground Railways in London has been one of the outstanding features of this branch of the industry during the last year, and numerous tube lines are in course of construction, all of which work has up to the present been carried out on the composite system, first initiated in this country by the Central London Railway Company, employing three-phase currents in the line transmission and direct current on the motors. This system may be good enough for tube and suburban lines, but most engineers are agreed that it will not solve the problem of main-line working, and it is towards the solution of this latter problem that more than ordinary attention has been given lately. The alternative to the composite system hitherto adopted, but of which there is no example in this country—viz., three-phase currents stepped down from the pressure of the transmission lines and supplied to three-phase motors—has given satisfactory results in a good many places on the Continent, notably on the Burgdorf-Thurn, Valtellina, and Berlin-Zossen lines, under the conditions to which it has been applied, but it would not meet all the essential requirements for the electrification of main-line railways. The impetus to this latter movement was unquestionably given by Finzi's experiments in Milan in 1903, and since that date there has been considerable activity displayed in Germany and the States towards the development of the single-phase commutator motor, which in its perfected form is expected to greatly help forward the solution of the problem of main-line working. This theory appears also to have appealed to one or two of the British manufacturing firms who are now tackling the problem on similar lines.

The question of a standard railway motor is of the utmost importance, and unquestioned advantages would result from a single-phase system as regards chiefly economy, reliability, and simplicity of the track construction and rolling-stock. As far as the motor is concerned, the essential qualifications may be taken as: (1) ability to give a large starting effort; (2) the power to vary the speed through wide limits; and (3) they should return energy to the line when coasting or stopping. Recent developments of the series compensated single-phase motors have made them equal to direct-current motors as far as the first point is concerned, and by the introduction of a transformer between line and motor, with variable ratio of transformation, thus giving a means of regulation between fairly wide limits without serious waste, the second requirement is satisfied. For long lines with no severe gradients and few stops the third point is not of great importance, but for short suburban lines it is of considerable moment, and up to the present this condition is not met by the single-phase motor. The Oerlikon system of a combination of the direct-current locomotive with the motor-generator sub-station carried by the locomotive is not one that is likely to commend itself as a final solution of efficient single-phase working, although it should be remembered that the ideal system will be one that admits of different kinds of application as far as the motors are concerned to suit the different kinds of service over the line. Although the work which has been done with one-phase commutator motors has been largely of an experimental nature, and on experimental lines, the present year has seen the putting into operation of the first single-phase electric railway in the States, and it is understood that one of the English railway companies has decided on applying the same system to a portion of one of their suburban lines. On the American line referred to the motors are of the series type, working from a trolley line fed at 3,300 volts, and at a low periodicity. An auto-transformer carried on the car reduces the trolley line voltage to that for which the motors are wound, and control is obtained by the use of an induction regulator of a type with which we are familar in this country, in which the secondary of the regulator is arranged to oppose or assist the voltage of the main auto-transformer. When the problem of electrifying the main lines in this country comes to be undertaken, it will be desirable to place the generating stations as close as possible to the natural sources of energy—viz., the coal-fields—providing the other conditions governing the selection of suitable sites for power stations are reasonably complied with, therefore to make the supply commercially possible, high pressures must be adopted for the transmission lines. Employing an alternating-current system does away with the serious conversion losses to direct current. The number of static transformer stations could be more economically increased than would be the case with rotary transformer sub-stations, thus giving a better distribution along the track. Further, the alternating-current system admits of a higher pressure on the overhead lines than with the direct-current system, and any such high pressure is capable of reduction by transforming units carried on the train. Simplicity and security of operation is undoubtedly best secured by the use of one overhead line only, and economy of supply to the line is best secured by an alternating-current system.

Although the single-phase system has made very considerable strides during the past year, the advocates of the three-phase system are not prepared to lightly give way. Stress is laid on the fact that the three-phase induction motor is a more mechanical piece of work, and therefore the decreased cost of upkeep for the motor would affect the increased repairs due to the use of a double trolley line. Again, importance is attached to the ability of three-phase motors to return energy to the line in braking and slowing down. The objections are: at least two track conductors are necessary, and there are but two efficient speeds as in the ordinary series-parallel direct-current system at which the motors operate. Whatever may be the outcome of the present developments, whether a standard system applicable to all classes of railway working be evolved, the past year has certainly claimed more attention from engineers for this branch of the industry, and the future is pregnant with great possibilities. Incidentally it may be noted, in passing, the recommendations of the London Traffic Commission bearing on the question of electric traction, and its advocacy of the provision of 50 miles of tramways within the county of London, in addition to several miles of subways, and substantial additions to the existing city and suburban railways. These recommendations, if ever adopted, will provide the electrical industry with a task of furnishing the Metropolis with a transit system equal to any existent. It is interesting, also, to note that the report speaks out with no uncertain voice in favour of electric tramways as against the much-belauded motor 'bus, which should bring consolation to many threatened tramway undertakings.

(*To be continued.*)

A MINE OF INFORMATION.

It is a happy idea on the part of the General Electric Company to collect the numerous catalogues issued by them describing and illustrating their diverse manufactures, and at the end of the year to publish them in book form. The result is a volume which embodies everything electrical, from a terminal screw to a central-station equipment. We have received from the General Electric Company a copy of their 1905-6 edition, and in this vast storehouse of information the buyer and the engineer cannot fail to find something to meet their requirements. Those who have occasion to use and refer to books of such dimensions—for this one extends over 1,500 pages—are often confronted with the difficulty of finding out just what is wanted at a certain time, and, in many cases, a little lack of forethought on the part of the compilers has reduced a really valuable work to a mere chaotic mass of matter. No such description, however, can be applied to the work at present before us, for the excellent system of indexing and classification, and the whole general arrangement, is evidence of the great pains which have been taken to reduce the trouble of reference to such insignificant dimensions that no loss of time need be entailed in the task. The book is divided into 13 different sections, each section representing a different department. The method of arranging the sections is one which enables particulars of all goods likely to be required in connection with one another appearing in close proximity. This comprehensive classification greatly obviates the loss of time consequent upon having to make cross references; thus all plant is kept together in one section, as arc lighting supplies and cables, so that if the price of wall plugs be required it can be speedily obtained by turning to the particular section in which it is classified, where prices of other accessories which are all within the one section can also be seen. Among the new sections the two which will, no doubt, be of considerable interest are "P" and "X." "P" is the electrical plant section, and is devoted to prices and particulars of continuous-current, single and polyphase generators and motors, combined sets, electric cranes, boilers, engines, etc. It extends over 200 pages, and contains, besides illustrations of the manufactures, a number of excellent photographs of central station work carried out by the company. Switchboards are included in Section "X," which is illustrated by a number of plate depicting some of the installations which the company have carried out. What are usually jumbled together and classified under the heading of accessories have in this case been sub-divided and placed in separate sections, so that they can be referred to with facility. The whole of the 13 sections manifest the energy of the company in the very extensive field in the electrical world in which their activities are centred. The sections devoted to large plant and switchboards admirably illustrate the rapid strides which have been made at the Witton Works in the manufacture of this class of apparatus, and give a good idea of the extent of the company's development.

This catalogue must prove of immense value to all engaged in the electrical industry. An enormous amount of time and expense must have been spent upon its production, but we feel assured that all who have one in their possession, and those who must needs be constantly referring thereto, will ever keep the General Electric Company in grateful remembrance for compiling such an indispensable work, and for providing the excellent facilities for enabling them to wend their way with ease through the labyrinth of matter. Our advice to our readers is to write for a copy of the work and judge for themselves as to its value.

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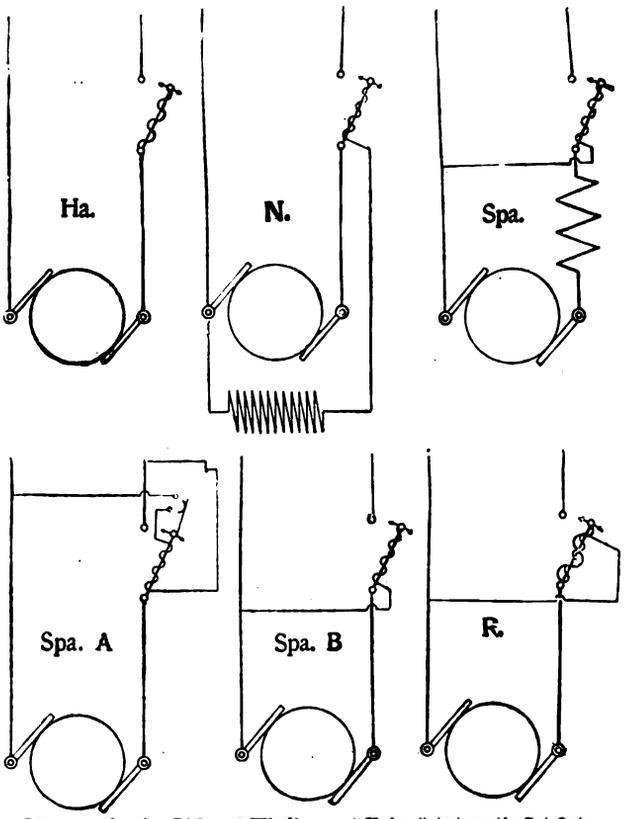
TRADE NOTICES AND NOVELTIES

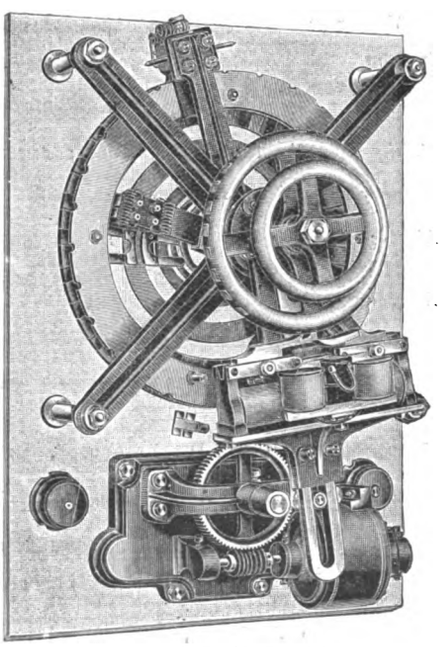
Automatic Circuit Breakers, etc

A list recently issued by the Union Electric Co., Limited, 151, Queen Victoria-street, E.C., deals with direct and alternating



Diagrams showing Different Windings. "Union" Automatic Cut-Outs.

current automatic circuit breakers, suitable both for ordinary motor installations and for the heaviest duties imposed by traction working. The accompanying diagrams illustrate the different methods of operating these cut-outs. The "Ha" series winding is designed to protect a dynamo against reverse current from a battery or other circuit. In the "N" shunt winding type the working coil of the cut-cut is placed in the circuit of a shunt or compound wound motor to disconnect the motor from the mains if current should fail in the circuit, whereas in the "Spa" type it is connected to the terminals of a series motor. Again, in the case of the maximum cut-outs the "Ha" series arrangement is used for protecting a motor or dynamo against overload or a battery against charge or discharge at too high a rate, while the pressure winding "Spa" A with independent circuit is adopted when it is desired to open a circuit at a distance, and the winding "Spa" B for constant load, to open a circuit in which the pressure has exceeded a given maximum. The reverse-current cut-out type "R" can be fitted with supplementary contacts to close another circuit directly it opens, and all sizes are fitted with a magnetic blow-out. The arrangement permitting the fixing of the large circuit breakers behind the switchboard panel is also in accordance with the most recent practice, which is in favour of putting the electrical parts behind the board, and having insulated operating handles in front. The traction type overload cut-outs have a loose handle device of substantial construction, rendering it possible to operate the circuit breaker on a dead short-circuit, without injury either to the apparatus or the operator. On the last page of the list under notice some particulars of cell regulators are given. A novelty is the automatic double regulator, illustrated herewith. This device is eminently suitable for large installations, and such as have to run with a minimum of attention.



Automatic Double Regulator.

Seasonable Novelties.

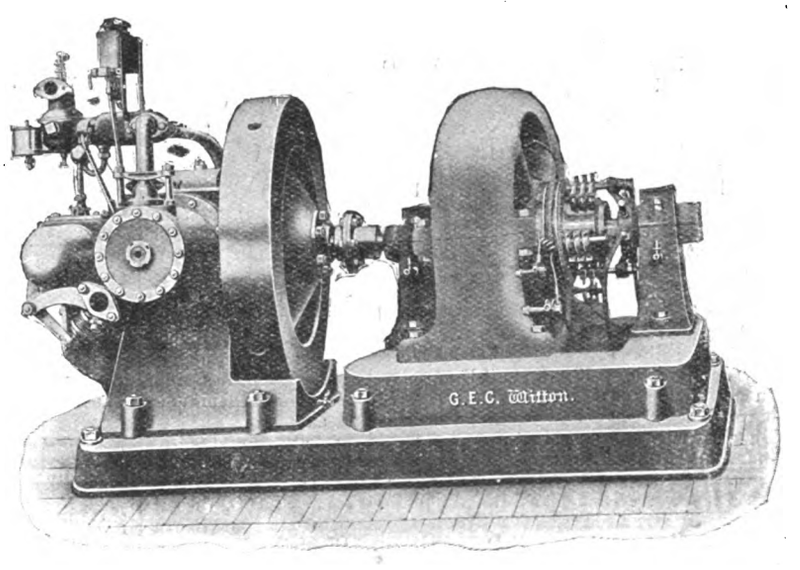
A new catalogue just issued by Messrs. F. Darton and Co., 142, St. John-street, London, E.C. includes illustrations, prices, and particulars of a large variety of seasonable novelties, in the shape of electric motors, small dynamos, gas and oil engines, portable batteries for lighting, telephones, etc. Scientific toys are in great demand just now, especially those of the kind enumerated, so this catalogue should be welcome. We notice also that Messrs. Darton and Co. supply dynamo castings, armature stampings—in fact, all the requisites to enable the enthusiastic amateur to build up machines, and thereby gain additional knowledge.

Magneto Ignition.

Motorists and dealers in motor accessories will be interested in a little pamphlet just issued by the General Electric Company, Limited, which gives full particulars of their new system of magneto ignition (Coate's Patent).

G E C. Electrical Plant.

The "Electrical Plant" catalogue just issued by the General Electric Company, Limited, 71, Queen Victoria-street, E.C., contains particulars of direct-coupled steam, gas, and oil engine generator sets, steam-turbine generator sets, electric lifts and cranes, water-turbines, boilers, steam, gas, and oil engines, etc. It appeals especially to contractors who undertake the installation of self-contained private plants. Some of the generator sets dealt with are exceedingly compact. This is notably the case with regard to the oil-engine set, which we illustrate herewith, by way of example. This set has been designed for small installations, such as for lighting country houses, private yachts, etc., where skilled attendance may not be available, and where safety and reliability are first considerations. The engine is direct-coupled on the same bedplate to a "Witton" continuous-current multipolar-type dynamo, wound for any required voltage. All moving parts of the engine are enclosed, and by the use of a new carburettor, perfect safety is secured.



G.E.C. Oil-Engine Dynamo Set.

Catalogues, etc.

SECRET TELEPHONES.—A little pamphlet which we have received from the Sterling Telephone and Electric Company, 200, Upper Thames-street, E.C., includes prices of their secret intercommunication telephones.

ELECTRICAL DISTRIBUTION APPLIANCES.—The catalogue (1905 edition) of electrical distribution appliances published by Messrs. Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, London, E.C., is an

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exceedingly meritorious compilation. It embodies a comprehensive and illustrated price list of designs carefully selected as standards by the company. The plans and sections given could not well be improved upon for clearness, and must have involved the drawing office in a great deal of extra work.

SWITCHES.—Some sheets which we have received from Messrs. A. Seage and Co., Cambridge Works, Hammersmith, London, W., deal with the firm's double-pole switches in cast-iron cases for voltages up to 600.

MOTORS.—The Rhodes Electrical Manufacturing Company, Limited, Bradford, have issued a well-got-up new catalogue of their direct and alternating current motors. The compact form, neat appearance, and other admirable features of these machines are well known to our readers.

WATER MOTORS.—A catalogue recently issued by Messrs. Carrick and Ritchie, Waverley Engineering Works, Edinburgh, illustrates a large variety of turbines, Pelton wheels, and other water motors, incidentally showing what an immense amount of work the firm are doing with this class of machinery for electric lighting and transmission of power.

KNIFE SWITCHES.—Messrs. Ferranti Limited, Hollinwood, Lancashire, have sent us a copy of their catalogue of single-pole, single-throw, quick-break knife switches for currents of 25 to 2,500 amperes; also a catalogue of their double-pole, single-throw, quick-break knife switches for currents of 25 to 1,400 ampere. These switches are of scientific design, and very carefully made.

KORTING GAS-ENGINES.—From Messrs. Mather and Platt, Limited, Salford Ironworks, Manchester, we have a copy of the fourth edition of their two-cycle gas-engine catalogue. The principle of the Körting engine is now well known, but, incidentally, this catalogue records the considerable favour which it has met with in the United Kingdom since Messrs. Mather and Platt, Limited, became licensed manufacturers. Several large plants already installed are described and illustrated.

PRIVATE BILLS AND PROVISIONAL ORDERS.

Further notices have appeared in the *London Gazette* of intended application for private Bills or provisional orders as follows:

Electricity Supply.—Calverley U.D.C. (Extension of Time, etc.), St. Pancras B.C. (Extension of Stations, Refuse Destructor, etc.), London Electric Supply Co. (Extension of Area), North Metropolitan Electric Power Distribution Co. (Wembley), ditto (Edgware), ditto (East Barnet Valley), ditto (Wealdstone). Hackney B.C. (Bethnal Green, Islington, Poplar, Shoreditch, West Ham, Leyton, and Walthamstow), (Kidderminster Electric Lighting and Traction Co. (Stourport and Kidderminster). County of Northampton Electric Traction and Power Co. (Higham Ferrers, Rushden, and Wellingborough), West Cumberland Electric Tramways (Provisions as to Transfer of an Application for Electric Lighting Provisional Orders), Twickenham and Teddington Electric Supply Co. (Twickenham, Hampton, Teddington, Hampton Wick, Sunbury, Feltham, Hanworth, Ashford, Shepperton, Ham, East and West Molesey, Esher, and the Dittons), Brush Electrical Engineering Co. (Workington), ditto (Maryport), Shoreditch and Stepney Borough Councils (Shoreditch, Stepney, Bethnal Green, Bermondsey, Hackney, Islington, Poplar), Camberley Electric Supply Co. (Frimley, Sandhurst, Easthampstead), Market Harborough U.D.C. (Urban District), Hoaforth U.D.C. (Extension of Time, etc.), Hexham and District Electric Supply Co. (Extension), Foots Cray U.D.C. (Extension of Time), West London Electric Undertakers' Association (Power to Westminster Electric Supply, St. James's and Pall Mall Electric Light, Kensington and Knightsbridge Electric Lighting, Notting Hill Electric Lighting, Metropolitan Electric Supply, Chelsea Electricity Supply, and Brompton and Kensington Electricity Supply Companies, and Councils of Hampstead, St. Pancras, Hammersmith, and Fulham, and Central Electric Supply Co. to associate with and supply one another with electricity), Bournemouth and Poole Electricity Supply Co. (Swanage), Mutual Electricity Supply Co. (Henley), ditto (Aylesbury), Newcastle-on-Tyne Electric Supply Co. (Additional Powers), ditto (Castle Ward, Westslade, and Cramlingdon), Farsley U.D.C. (urban district), S. M. H. Tramways Syndicate (Seaham Harbour Urban District), Betwys-y-coed U.D.C. (Urban District), Dorchester Corporation (Extension of Time, etc.), Christy Bros. and Middleton, Chelmsford (Stratton and Bude), Exeter Corporation (Heavitree Urban District), Yardley R.D.C. (Extension of Time, etc.), Slough and Datchet Electric Supply Co. (Extensions), National Provincial Electricity Corporation (Tiverton), Abercarn U.D.C. (Urban District).

Power Companies.—Charing Cross, West-end, and City Electric Supply Co. (London and Essex), L.C.C. (London, Surrey, Middlesex, Kent, Essex), South Metropolitan Electric Supply Co. (supply in bulk), Cumberland Electricity and Power Gas Co. (Workington, Whitehaven, Cockermouth, Maryport, Aspatria, Harrington, Cleator Moor, Egremont, Keswick, Arlecdon and Frizington), London Electrical Supply Co. (Additional Powers to Companies having Statutory Authority for the Supply of Electrical Energy within the Administrative County of London).

Tramways and Railways.—West Cumberland Electric Tramways (Extensions), Wallasey U.D.C. (Extensions), Macclesfield and District Tramways Co. (Borough, Rural District, and neighbourhood), Preston, Chorley, and Horwich Tramways Co. (Extension, etc.), West Yorkshire Tramways Co. (West Riding), Folkestone, Sandgate, and Hythe Tramway Co. (Fotherstone, Sandgate, Cheriton, and Hythe), Ossett Corporation (Extension), Dewsbury Corporation (Extension), Southport and Lytham Tramroad Co. (Extension of Time), Cork Link Railways Co. (Cork), Sandgate and Hythe Electric Co. (to acquire the Sandgate and Hythe Tramway Undertaking of the South Eastern Railway), Hammersmith, City, and North East London Railway Co. (London and Middlesex).

Light Railways.—Mid-Suffolk Light Railway Co. (Financial), Warrington and Northwich Light Railways (Extension of Time), Lindsey Light Railway Syndicate (Fairford and Cirencester), Blackpool and Fylde Light Railway Co. (Extension), Llanelly and District Electric Lighting and Traction Co. (Llanelly and District Light Railways), C. Sinclair and C. E. Straker (Middlesbrough and West Hartlepool Light Railway), Lord Allington and others (Branksome Park and Swanage Light Railway), Middlesex C.C. (County of Middlesex Light Railways), Henry Kaye and others (Clayton West and Darton Light Railway), Bath Electric Tramways (Amendment of their Light Railways Extensions Order), Empire Electric Light and Power Companies (Halesowen Light Railways), Aldershot and Farnborough Light Railway Co. (Amendment).

General Power Bills.—Bacup Corporation (Extension of Electricity Undertaking), Channel Ferry Railway and Quay (Powers to Corporation of Dover as to Supply of Electricity).

NEW COMMITTEES.

The following additional committees have been appointed:

ABERDEEN.—*Gas and Electric Lighting*—Councillor Reilley has been added to the committee in room of ex-Councillor Hutcheon, and Councillor George Allan in place of ex-Councillor Laing, and Dean of Guild Murray takes the place held by the former Dean of Guild, Murray. Councillor Kemp has been reappointed convener. *Tramways*—Councillor Taggart, convener. Councillor Reilley has been added in place of Mr. Hutcheon, and Councillor Glass substituted for Mr. Coutts.

BERMONDSEY.—*Electric Lighting*—Alderman Wilkinson; Councillors Fogden, Bessell, Clark, Moss, Roche, Vesey, Pridmore, Martin, Dean Murphy, and Tovey.

CROYDON.—*Lighting and Electricity*—The committee re-elected Alderman Miller chairman and Councillor Rogers vice-chairman for the current year.

HAMMERSMITH.—*Electricity and Lighting*—Councillor A. Atkinson, chairman; Councillor W. Tomes, vice-chairman; Aldermen Cramp and Pascall; Councillors Bendon, Dr. Bevan, Boarder, E. Davies, Howell, Johnson, May, Neville, Platt, White, and Watkins.

NORTHAMPTON.—*Tramways*—Alderman Wooding, chairman; Councillor Martin, deputy-chairman; Councillors Collier, Green, Martin, Staton, and Webb. The following sub-committees have been appointed—viz: Finance Orders and Claims—the chairman, deputy-chairman, Councillors Collier, Green, and Pearse. Emergency—the chairman, deputy-chairman, and Councillor Green.

NEWPORT.—*Electricity and Tramways*—The Mayor; Alderman Bear and Greenland; Councillors Brown, F. Phillips, Williams, Baker, Abrahamson, Collier, Robjent, Evans, Searles, Parfitt, and Twoomey.

WEST HAM.—*Electric Lighting and Tramways*—The Deputy-Mayor (Councillor Littler); Aldermen Bishop, Byford, Crow, and Ivey; Councillors Baldock, Croot, Cunningham, Dyer, Fielder, Saunders Jacobs, Enos Smith, Spittle, Stoner, and White.

APPOINTMENTS VACANT.

Electrical Engineer, Radcliffe Urban District Council. Salary, £150 to £172 per annum.

Improver. Wages, 10s. per week. Applications to Box 702, *Electrical Engineer* Office.

Wireman for electric light and power plant. Applications to Box 29, *Electrical Engineer* Office.

Representatives for an electrical contracting firm. Applications to Box G 33, *Electrical Engineer* Office.

Laboratory and Workshop Assistant, Battersea Polytechnic, S.W. Commencing salary, 20s. a week.

Switchboard Attendant. Wages, 25s. per week. Applications to Box R P 5, *Electrical Engineer* Office.

Assistant Lecturer and Demonstrator in Electrical Engineering. Leeds University. Salary, £175 a year.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Electrical Engineer, colliery in the North of England. Applications to Box Q 11, *Electrical Engineer* Office. See advertisement in last issue.

Junior Charge Engineer. Salary, 30s. per week, rising to 35s. Applications to the Borough Electrical Engineer, 335, High-street, Cheltenham.

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LEGAL INTELLIGENCE.

CROYDON TRAMWAYS ARBITRATION.

Certain questions of law in the matter of the arbitration between the British Electric Traction Co. and the Croydon Corporation were down for argument before Mr. Justice Farwell in the Chancery Division last Friday. The arbitration was held by Mr. Parker, and was to settle the form of the lease of the Croydon and District Tramways.

Mr. THOMSON, for the British Electric Traction Co., stated that it had been arranged between counsel that the questions stated by the arbitration should be answered in a certain way.

Mr. WARMINGTON, K.C., for the Corporation, thought it ought to be mentioned that the award was in favour of his client, and as he understood it now the opposition to the award had been withdrawn.

The parties having agreed that the questions stated by the arbitrator should be answered in the negative, his LORDSHIP said the only order he should make was one as to costs.

SWANSEA TELEPHONIC INTERCOMMUNICATION.

National Telephone Co.'s Appeal.

In the Court of Appeal on Saturday last, before Lords Justices Vaughan Williams and Cozens-Hardy, application was made on behalf of the Corporation of Swansea for the appointment of an early date for hearing this appeal. The case was decided some time ago, but execution was stayed on certain terms The action was by the Corporation of Swansea, which had just instituted a telephone system in the borough. The National Telephone Co. had already a system in the borough, and under the Telegraph Act of 1899, on certain conditions and terms, there was a right of intercommunication between the two systems. The action was brought to establish that right. The Corporation succeeded, and the appeal was from the order made in the Court below, and the execution under the order was stayed on certain terms that three exchanges—the two Swansea main exchanges and a local system—will have to be connected, and the interconnection was only to be used for local traffic in each case. The Corporation contracts were all coming to an end, and would have to be renewed in January, and unless they got this made clear before then probably all their subscribers would not take the risk for another year, and subscribe to the National Telephone Co. instead. It was very important from the point of view of the Corporation of Swansea that this should be decided, as far as the Court of Appeal could decide it, before the end of the year.

Their lordships fixed Monday, Dec. 11, for the hearing of the appeal.

BOROUGH OF FULHAM v. NATIONAL CONSTRUCTION CO.

This case was heard in the King's Bench Division before Mr. Justice Bigham on Tuesday, and was an appeal from the award of the arbitrator.

It appeared that in June, 1901, the Fulham Borough Council, the claimants, employed the respondents to put an electrical installation in the Fulham baths. The "non-continuous" system was adopted. On Dec. 23, 1902, two men, named Line and Brown, were using the baths. These baths were separated from each other by slate slabs, about 8ft. high, on the top of which ran an iron tube conducting the electricity. Line was heard screaming, and an attendant found him with his hands on the top of the tube at the top of the slab partition, from which he could not release himself. After the electricity had been switched off, he was taken down, but died shortly afterwards. About an hour later Brown also was found dead in practically similar circumstances. It was admitted that the sections of tubing in these baths were not properly earthed, and that there was a leak in the electric current, and owing to these facts the above accidents resulted. It was contended that this failure to "earth" the tubing was a breach of contract, and that, therefore, the company was liable for the consequent damage to the Fulham Council. This consisted of the sum of £1,100 odd paid by them to the relatives of the two men. The arbitrator found that there was no lack of reasonable care on the part of the respondents in not "earthing" the tubes, having regard to the state of electrical knowledge at the time.

In giving judgment, his LORDSHIP said that the work was carried out under the rules of the Phœnix Fire Office. One of these rules was: "When the system of tubes is employed, the main tube shall be earthed, except in such cases where earthing would not be desirable." In this case the arbitrator to whom the dispute had been referred had held that it would not have been desirable to earth the tube. There had, therefore, been no negligence on the part of the contractor.

Judgment was entered for the electric company.

BRITISH PIONEER ELECTRIC LIGHT AND POWER CO. OF INDIA.

In the Companies' Winding-up Court on Tuesday, before Mr. Justice Buckley, the application for a compulsory order against the British Pioneer Electric Light and Power Co. of India again came on for hearing on the petition of S. T. Biggs and another. The allegation of the petitioners was that there were certain transactions arising out of a concession for a tramway line in Bombay which ought to be looked into by an official receiver.

HIS LORDSHIP, in giving judgment, said the company was incorporated on Feb. 27, 1899, with a capital of £3,000 in £1 shares, on which 15s. had been paid. The operations of the company consisted chiefly in the acquisition of a concession for the construction of an electrical tramway in Bombay and certain dealings and subsequent sale of that concession. The result had been to produce £20,000. There had been returned to the shareholders £6. 15s. per share, or nine times the amount paid up, and there were still some further assets. The company had by special resolutions passed on Nov. 23, and confirmed on Nov. 25, gone into voluntary liquidation. The petition before the Court was presented by the holders of 300 shares and was presented on Nov. 22, the day the special resolutions were passed. The petitioners were two gentlemen named Biggs and Sawyer, who were mortgagees from Mr. Bingham, holding 300 shares, 200 of which had been given for services rendered. Petitioners said that certain transactions which had taken place during the life of the company had given rise to claims against directors of the company for misfeasance. His Lordship reviewed the history of the company and its association with Messrs. Kelmen, and negotiations for the sale of the concession to the Brush Electric Light Co. for £40,000. He said there was no basis for a claim for misfeasance so far as he could see. The petitioners were the holders of only 300 shares, while the holders of the remainder of the 3,000 appeared to oppose the petition. The majority of the shareholders apparently were satisfied at the exceedingly beneficial result of the operations of the Pioneer Co., and they saw nothing to question in the transaction. There did not seem to be anything to investigate. The petitioners were not prejudiced by the voluntary winding-up. They had failed to make out their case, and the petition would be dismissed with costs.

THE RATING OF LIGHT RAILWAYS.

An important point affecting the rating of tramways and light railways came before the City Justices at Wakefield last week, when the Wakefield and District Light Railways Co. were summoned by the Corporation for non-payment of rates, amounting to £40. 2s. 2d.

The light railways company refused payment on the ground that, like ordinary railways, they were liable, under Section 211 of the Public Health Act, 1875, to be rated only at one-fourth of the assessment.

For the Corporation it was contended that a light railway was not a railway within the meaning of the Act, because it was not constructed upon land used only as a railway, but upon public highways repairable by the public at large. In support of this contention the decision of the Swansea Improvement and Tramway Co. *v.* the Swansea Sanitary Authority, 1898, was referred to, in which it was held that the land used by the tramway was not used only as a railway, and therefore was not entitled to be rated at one-fourth. The defendants argued that the provisional order for the making of light railways came within the general enactments, which applied to light railways in the same way as other railways; that, in fact, light railways were exactly in the same position as if constructed under a special Act of Parliament. The company had a right to the exclusive use of the tramlines on the highway, and people had been prosecuted for obstruction; and because of that exclusive use they were entitled to the exemption of three-fourths.

The Bench, after conferring in private, intimated that they decided in favour of the Corporation, and made an order for the rates to be paid in full. They agreed to state a case for the High Court.

PRIVATE TELEPHONES.

A case heard by Judge Woodfall at Westminster on Monday last, in which the Private Wire and Telephone Installation Co., of 5, Palmer-street, Westminster, sued Messrs. Portman and Co., described as commission agents, for £30 rent of private telephone wires.

Plaintiffs' case was that they were the successors and assignees of the Consolidated Telephone Manufacturing Co. In 1901 an agreement was entered into between that company and the defendants, under which private telephone wires were constructed between various offices occupied by the defendants at 8, John-street, 110, Strand, 97, Regent-street, and 2, Sussex mansions, Maiden-lane. The agreed rental was paid at the usual intervals by the defendants to the Consolidated Telephone Manufacturing Co., and subsequently to the plaintiffs as their successors. In March last, however, defendants refused to pay the rent, and now pleaded that the plaintiffs had not obtained the necessary license for the Postmaster-General for putting up these instruments, and, therefore, there could be no contract.

In reply, plaintiffs admitted that they had not the Postmaster-General's license, but pointed out that in the agreement defendants undertook that these telephone wires should only be used by themselves and their servants, and that consequently it was not necessary to obtain a license from the Postmaster-General.

The hearing was adjourned until Dec. 19.

LLOYD'S v. THE MARCONI INTER-MARINE COMMUNICATION CO.

On Saturday last the case of Lloyd's *v.* the Marconi Inter-Marine Communication Co. was again before Mr. Justice Buckley. The action had been in the list for hearing all last week. On Friday counsel asked for a postponement, as settlement was then in negotiation. On Saturday it was announced that the details had been arranged. The result was proceedings in this and another action would be stayed on terms initialled by the leading counsel.

TRAMCAR COLLISION.

At the Sunderland County Court last Saturday an action was brought against the Sunderland Corporation by Robert Reavley for damages sustained through a collision between a Corporation tramcar and one of plaintiff's wagons. The latter was being driven by a pair

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of horses along a road along which the Corporation tramcars ran. A coal cart, which was in front, got over the tramlines safely, but when the plaintiff's cart tried to cross, the tramcar dashed into it and overturned it. His Honour Judge O'Connor found for the plaintiff for £25. 2s. 10d.

RECEIVER OF RUBBER COMPANY.

Mr. Justice Buckley has granted an application in the action Oppenheim and others *v.* the British Seamless Rubber Co. for the appointment of a receiver. Mr. Crittle, secretary of the company, was appointed receiver.

ELECTRIC CAR AND STEAM-ROLLER.

Before Judge Addison, K.C., at the Southwark County Court, the London County Council sued Jesse Ellis and Co., road contractors, of Maidstone, to recover compensation for damage to an electric car. The defendants put in a counter-claim for £32. 9s. 11d. for damage to a steam-roller.

The Council's case was that an electric car was proceeding along New Kent-road at eight miles an hour, when one of the defendant's steam-rollers approached it, and just before they met the steam-roller was turned suddenly to its off-side and collided with the tramcar.

The defence was that the steam-roller turned to the off-side to avoid a stationary van when the car was 50 yards off. The car proceeded on its journey, the driver apparently mis-judging his position and collided with the steam-roller, breaking the front of the roller.

The presence of the stationary van in the road was denied by the plaintiffs, and his Honour holding that the steam-roller ought not to have left a position of safety and got into the way of the car, found for the Council on claim and counter-claim for £12. 10s., with costs on the B scale.

THE ELECTRICAL FRAUDS CASE.

The trial of W. Leslie, Alice Norton Cheeseman, George Webber, and Richard T. Rosenberg, who were charged, on 25 counts of an indictment, with conspiracy and with obtaining goods and money from firms of electrical engineers by false pretences to the amount of £30,000, was concluded at the Old Bailey on Saturday last. Leslie and Webber (who was in business as an ironmonger at Putney) had been associated for a considerable period, and the case for the prosecution was that they, in conjunction with the two other accused persons, had conspired to obtain large quantities of electrical fittings with no intention of paying for them. Orders for goods were given wholesale by Webber to the prosecuting firms, it being pretended that the particular class of fittings that were required for immediate delivery for use at the Fulham Theatre, where Leslie was employed, could only be obtained through the "Electrical Accessories Company," of Terminus-chambers, Holborn. This was alleged to have been a bogus company, and used mainly for the purposes of the fraud. In a box in the room occupied by the woman the police found £2,000 in gold and £1,500 worth of jewellery, while at the cloakroom of the railway station, where it had been deposited by Leslie, the police found a box containing £4,000 in gold in bags wrapped in some old clothes. It was stated that there was still a sum of £7,450 in Bank of England notes, part proceeds of the frauds, which the police were unable to trace.

The jury found Leslie, Webber, and Cheeseman guilty generally, and Rosenberg guilty of conspiring only, with a recommendation to mercy.

The Recorder sentenced Webber and Leslie each to five years' penal servitude, Rosenberg to nine months' hard labour, and the woman to 12 months' imprisonment in the second division. He also made an order of restitution from the £6,000 found in Leslie's possession on arrest to the amount of the cheques mentioned in the indictment.

COMPANIES' MEETINGS AND REPORTS

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL.

An extraordinary general meeting of this Company was held last week at Winchester House, E.C. (Mr. John MacFarlan presiding), for the purpose of submitting the following resolutions: "(1) That each of the existing 29,100 issued preference shares of £2 each in the capital of the Company be divided into two fully-paid-up preference shares of £1 each. (2) That 8,500 of the existing preference shares of £2 each in the capital of the Company, part of the 20 900 preference shares which remain unissued, be each divided into two preference shares of £1 each. (3) That the remainining 12,500 shares, being the balance of the said existing 20,900 preference shares of £2 each which remain unissued, shall be and the same are hereby converted from preference shares into ordinary shares, and that each of such 12,500 shares be divided into eight ordinary shares of 5s. each. (4) That the capital of the Company be reduced from £162,981, divided into 75,000 preference shares of £1 each, 62,981 ordinary shares of £1 each, and 100,000 ordinary shares of 5s. each, to £115,745. 5s., divided into 75,000 preference shares of £1 each and 162,981 ordinary shares of 5s. each, and that such reduction be effected by cancelling capital which has been lost or is unrepresented by available assets to the extent of 15s. per share upon each of the 62,981 ordinary shares of £1 each, which have been issued and are now outstanding and are credited as fully paid, and by reducing the nominal amount of the said 62,981 ordinary shares from £1 to 5s. per share. (5) That from and after the confirmation by the Court of the foregoing reduction of capital, the rights of the holders of the preference and ordinary shares respectively shall be varied to the following extent. And it is hereby resolved as follows: (*a*) the net profits of the Company available for distribution as dividend in each year shall, after payment of the preferential dividend of 7 per cent. for that year on the amounts paid up on the preference shares, be applicable to the payment of a dividend of 80 per cent. for that year on the amounts credited as paid up on the ordinary shares, and the surplus only (if any) of such net profits remaining after such payments shall be divided between the holders of the preference and ordinary shares in proportion to the number of shares, whether preference or ordinary, held by them respectively; (*b*) in article No 72 of the articles of association the word 'two' shall be substituted for the word 'five.'"

On the proposition of the Chairman, seconded by Mr. John Heal, the resolutions were carried unanimously.

BARCELONA TRAMWAYS.

An extraordinary general meeting was held on Monday at the offices, Winchester House, Mr. J. B. Concanon presiding, to consider a resolution for winding-up the Company voluntarily.

The CHAIRMAN, in proposing the resolution, reminded the shareholders that the directors promised at the last meeting to take the very earliest opportunity of closing up the sale of the undertaking, and to lose no time in connection with the distribution of the assets. Having that promise in view, the present meeting had been called, but he particularly wished to impress on the shareholders that the resolution would not be binding in any sense until the confirmatory meeting to be held about 16 days hence. The balance of the purchase money (£387,000) was not yet paid over, but it would be received on Dec. 11. They were, therefore, somewhat anticipating in holding the meeting before the money was actually in their hands, but, as he had said, the resolution before the meeting was not in any sense binding, nor would the Company be in liquidation until the confirmatory meeting was held. If the resolution should be confirmed at the latter meeting, the bulk of the money would be at once distributed; in fact, they hoped to get it out the same night. He could not state exactly how much the shareholders would receive, but he could confirm his statement at the last meeting—namely, that the amount would be at least £14. 10s. per share. There were various other items to be considered, such as the valuation of the stocks and the amount they were entitled to receive—£5,000—when the unification of the concessions had been confirmed. Until these sums were received the directors could not state the exact amount per share which would be distributed.

Mr. W. F. HAMILTON, K.C., in seconding the motion, stated that the directors had no intention of going into liquidation until the £387,000 referred to had been received in hard cash, and, therefore, if by any chance the money should not be paid by the 11th prox. and the confirmatory meeting were called for the 13th it would not be held, and another meeting would be convened. The reason the directors were running the matter so fine was that they desired at the earliest opportunity to distribute among the shareholders as much as possible of the assets.

The resolution was unanimously passed.

FRASER AND CHALMERS.

The report of this Company for the year ended June 30 states that the business has been generally satisfactory, and the earnings have been about the same as those of the two preceding years, but the total income has been reduced by the non-receipt of dividends on the holding of preference shares of the Allis-Chalmers Co. The changes in the conditions of trade in the United States as respects certain classes of machinery have necessitated continued large expenses by the Allis-Chalmers Co. in laying down plant for the economical manufacture of electrical machinery, steam-turbines, gas-engines, etc., and the profits of the business have been expended in this outlay. The net earnings are £28 922, after the usual allowance has been made for depreciation of buildings and plant at Erith. Competition for trade in South Africa has been severe, and for the first six months of the year the demand for heavy machinery was small. In the last six months some larger orders were obtained, and trade generally has improved. The progress of the mining industry of South Africa offers prospects of a continued demand for high-class machinery, and the Erith shops are at present well supplied with work both for home and foreign use. Owing to the demand for certain classes of machinery and to special requirements for the lately established manufacture of steam-turbines, it has been necessary to add new buildings and tools to the shops at Erith. These improvements will enlarge the capacity of the works, and should increase the Company's earnings on manufactures. The profit of £28 922 added to the balance brought forward, makes a total of £117,624. The dividend on the preference shares and an interim dividend of 3 per cent. on the ordinary shares absorbed £16,065, and a final dividend of 4 per cent. on the ordinary shares is now proposed, amounting to £15,120, leaving a balance of £86,339 to be carried forward.

MORECAMBE TRAMWAYS.

Mr. O. CARR presided at the annual meeting of shareholders in the Morecambe Tramways Co., and, in moving the adoption of the report, which showed a balance to revenue account of £1,630, said that during the year the horse cars had run 145,000 miles, at a profit of 1·88d. per mile, and 1,212,240 passengers had been carried. The number of fares collected had increased by 11 048. The directors regretted that they could not report any further progress in respect to electrification.

Mr. W. H. PICKLES seconded the motion, which was adopted.

A dividend at the rate of 4 per cent. was declared, an increase of ½ per cent. on last year.

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NEW COMPANIES REGISTERED.

Rubber Estates Syndicate (of Brazil), Limited.—Capital, £4,150. Object: to acquire any estates for the production of rubber or otherwise and to carry on the business of planters and producers of rubber and other produce, etc. Registered office: 97, Gresham-street, E.C.

Cartomite and Arborite Syndicate, Limited.—Capital, £3,000. Object: to adopt an agreement with W. Love to manufacture and deal with machines, the subject of the patents therein mentioned, and to carry on the business of engineers, electric light and bell installers, etc. Registered office: 78, Fleet-street, E.C.

Ore Concentration Co. (1905), Limited.—Capital, £250,000. Object: to adopt an agreement with B. C. Hiuman, to acquire and turn to account any inventions for the concentration of minerals and the obtaining or separation of metals from their ores, or for the recovery of values from minerals by electrical or other means.

P. M. Electric Manufacturing Co., Limited.—Capital, £3,000. Object: to carry on the business of manufacturers of and dealers in electrical apparatus, sparking plugs, induction coils, tremblers, and all accessories, parts, or articles used in connection with the electrical portion of motor cars, launches, and omnibuses, and other self-propelled vehicles, manufacturers and vendors of electrical apparatus of any kind, etc.

Stratford-on-Avon Electricity Co., Limited.—Capital, £15,000. Object: to acquire rights conferred upon or belonging to any company, corporation, or person to supply electric light or power in Stratford-on-Avon or elsewhere in the United Kingdom, to adopt an agreement between the Corporation of Stratford-on-Avon of the one part and the Birmingham Installation Co. of the other part, and to carry on in Stratford-on-Avon and elsewhere the business of electrical and general engineers, electricians, manufacturers of and dealers in electrical apparatus, suppliers of electricity for light, heat, power, and otherwise, etc.

Evans's Carburetter and Motor Pump Syndicate, Limited.—Capital, £2,000. Object: to acquire certain patents for inventions relating to (1) new and improved carburetters and vaporisers for internal-combustion engines; (2) to motor pumps; (3) to a compound nozzle for blowing compressed air with a suction principle in combination therewith; (4) to a radiator to be attached to internal-combustion engines for cooling water and for other purposes in connection therewith; to develop, deal with, and turn to account the same or any improvements thereon; to carry on the business of mechanical, electrical, and hydraulic engineers, etc.

Liens Registered.

British Electric Co., Limited (London).—Issue on Oct. 13 of £50 debentures, part of a series created same date, to secure £250, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees.

Hopper and Co., Limited (Electricians, Walthamstow).—£2 900 debentures, created and dated Nov. 9, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Keynsham Electric Light and Power Co., Limited.—Issue on Nov. 9 of £1,104 debentures, part of a series created same date, to secure £1,500, charged on certain land and buildings occupied by the company at Keynsham, Somerset, and the company's undertaking and property, present and future, including uncalled capital, subject to £1,500 first debentures. No trustees.

Electrical Corporation, Limited (London).—A charge on book debts and sums of money due to the corporation and its undertaking and property, present and future, including uncalled capital, dated Oct. 31, 1905, to secure £272 2s. 6d., and further advances up to £800, has been registered. Holders: E. S. Parker and A. H. H. Richardson, both of 52, New Broad-street, E.C.

Buenos Ayres Port and City Tramways, Limited.—A trust deed, dated Oct. 30, 1905, to secure £200,000 debenture stock, created by resolution of Aug. 1, 1905, has been registered. Property charged: a certain concession relating to the construction, etc., of electric tramways in the port and city of Buenos Ayres, and the company's lands and general assets, present and future, including uncalled capital. Trustees: C. W. H. Lowther, M.P., Albany, Piccadilly, W.; and J. G. B. Stone, 1, Sloane-terrace-mansions, S.W.

Bombay Electric Supply and Tramways Co., Limited.—A trust deed, dated Nov. 7, 1905, to secure £600,000 debenture stock, with power to issue further debenture stock not exceeding (together with the present issue) half of the company's issued capital, has been registered. Property charged: (1) a concession from the Corporation of Bombay, dated Aug. 7, 1905; (2) the Bombay electric license, 1905, and the Bombay electric traction license, 1905, and any licenses which may be vested in the company in substitution for or supplemental thereto; and (3) the company's undertaking and remaining assets, present and future. Trustees: The Right Hon. Lord Hillingdon, 67, Lombard-street, E.C.; and G. Herring, 1, Hamilton-place, London.

CONTRACTS FOR ELECTRICAL SUPPLIES.

London, W.—Messrs. Grice and Co., Addison Wharf, Warwick-road, Kensington, require a 10-ton electric derrick crane with 60ft. to 70ft. jib, continuous current.

Yarmouth.—Tenders are to be invited by the Port and Haven Commission for an electrically-driven crane. Including foundations, etc., the cost is estimated at £2,000.

Bermondsey.—Tenders for new plant, estimated to cost £5,390, will shortly be advertised for. An estimate is being prepared for condensing plant, for which tenders will be invited.

Omnibus Lighting.—A London motor omnibus company is open to receive proposals for the lighting of its vehicles by acetylene or electricity. Apply to Box 306, Willing's, 125, Strand, W.C.

Glasgow.—The Corporation invite tenders for the supply of 1,000-kw. motor-generators and high and low tension sub-station switchgear. Tenders by Dec. 4. See advertisement in last issue.

Brussels.—The Belgian Government Railways require tenders for lamps, accessories, etc., for railway carriage lighting. Specification No. 698 may be obtained from that authority. Tenders by Dec. 6.

Sao Luiz.—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 16. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Launceston (Tasmania).—Tenders are invited for the supply of 500 or more electric meters and for maximum demand indicators. Tenders to Mr. C. W. Rocher, town clerk, Town Hall, Launceston, Tasmania, by 12 noon on Jan. 15.

Guadalajara (Spain).—Tenders are required for the electric lighting installations in various public buildings. The estimate is 11,343·00 pesetas. Particulars may be obtained from the Secretary of the Provincial Government at Guadalajara. Tenders by Dec. 8.

Castlerea.—The Rural District Council invite tenders for the construction of works for lighting the town of Ballaghaderreen: (1) builders' work; (2) hydraulic turbine plant; (3) electrical work. Specifications and particulars may be had from Mr. C. Mulvany, M.I.C.E., Engineer's Office, Athlone, on payment of £1 as a deposit, returnable after receipt of bona fide tender. Tenders by Dec. 23.

Poplar.—The Guardians invite tenders for the supply and erection of the following plant at the children's homes and schools now in course of erection at Hutton, Essex: (Section X) steam-engines, dynamos, pipework, etc.; (Y, part 1) main switchboard, wiring, motors, etc.; (Y, part 2) fire-alarms, telephones, and electric bells. Tenders to Mr. G. Herbert Lough, clerk, Guardians' Offices, 45, Upper North-street, Poplar, E., by 6 p.m. on Dec. 13.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension to that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Madrid.—The Directorate-General of Public Works, Madrid, require tenders for the concession of an electric tramway between Zumárraga and Azioitia, in the province of Guipúzcoa. An application for this concession has already been made by Don Dionisio Sorseta, who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on a reduction of the tariffs proposed, and if two or more identical propositions are made, a further competition will take place verbally as to any reduction tenderers may be prepared to accept of the period (60 years) of the concession. A deposit of 6,897 pesetas (about £208) is required to qualify any tender.

Australian Commonwealth.—Tenders are invited by the Deputy Postmaster-General, Brisbane, for the supply and delivery at the Departmental Stores, Brisbane, of insulators, phosphor-bronze wire, copper sleeves, binders, and tapes. Tender forms, specifications, and conditions may be obtained from, and samples seen at, the Stores Branches, Postmaster-General's Department, Sydney, Melbourne, Adelaide, and Brisbane. Tenders by noon on Dec. 18.—Separate tenders are required by the Deputy Postmaster-General, Melbourne, for the supply and delivery at Melbourne of (1) 10 miles of 26-pair lead-covered paper-insulated telephone cable; (2) 1 mile of 156-pair lead-covered paper-insulated telephone cable (12½lb. conductors); (3) 5,000 barrel insulators delivery within three months of date of acceptance of tender. Tender forms, specifications, etc., and sample of insulator, may be seen at the General Post Offices, Melbourne, Sydney, Brisbane, Adelaide, Perth, and Hobart. Tenders must be endorsed "Tender for ——," as the case may be, and addressed to the Deputy Postmaster-General, Melbourne. They may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. Tenders by Dec. 17.

RESULTS OF TENDERS.

Melbourne.—The Corporation have accepted the tender of the Key Engineering Co. for 10,000 yards of 3in. fibre conduit

Salford.—The Electricity Committee have placed an order for 6,000 yards of fibre conduit with the Key Engineering Co.

Manchester.—The Electricity Committee have placed an order for 6,000 yards of fibre conduit with the Key Engineering Co.

Oldham.—The Electricity Department have placed an order for 3,000 yards of 2½in. fibre conduit with the Key Engineering Co.

Colonial Orders.—The D.P. Battery Co. have booked a 100-kw. battery for Australia and a small battery of 15 kw. for New Zealand.

Handsworth.—The Urban District Council have accepted the tender of Ellis and Ward, at £71. 19s. 10d., for altering the electric wiring and fittings at the Council house.

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Northampton.—The tender of Nunn, Browne, and Co. to supply coal at the generating station for the ensuing 12 months has been recommended for acceptance.

Manchester.—The Electricity Committee have accepted the tender of the Key Engineering Co. for the supply and erection of a Harris-Anderson feed-water purifier for their Bloom-street works.

London County Council.—The amount of the contract for the ploughs for the 34 single-deck cars, which are being obtained for use on the southern tramways from the British Westinghouse Electric and Manufacturing Co., is £408.

London County Council.—The tender of Siemens Bros., of York-mansions, York-street, at £99. 16s. 6d., for providing a 30 h.p. electric motor in connection with the heating and ventilating apparatus at the Old Montague-street School, has been accepted.

Erith.—The Electricity Committee recommend that the contract with the Electric Construction Co. for the supply of motors to the Council for letting on hire be extended to March 31, 1906, upon the revised schedule of prices submitted by the company dated Nov. 10.

Bray (Ireland).—The Urban District Council have accepted the tender of Johnson and Phillips, Old Charlton, Kent, for 220 yards $^{7}/_{16}$ concentric paper-insulated and lead-covered cable, for a working pressure of 600 volts, at £13. 5s. per 220 yards; and that of the British Thomson-Houston Co., Rugby, for 10 10 ampere alternating-current induction voltmeters, 100 volts 60 periods, at £2. 2s. 9d. each.

London, S.W.—The London County Council are recommended to accept the following tenders for electric fittings, cables, etc. for the year 1906: Evered and Co., London; General Electric Co., London; Scerryn and Co., Birmingham; Dorman and Smith, London; J. Harrison, London; Armorduct Manufacturing Co., London; Baxter and Canter, London; Drake and Gorham, London; Verity's Limited, London; Craigpark Electric Cable Co., Glasgow.

Brighton.—The Town Council have accepted the tender of the British Westinghouse Electric and Manufacturing Co., at £1 462. 10s., for the installation of a motor-generator at the Southwick power station in connection with the supply of electricity to Aldrington; and that of the British Thomson-Houston Co., at £670, for the provision of a switchboard for controlling the low-tension circuits for Aldrington, the lighting, and the auxiliary motors at the Southwick power station.

Westminster.—The Finance Committee have received the following tenders for putting the electric light installation of St. Martin's-lane library in thorough repair:

T. Potter and Co., 44, South Molton-street*	£75	0	0
F. J. Coleby and Co., 7, Thayer-street, W.	73	12	0
Lund Bros and Co., 78, Queen Victoria-street, E.C.	88	0	0
L. Sunderland and Co., 39, Victoria-street, S.W.	104	0	0
Drake and Gorham, 66, Victoria street, S.W.	110	0	0
Foote and Milne, 66, Victoria-street, S.W.	119	10	0

* Recommended for acceptance.

Japan.—Messrs. Tokata and Co. have placed the following orders for electrical plant with the Westinghouse Co. of America: For the Furukawa Western Bureau—one 62½-kw., 570-volt, compound-wound, direct-current engine-type generator, direct connected to a Westinghouse 11 by 19 by 11 automatic compound engine. For the Senju Seijusho—two type 7 B direct-current generator panels; one type 7 B direct-current feeder panel; one type 7 B blank panel, all arranged to make a complete switchboard to control two 33-kw., 110-volt, shunt-wound, direct-current generators connected for three wire distribution. For the Kosaka Mine—one 15-h.p., 7 200 alts., three-phase, 220-volt, type C induction motor; one 3-h.p., 7,200 alts., three-phase, 220 volt, type C induction motor, which are to be direct connected to Denver Engineering Works electric mine hoists. For the Naval Briquette Works—one 10-h.p., 110-volt, shunt-wound, open-type S motor, with back gear, ratio of 5 to 1; one 5-h.p., 110-volt, shunt-wound, open-type S motor, with back gear, ratio of 5 to 1. For the Kimura Gold Mine—one type 13 three-phase generator panel, for one three-phase generator and one three phase feeder, 3,500 volts, 40 amperes; two 30-h.p., 200-volt, three-phase, 7 200 alts., type C induction motors; three 37½-kw., 7 200 alts., transformers: three 7½-kw., 7,200 alts., transformers.—*The Anglo Japanese Gazette.*

BUSINESS NOTES.

TRACTION.

Malaga (Spain).—The Malaga Tramways have obtained a concession for an electric tramway in Malaga.

Chili.—Don Fernando Petite has obtained sanction to construct and work an electric railway between Santiago and Banos de Colina.

Hythe.—Mr. Sellon, of the Folkestone, Hythe, and Sandgate Co., explained his tramway scheme to the Town Council last week, but was asked to submit same in writing.

Brighton.—The question of introducing ½d. fares into the tramway system has been before the committee, but further consideration has been deferred until the next meeting.

Cheshire.—We understand that the promoters of the Cheshire trams have decided not to proceed with the line between Cheadle, Handforth, Wilmslow, and Cheadle Hulme.

Dumbarton.—It has been agreed by the Western District Committee of the Dumbarton County Council to petition against the Dumbartonshire tramways order and the Dumbartonshire burgh extension order.

Belfast.—The municipal electric tramway service at Belfast was inaugurated at Belfast on Wednesday by a triumphal procession of six cars, on which were members of Parliament and representatives of all the local public bodies.

Cuba.—Application has been received by the Secretary of Public Works from Mr. G. F. Greenwood, the representative of the Cuban Electric Co., for permission to construct and work electric tramways in Regla and Guanabacoa.

Erith.—The Tramways Committee have invited the Bexley Urban District Council to discuss with them the question of inter-running and other matters of joint interest in connection with the tramway undertakings of the two authorities.

Scarborough.—The Marine-drive Sub-Committee have decided to submit a plan to the tramway company for the construction of tramways round the drive, which connects the North and South Bays, and is costing over £100,000 to construct.

Swinton.—The plans submitted by the tramway company for the construction of a tramway across the Midland bridge have been accepted by the Town Council, and an agreement will be entered into between the company and the Council as to details.

Northampton.—It will be recommended at the Council meeting on the 4th inst. that special school tramway tickets be in future printed and supplied by the Tramways Committee for the conveyance of scholars attending the Wellington-place School by trams at half fare.

Cleckheaton.—The District Council have agreed to confer with the Bradford Corporation in reference to the suggested linking up of the Spen Valley and Bradford tramway systems at Oakenshaw, on the suggestion of the Yorkshire (Woollen District) Electric Tramway Co.

York.—The Streets and Buildings Committee have appointed a sub-committee to deal with the resolution of the City Council remitting the question of the acquisition of the street tramways to them, with instructions to effect the purchase of the tramways if possible.

Liverpool.—The widow and daughter of Mr. James Sykes, a cashier, of Liverpool, were at Liverpool on Tuesday awarded £1,100 damages against the Lancashire and Yorkshire Railway Co. in respect of the loss of Mrs. Sykes's husband, who was killed in the Hall-road electric train accident.

London, Brighton, and South Coast Railway.—A correspondent writes to the *Times* that the London, Brighton, and South Coast Railway Co. are preparing to go ahead with the electrification of their South London line on the single-phase system. It is believed the contract will be undertaken by the Allgemeine Elektricitäts-Gesellschaft.

Dunfermline.—The promoters of the Dunfermline and district tramway scheme have agreed that the system to be introduced in the town should be the single-double line; that means the laying down of the double rails, but only traffic on one side of the street at a time. Application is to be made to the Secretary for Scotland for power for the construction of the tramways in the town and district.

Lincoln.—A public service of cars over the new electric tramways was started on the 23rd ult., the first car being used by the mayor and Corporation for a trip along the entire system. The line, which is a little under two miles long, is operated by the "G. B." surface-contact system, Lincoln being the first town to adopt it for a public service. The tramways have cost £20,000, and there are eight cars, which have cost about £600 each.

Heywood.—The section of the tramways from Heap Bridge to the Reform Club was officially inspected last week. The inspector (Colonel Druitt) went over the whole of the track and passed it, fixing the speed at which the cars should travel at 14 miles an hour, with the exception of Bridge-street and Market-street, Heywood, the speed in those streets not to exceed 10 miles an hour. The route was opened for traffic on the same day.

Torquay.—The Town Council Electric Lighting Committee have under consideration an offer from the National Electrical Construction Co., of Westminster, who are constructing the tramways for the Dolter Co., to buy or lease the electrical station from the Corporation. The Local Government Board has, after nearly 12 months, sanctioned the enlargement of the electrical station, at a cost of about £10,000, in order to provide current for trams.

West Ham.—The Electric Light and Tramways Committee recommend the Council not to identify themselves at the present time with the metropolitan boroughs who are contemplating the promotion of Bills in Parliament during the ensuing session for obtaining powers for supplying electricity in bulk. A proposal was before the Council at their meeting on Tuesday for the adoption at the various tramway termini of a better method for the regulation of passenger traffic.

Hampstead.—The application of the London Motor Omnibus Co. for the Borough Council to withhold their support to the Bill to be promoted by the London County Council for the provision of an electric tramway from Cricklewood to the Marble Arch, on the grounds that the problem of London traffic could be better solved by the provision of motor omnibuses than by the provision of electric tramways, has been referred to the General Purposes Committee for consideration.

Wembley.—The District Council having objected to the scheme of the Middlesex County Council for an extension of the tramway system to Swan, had before them an intimation from the same authority that they were going to apply for powers for a light railway commencing at a point one chain east of the Wembley and Harrow boundary, extending east to link up with the line in course of construction. The District Council have passed a resolution to the effect that this proposal is sufficient compliance with their wishes to enable them to reconsider the question.

Dundee.—A report has been issued by the tramway manager on the question of interchanging traffic with the new district tramway from Dundee to Monifieth, which will be opened shortly. The latter belongs

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to a limited liability company, and when the company obtained the order, power was taken for the changing of crews at Dundee. Mr. Fisher, the Dundee manager, suggested, however, that the drivers should run right through either way, and that the conductors only should change at the boundary, pointing out that this would obviate the conductors collecting fares in territory over which their employers were not owners.

New South Wales.—The report of the Railway Commissioners on the working of railways and tramways in the Colony for the quarter ended Sept. 30 shows that the tramway earnings were increased by £2,247, while the expenditure was decreased by £2,879, which is an improvement of £5,126 over the corresponding quarter of last year; 16,892 additional passengers were carried, but tram mileage shows a decrease of 86,082 miles. The revenue during the period under notice amounted to £194,598, expenditure £160,033. The total number of tram miles run were 4,035 595, the earnings of which were 11½d. per mile, as against an expenditure of 9½d. Expenditure absorbed 82·24 per cenc. of the earnings.

Musselburgh.—With regard to the proposed application for powers to construct tramways which we announced last week, we understand that the Town Council consider some of the routes dangerous, and have decided to insist that where the new line ran through the burgh there should be at least the regulation minimum of 9ft. 6in. space left on each side of the road between outer rail and kerb, and that the road be widened where necessary to effect this; also that a minimum of 5ft. of footway be left on the north side of the road, and that Ravenshaugh Bridge be widened and made secure for traffic. They have also agreed that wayleave be charged, but the sum and other matters have been referred to the committee.

Longton.—Major Druitt inspected the new section of the Potteries Electric Tramway on behalf of the Board of Trade on Friday last. The new line traverses a long incline and terminates near Heathcote-street close to the cutting which opens into Adderley Green district. The termini of the new tramway will be Longton Market-square and Heathcote-street, and the fare will be 1d. for the single journey. The contract for the permanent road has been carried out by Mr. Law, of Kidderminster, and the installation of the overhead equipment was in the hands of the Potteries Electric Traction Co. We understand that subject to the inspector's satisfaction the new section will be opened to the public to-morrow ((Saturday).

Cardiff.—In answer to the complaints made against the frequent repair of the track between Leckwith-road and Theobald-gardens, the engineer (Mr. Harpur) reported to the Tramways Committee that the unsatisfactory state of the track between these points was due to the Corporation having utilised, with the object of economy, the concrete foundation of the old tramway, for which they had paid a big price. The Chairman said the only remedy was relaying and a double track, while Mr. Harpur added that rewidening was proceeding now at the spot referred to. The committee have declined to receive a deputation of tramway employés and representatives from the Tramway and Vehicle Workers' Association to discuss the charges made by the tramways manager against some of the employés.

Wandsworth.—The Borough Council have consented to the introduction of a Bill by the London County Council to obtain powers for the construction of a tramway from Clapham to Lavender-hill, upon the following conditions: the London County Council to pave with wood the whole width of the carriageway of Long-road and North-side, Clapham Common, from South-side to Cedars-road, making the width 33ft., and setting back the kerb for that purpose, and adding a strip of the common to the public way if necessary; the London County Council to construct a surface-water sewer along Long-road; the Borough Council to pay one-third of the cost of the works referred to; the London County Council to reconstruct as a double line and electrify the existing tramways from the junction of Cedars road and Lavender-hill to East-hill, Wandsworth, as soon as possible.

Newcastle.—A meeting of the representatives of the Tramways Committee of the Corporation and the representatives of the tramway employés took place on Tuesday for the purpose of endeavouring to settle the dispute arising out of the late strike. The questions brought forward by Mr. Tate (on behalf of the tramway employés) for consideration were extra remuneration for men working on Sundays, and also extra duty on other days; excessive hours of work; and the reinstatement of a Gosforth conductor, who was alleged to have been wrongfully dismissed. A long discussion took place, but no definite conclusion was come to. It was, however, arranged that a special meeting of the sub-committee, along with Mr. Tate, be held to-day to consider the case affecting the car conductor, and that the next conference between the whole of the representatives take place on Tuesday next.

Hammersmith. — In response to the application of the London County Council for payment of a sum of £1,973. 11s. 11d. by way of a contribution towards the costs and expenses incurred by the Council in carrying out reconstruction and widening of roads in the borough, the Borough Council have informed the London County Council that before any payment is made the whole of the improvement should be completed. The Council consider that the number of men employed in repairing the tramways permanent track in the borough is not sufficient, and have informed the London United Tramways Co. that unless the work of repair is pushed forward more rapidly to the satisfaction of the Council, the Council will put in force the provisions of Section 28 of the Tramways Act, 1870, enabling the Council to do the works necessary for the repair and maintenance of the roads and charge the company with the cost.

Dewsbury-Batley.—The Bradford-road section between Dewsbury and Batley was officially inspected last week by Colonel Druitt on behalf of the Board of Trade. As far as construction was concerned, Colonel Druitt found everything to his satisfaction. In regard to a portion of the Dewsbury section near the railway arches, he had to draw attention to the manner in which the ordinary paving had been joined up with that nearest the tramrails. The Dewsbury Corporation aver that it is the duty of the British Electric Traction Co. to put this right, while the company throw the responsibility upon the Corporation. Sanction was given for the running of cars for the public at noon, and it is understood that between Dewsbury and Branch-road, Batley, a speed of 14 miles per hour will be allowed, and between Branch-road and Birkenshaw 16 miles per hour. This is more than double the speed of the old cars, so that travellers will be able to appreciate the difference.

New London Tube.—A new railway from the Marble Arch to Cricklewood, authorised in 1899 but delayed on account of the South African War, is now to be carried out, and, in addition, powers will be sought from Parliament in the coming session to extend the line to Victoria. The promoters of the scheme propose to construct subways for the convenience of passengers wishing to change to other lines, communicating with the District Railway, Victoria, the Great Northern, Piccadilly, and Brompton Railway at Hyde Park-corner, and the Central London at Marble Arch. It is probable also that the Baker-street and Waterloo Railway's extension to Paddington will be connected with the proposed North-West London line. It is also intended to construct some short branch lines to facilitate intercommunication with the tramways. The actual lines will not, of course, be joined, but subways will be built leading to the existing tramway route. It is understood that the estimates aggregate over £2 500,000. The proposed extension to Victoria follows the lines of one of the recommendations of the Royal Commission on London Traffic.

Abram.—The following are some of the conditions upon which the Council would consent to the sale to the Wigan Corporation of that portion of the South Lancashire tramway undertaking which is in their district: That any setts excavated in the construction of the tramway shall not be broken up into road ballast, but shall be applied only as setts in or towards the reinstatement of the road; that the Corporation when constructing the tramway shall at their own expense provide proper means of lighting the entire route of the tramway (constructed) on the trolley wire standards at points in the road, to be approved by the Council, and shall continue, so long as the tramway remains in existence, to light the road at their own expense with electricity; that so long as the tramway continues in use there shall be issued to the Council, free of charge, passes over the Corporation tramway system for the clerk, surveyor, medical officer of health, nuisance inspector, and collector for the time being, and also for three members of the Council, whose names shall from time to time be furnished by the Council to the Corporation; that the Corporation shall widen Dover Bridge.

Southampton.—The report of the tramways manager upon the working of the undertaking for the six months ended Sept. 30 was presented to the Town Council at the meeting last week. From it we gather that the working expenses, excluding any work on the track, showed a saving on the estimate of practically £240, and a saving of about £150 on the power bill. Allowing for the extra mileage run, the units per car mile have dropped from 1·185 to 1·161. In spite of the large amount of work done, the expenditure for track repairs only exceed the estimate by £54. The traffic receipts show a small decrease when compared with the corresponding period of last year, the amount taken being £26,939, as against £27,464 being a decrease of £51b. The interference to traffic caused by the various reconstruction works accounts for some of this decrease, while the absence during the six months under review of any popular attraction in the town was very noteworthy, and had been a severe loss to the department. This decrease of traffic receipts was not local, for very nearly all the undertakings in the country which have not increased their route mileage and car mileage show a similar decrease. During the six months the Corporation have reconstructed 1,824 yards of single track at a cost of £4,663, and have also put a further 500 yards of track into a state of thorough repair. In moving the adoption of the report, the chairman of the Tramway Committee consented to refer back the financial portion for preparation by the borough treasurer.

Durban.—The annual report of the manager of the tramways states that with the exception of an interruption of the supply owing to the failure of water, as the result of the storm in June last, no serious hitch occurred to the supply of current to the tramways, and they are now being charged for all current at the rate of 1½d. per unit, which, of course, only includes the actual operating cost, and does not include any capital charges. As there appears to be considerable misapprehension in certain quarters as to the reason of this, and an idea that the capital accounts of the tramway and electrical departments have not been regularly kept, the manager explains that the reason the latter do not make a charge for interest, etc., is that the machinery in the power station for generating current for tramways was bought and paid for out of the tramway loan, and this was the only course which could have been taken, as such machinery could not have been paid for out of a loan which was raised for electric lighting purposes. When the electrical department was completely separated from the tramway department, it became necessary, or convenient, that the cost of tramways machinery should be transferred to the other account; but until recently the capital account of the electrical department was overdrawn, and had not the funds to take over this expenditure. Funds now, however, are available, and the transaction of transferring about £40,000 to £50 000 can be made, and the price charged to the tramway department per unit will have to be increased to cover the interest and depreciation on the amount transferred. The cost to the electrical department of generating 1,548,000 units was £7,110, and the repairs to underground mains necessitated an expenditure of £334.

The Underground Railways.—Some important reductions have been announced by the District Railway Co., which come into operation to day. Over the Inner Circle portion of their system the single-journey fares will in no case be in excess of 4d. first-class and 2d. third-

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class. The fares from Earl's Court, High-street (Kensington), Gloucester-road, South Kensington, Victoria, etc., to all City stations to Aldgate East will now be 4d. first and 2d. third, instead of 6d. first and 3d. third, as formerly. The Metropolitan Railway are also reducing the fares by their route from South Kensington to the City *via* King's Cross, the journey being accomplished on and after to-day for 2d. third-class and 3d. first-class. Already the omnibus companies have extended some of their stages westwards to meet the competition by the electrified railways and motor-driven 'buses. The increased comfort with which a journey can now be made on the Underground Railway has fully justified the electrification from the public point of view. The change is also being justified from the standpoint of the companies. In conversation with a representative of the *Evening Standard and St. James's Gazette*, the deputy-chairman of the District Co. said that over 200 000 more passengers were being carried than was the case at this time last year. The increase has temporarily added to the army of "strap-hangers," but at present the company is helpless in the matter. The Board of Trade, Mr. Perks pointed out, would not allow a more frequent service of trains to be run until the automatic signalling arrangements were at work. He believed, however, that the last of the steam trains—those of the London and North-Western—would be adapted to the new conditions by Friday, and he hoped the automatic signals would be installed before the close of 1905.

Middlesbrough.—Details of an important private scheme in the shape of a light railway for more rapid communication between Middlesbrough and Hartlepool have been issued, which include the erection of a transporter bridge across the Tees. A junction will be effected with the Middlesbrough tram system at the Ferry-road terminus, and the lines will be laid along Ferry-road to within about four yards of the clock tower, thence across the transporter bridge (measuring, with its approaches, about 360 yards), terminating at the southern end of the road leading from the existing ferry entrance gates to the Port Clarence railway station. From this point it is proposed that a line will be laid along the Haverton Hill-road to Haverton Hill, and thus along Clarence-street to Hope-street. From this point the line will cross the fields to Cowpen Bewley. Crossing by an overhead bridge the railway lines at the Cowpen gates, the route taken will be in the direction of Greatham, entering the village at the point where the footpath from Cowpen enters. Passing along by the graveyard to the main roads, the light railway is to be laid along the west side of the road to a point opposite the Travellers' Rest public-house, thence along the road to its junction with Stockton-road, and afterwards to Foggy Furze, terminating by a junction with the electric tram system at their termination. The full length of the route is over 7½ miles, and the depôt and power station is to be situated at Cowpen Bewley. The lines will be constructed with a gauge of 3ft. 6in., and electric power independent of the light railway or tramcar system. Representatives of the Council have given their opinion that the Corporation should construct the transporter bridge, and at a reasonable figure give the company running powers over the bridge. It is likely, however, that the scheme will meet with opposition from the N.E.R. and the Middlesbrough Corporation.

London County Council.—At the usual weekly meeting on Tuesday last Mr. Allen Baker, M.P., chairman of the Highways Committee, said that the projected tramway from Holborn to Hampstead, through King's Cross, was in the third section of the northern tramways, and would be proceeded with probably within a year or two of the completion of the first 22½ miles. It was hoped that the Dulwich line would be proceeded with as soon as the generating station at Greenwich was ready. The special report on the electrification of the northern tramways would be presented at the meeting next week. The Highways Committee recommend that the estimate of £1,200 in respect of the provision of 500 additional ticket-punches for use on the Council's trams be approved, and that the punches be made by the staff of the tramways department. The Highways Committee, as to through tramways from Aldwych to the Angel at Islington, resolved: "That the supplemental estimate of expenditure on capital account of £7,000 be approved, in addition to the amount of £33,000 included in the estimate approved on Aug. 1, for the purchase of electric cars for use on the through tramways route between the Strand and the Angel, Islington. That expenditure on capital account not exceeding £27,761 be sanctioned in connection with the supply of 34 single-deck steel electric cars required for use on, or in connection with, the through tramways route between the Strand and the Angel, Islington. That, subject to the result of the usual inquiries proving satisfactory, the tender, amounting to £14,280 of the Brush Electrical Engineering Co. for the supply and delivery of 34 single-deck steel tramcar bodies be accepted. That, subject to the result of the usual inquiries proving satisfactory, the offer of the British Westinghouse Electric and Manufacturing Co. to undertake the supply and delivery of 34 tramcar trucks and electrical equipments, and the assembly of the cars for the sum of £13,184 be accepted." The Council confirmed the committee's resolutions without discussion.

Croydon.—The obstacles which have stood in the way of an amicable settlement of the tramways question now seems to be disappearing by the submission of the differences between the Corporation and the British Electric Traction Co. to arbitration, and by the report which was presented by the Tramways Committee at the last meeting of the Council. The committee are advised and recommend the Council to resolve and determine that notice be given to the company terminating the leases of Jan. 23, 1900, and March 2, 1903; that the corporate seal be affixed to the lease to the British Electric Traction Co. of tramway No. 20, authorised by the Croydon and District Electric Tramways Act, 1902, in accordance with the said Act and the award of the arbitrator; and that six months' notice to determine the proposed lease of tramway No. 20 aforesaid, such notice to expire at the same time as any notice given by the Corporation to determine the lease of Jan. 23, 1900, be given to the company in accordance with Section 35, Sub-Section 14, of the Croydon and District Electric Tramways Act, 1902. The committee recommend that the extension of the tramway from Thornton Heath terminus to the Gloucester, authorised by the Croydon Corporation Act, 1905, be constructed as a double line throughout. The borough road surveyor and the borough electrical engineer reported with reference to the condition of the tramway track and electrical equipment, giving details of repairs and renewals required, at an estimated cost of £2,106. 16s. 11d., that the track paving is in good condition throughout. The lessees have not yet, however, attended to the corrugated rails mentioned in the former reports. The committee have been in communication with the local manager as to the wearing down in places of the rail lip or check to below the running tread, on an average from ¼in. to ⅜in., and also as to several necessary renewals. The overhead equipment appears to be in good condition. The feeder section and Quin pillars have been examined and found satisfactory, and the Quin switches were tested and found in working order. The state of these boxes is much better than it was 12 months ago. A general examination of the cars was made and a detailed examination of the equipment of certain of the cars taken haphazard. The motor bearings, gearing, lifeguards were found in good order. Certain controllers were selected and examined, and these were also found in good condition. Electrical tests were carried out on some of the motors, and these were also found satisfactory. Trial trips were made on two bogie cars and the brakes tested, and found to be in order. The whole of the above part of the equipment, etc., of the tramways are maintained in a satisfactory condition, with the exception of certain bonds which show a leakage of current. The report was adopted by the Council. An order has been received from the Board of Trade sanctioning the borrowing of the following sums for the construction and equipment of tramway No. 20, authorised by the Croydon and District Electric Tramways Act, 1902: £4 302 in respect of the permanent way, to be repaid in 30 years from date of borrowing; and £1,798 in respect of the electrical equipment, to be repaid in 20 years from date of borrowing.

LIGHTING AND GENERAL.

Falkirk.—A new agreement with consumers has been prepared in consequence of the change of the price of current.

Carnarvon.—An inquiry has been held into an application for powers to borrow £1,000 for electric lighting purposes.

Leek.—Combined shops and houses having at least six 8 c.p. lamps fixed in the house are to be allowed an alternative flat rate.

Quillota (Chili).—The General Industrial Electricity Committee have obtained sanction to supply the town with electricity.

Salford.—Power consumers will from Jan. 1 be charged for current for lighting purposes at the power rate up to 15 per cent. of their power consumption.

Brussels.—During Sunday's storm the new municipal electricity works, which were approaching completion, sustained damage to the extent of £12,000.

Swansea.—The extensions for electricity supply to Morriston and Sketty are so far completed that the houses already wired may be supplied by Christmas.

Llanelly.—The electric lighting agreement with Mr. Howell was further discussed at the last Urban District Council meeting, but no decision was arrived at.

Holyhead.—An inquiry has been held into an application for sanction to borrow £3 000 for electricity extensions, £1,720 of which amount is for new work.

Valparaiso (Chili).—The Valparaiso Electric Lighting and Tramways Co. have obtained permission to make the necessary installations for lighting the streets in Valparaiso for the next 10 years.

Leeds.—The Yorkshire Electric Power Co. are about to lay down an electric installation at Horsforth, and throughout the West Riding are developing the system of electricity for manufacturing and public purposes.

Northampton.—Notices from the electric light and power company of their intention to extend electric light mains in Henry-street, Shakespeare-road, and Grey Friars-street have been received by the Town Council.

Maryport.—The Urban District Council have appointed a committee to consider the applications to Parliament for the supply of electric light and power by the British Electrical Engineering Co. and the Cumbrian Electric Power and Gas Co.

Mexico.—An application has been made by Señor Félix Araiza for an appropriation of 2 000 litres per second for the production of motive power from the waters of the River Bolaños, situated between the State of Jalisco and the Territory of Tepic.

Dunstable.—The Town Council have decided to appoint a committee in regard to the application of the Provincial Electric Light Corporation for a provisional order to empower them to supply electric current for light and power within the borough.

Rochdale.—The Corporation's high-tension supply will shortly be in working order. The cables for this would pass near the workhouse, and the Guardians have asked for a quotation with the view of considering the question of taking a supply of electricity from the Corporation.

Sheffield.—The electric supply department have decided upon a reduction in the price of electrical energy for heating and cooking to 1d. per unit from the commencement of the New Year. This is about the cost per hour of the four-light luminous electric radiator they supply.

Dover.—Messrs. Pearsons, the contractors, are being pressed by the Admiralty to complete the harbour works by next October. They

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consequently require additional supplies of electric power from the Corporation works. A committee has been appointed to deal with the matter.

Worcester.—The City Council have approved the expenditure of £225 in carrying out work in the electricity transformer chambers in the city to meet the demands of the factory inspector. The appointment of Mr. B. Smith as temporary junior assistant at 10s. per week has been approved.

Burslem.—The electric light installation at Chell workhouse is now in full working order. The whole of the work has been designed by and carried out under the superintendence of Mr. Ashton Bremner, the borough electrical engineer of Burslem, who has acted as consulting engineer to the Guardians.

West Ham.—Last Tuesday the Council received a report by the town clerk on electricity supply in London, in which he said that if the London County Council proceed with their suggested Bill it might be advantageous for West Ham to support the same in preference to joining the other borough councils.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Bombay Electric Supply and Tramways Co.'s 60,000 6 per cent. cumulative preference shares of £10 each, Nos. 1 to 60,000, and £600,000 4½ per cent. debenture stock.

Stirling.—Mr. Hanson's last report shows that during the four weeks ending Oct. 28, 28,368 units of electricity have been generated at the power station, as compared with 23,914 for the corresponding period of last year. The total connections in equivalent 8-c.p. lamps up to date was 18,291, as against 16 273 at the same period last year.

Brighton.—An inquiry will be held by Mr. H. Ross Hooper, C.E., on Dec. 12 into the application of the Town Council for power to borrow £38,500 for purposes of electric lighting, and £5 909 for the purpose of acquiring the site of the Star Foundry in Bread-street and the erection thereon of buildings in connection with the electric light undertaking.

A New Telegraph Line.—The *Globe* St. Petersburg correspondent says that direct telegraphic communication has been established between Ashabad and Meshed in North-East Persia. Meshed is of great importance, not only by reason of its trade, but also as being the Mecca of Persia. It is the capital of Khorassan, and is 201 miles north-west of Herat.

Norton (Malton).—The Northern Counties Electricity Supply Co. have obtained permission to lay a cable from the railway through the Council's premises to Commercial-street, subject to the company entering into a written agreement to remove same on being notified and paying 5s., such notice, however, not to be given until the expiration of 10 years from the date of the agreement.

New Zealand.—The Wellington city engineer is having plans prepared for the new rubbish destructor to replace the now obsolete one at Clyde Quay. The ratepayers lately sanctioned a loan of £20,000 for this purpose, and Mr. Norton is of opinion that very considerable energy can be generated by the heat, even an electric plant on a small scale.—*N. Z. Mining, Engineering, and Building Journal.*

Mansfield.—The electrical engineer in his last report gives the following figures: units passed out of works, month ended Oct. 31 1905, 24,972, an increase of 8,873 units on the previous year; traction units generated during the month, 17,334; number of applications to date, 247; new connections during the month with an equivalent of 449 8-c.p. lamps, 15. Feeder mains are about to be laid to Mansfield Woodhouse.

Westminster.—The Council have received a letter from the Westminster Electric Supply Corporation stating that they have decided to reduce the charge for current for purposes other than lighting—*i.e.*, for power, heating, and cooking—to 1d. per unit net as from Jan. 1 next. The charge for electric current for power purposes recently concluded with this and the other electric supply companies at present supplying premises belonging to the Council is 2d. per unit.

Johannesburg.—We are informed that Messrs. Newtons Limited, of Taunton, are this week shipping to the Jubilee Gold Mining Co., Johannesburg, a large generator and two motors of their well-known "Mawdsley" type, together with main switchboard and two controlling panels, and that this is the third repeat order they have received from that firm during the last few years, proving conclusively the suitability of their machines for mining purposes generally in South Africa.

Erith.—The Urban District Council having had some trouble with their rotary converters, and as they are required to take the tramway load during mealtimes, it has been agreed that the resident electrical engineer obtain estimates from not less than four electrical firms, alternatively, for one 200-kw. and for one 250 kw. rotary converter complete, with transformers and switchgear. Extension of mains, transformers, etc., are to be provided in connection with a supply to the works of Messrs. Vickers, Sons and Maxim.

Croydon.—The committee have decided to supply electricity on special terms to basements having no natural light for the purposes of power, heating, and lighting at a flat rate of 2½d. per unit. The borough electrical engineer in his last report says, with regard to work for unemployed that he is at the present time unable to find extra work for men inside the electricity works. In the outside department a considerable number of men are employed for cable-laying when the weather permits, and this work will extend more or less through the winter.

Henfield.—The National Telephone Co. have opened a local exchange at Henfield. The National Co. now embraces several areas not touched by the competing Brighton municipal system, Henfield, Keymer, Ditchling, and Rottingdean being exclusively served by the company. It is reported that in the Brighton area the National system has been making extraordinarily rapid progress. On Sept. 7 last the company had 3,681 stations in the Brighton area, compared with 1,973 Corporation stations. On Nov. 23 the Corporation had increased to 3,009 stations and the National to 3 902.

Heylake and West Kirby.—The last report of the Electric Supply Committee shows that during October 40,236 units were generated and 30,162 consumed, the total consumers numbered 692, and the estimated revenue was £567, while the estimated expenditure was £462, the net profit for the month being £105. The net loss since March was £526, as compared with a corresponding loss last year of £745. This profit of £105 compares with a net profit in October last year of £20, a gain of £85. The West Kirby station is progressing favourably, and the arc lamps will probably be completed early in December.

Barnstaple.—At their last meeting the Town Council discussed a recommendation of the Electric Light Committee that from Jan. 1 all private consumers other than the Town Council be allowed a discount on the year's account of 5 per cent. on amounts between £2 and £5; above £5 and not exceeding £10, 7½ per cent. discount; above £10 and up to £50, 10 per cent. discount; and above £50 12½ per cent. discount. On a vote the principle of allowing discounts was adopted, and the matter then deferred to the end of the year. The Ilfracombe Electric Lighting and Power Co.'s application to be supplied with current for all purposes at power rate for a branch they intend opening in Barnstaple was not entertained.

Hampstead.—The total income of the electric lighting undertaking of £23 189 includes £1 895 received from consumers transferred from the North-West London Electric Supply Co., whose business was recently purchased by the Council. The Council have decided to continue the tenancy of the land upon which the North-West London Electric Supply workshop and buildings purchased from the company stand. The Midland Railway Co. have increased the rent from £76 to £200 per annum. Certain parts of the premises, however, are let by the Council for £225 per annum, and the Council have still offices with rooms over and a workshop which can be used for the purposes of the electric lighting undertaking.

London Gazette.—The partnership between G. F. Frizell and E. C. Louis, carrying on business as electricians at 79, Denmark hill, Camberwell, has been dissolved by mutual consent. A receiving order has been made out on creditors' petition in the estate of W. G. Leather, electrical engineer, trading as the Windus Electric Co. at 25, Howard-street, Sheffield. The last day for receiving proofs in the estate of Messrs. Holmes and McCallum, electrical engineers, Crown Works, Darwen, is Dec. 13. Gerald Algar, electrical engineer, and trading as G. Leslie at 5, Denning-road, Hampstead, London, has made application for debtor's discharge. Luke Jesson Sharp, 191, Corporation-street, Birmingham, has been released from trusteeship in the estate of James Marsden, electric fittings manufacturer, Woodcock-street, Birmingham.

York.—The last report of the Electricity Committee contains the following return for the month of October last: Units generated—public lamps, 17,765; power and private lighting, 80,991; used at works, offices, and battery, 13,455; used by private arc lamps, 2 349; unaccounted for, 7,874—total, 122,344. Estimated income—public lighting, £99; power and private lighting, £916; motor and radiator rents, etc., £39—total, £1,054. Total income per unit sold, 2·56d.; horse-power of motors connected during month, 7; total horse-power of motors connected to date, 742; 8-c.p. lamps connected during month, 495; total 8-c.p. lamps connected to date, 48,817; equivalent 8-c.p. connected—total, 67,367. The total cost was £502, and cost per unit 1·22d. The total cost for the corresponding month last year was £473, and cost per unit 1·28d.

Barnsley.—An inquiry has been held into an application of the Town Council for sanction to borrow £3,000 for purposes of electric lighting. Mr. E. A. Barker, borough electrical engineer, said the works were opened on Feb. 17, 1900, and at the end of the financial year (March, 1901) the receipts were £2.250, and the expenditure £2,242, leaving a credit balance of £8. In the following year (1902) there was a debit balance of £97. receipts being £2 491, and expenditure £2,589. The income in 1903 was £3 338, and the expenditure £3 244, showing a profit of £93. In 1904 the income was £8 348, and the expenditure £7 376, the credit balance being £972. Receipts in 1905 totalled £9,675, and expenditure £7,832, the profit being £1,842. The loan was for the making of services, meters, and mains, the approximate cost of each being: services, £1,100; meters, £850; and mains, £1,050.

Brighton Telephones.—Competition being the theme of a discussion at the last Council meeting, Councillor Lintott said that subsequent to the Local Government Board inquiry about six months ago they received about 80 notices to discontinue. Of these, probably about 50 per cent. were the outcome of the influence of the company's canvassers. The committee, however, ascertained from the subscribers that these were provisional notices, with a request to be waited on a few days before expiry. In fact, quite 60 per cent. had withdrawn their notices, and although the Corporation had received 80 notices to discontinue they had added 195 new lines or instruments. To-day there were 2.009 lines or instruments connected, a number, he believed which had never yet been reached by the system; so no one could truthfully say the department was in any way going back. Considering the present state of uncertainty with regard to municipal telephones all over the country, the committee felt it was their duty to give their subscribers public assurance that it would be their endeavour to see that none were permitted to suffer through their loyalty to the Corporation system.

Leith.—The National Telephone Co. have just opened a new telephone exchange on the "central battery" system. A compact power plant, consisting of a duplicate set of motor-generators and a storage battery of 11 large cells, now takes the place of the magneto-generators and small primary batteries formerly attached to the subscribers'

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instruments. The storage battery, periodically charged by the motor-generator, supplies current for operating the system, while a separate motor-generator is utilised for ringing and testing purposes. The switchboard is at present equipped for 1,000 direct exchange lines, and has an ultimate capacity of 3,000; there are nearly 100 junction lines, and the service is under the control of 12 operators. It is interesting to note that at the present time there are 650 direct exchange lines and 130 private lines passing through the test-room. Over 1,000 instruments are working, and it is computed that about 30 000 messages pass through the exchange each day. For some time the National Telephone Co. has been occupied in converting its huge London system to the central battery method of working, and it has also constructed new exchanges of the same character in several of its provincial centres. The conversion of the Edinburgh system, where the switchboard is already equipped with lamp signals, but not with the full automatic working, will shortly follow, and it is the policy of the company to eventually convert all its large systems to the central battery working.

Preston Dust Destructor.—At the Sheffield congress of the Association of Cleansing Superintendents, Mr. Thomas Lloyd, cleansing superintendent to the Corporation of Preston, read a paper on cremation and utilisation of the town's refuse. The latest installation consists of four four-grate Meldrum patent Simplex regenerative destructor furnaces, each unit having a total grate area of 100 square feet, the plant being so arranged that any pair of units can work together. The economisers are of Messrs. E. Green and Sons' make, and contain 288 pipes, arranged in three groups, eight pipes wide. After describing the installation in detail, Mr. Lloyd said that steam was supplied by the destructor for the horizontal cross-compound engines, each with a maximum of 470 h.p., which supply the means for generating electricity, and supplying the tramway department with sufficient steam to generate 20 000 units per week on an average. The total number of units generated from Dec. 29, 1904, to June 21, 1905, was 487,644, sufficient to run the tramways over 10 miles of streets with a length of track of 16 miles for that period. During this time the cars have covered a distance of 354 046 miles. The destructor is shortly to supply the power to generate the electricity for lighting the car-shed and workshops at the car station; also for the destructor buildings, stables, storeyard, and workshops connected therewith, besides supplying steam for a large Defries disinfector, thus creating a considerable saving to the ratepayers.

Hammersmith.—The premises of 28 additional consumers, representing a maximum of 972 8-c.p. lamps, have been connected to the mains, and seven consumers have been disconnected. The present number of consumers taking current from the mains is 1,756. The Council will not join the Notting Hill Electric Lighting Co. in their Bill, which is being prepared under the instructions of the joint Boards of the Kensington and Knightsbridge Electric Lighting Co. and the Notting Hill Electric Lighting Co. The main object of the proposed Bill would be an association of the existing companies and local authorities now holding statutory powers under the Electric Lighting Acts in West London, including Hampstead, St. Pancras, Hammersmith, and Fulham and the Bill would authorise the associated companies and local authorities to interchange bulk supply, and to supply energy within the area of each of the associated companies and local authorities, but only with the assent of the company or local authority in possession of the area in question. A letter has been received from the Incorporated Municipal Electrical Association suggesting that an endeavour should be made to induce the Local Government Board to allow the expenses of delegates attending the conferences of the association, in the same way as are expenses of delegates to meetings of the Urban District Councils' Association. We understand that no action will be taken in the matter. A second crane is to be purchased for the works at a cost of £49.

Birmingham.—The Electric Supply Committee, in their report to the City Council, recommend the adoption of a reduced scale of charges, as follows: Lighting supply—for first 300 units per quarter, proposed new charges, 5d. per unit (present charges, 6d.); for any further quantity in same quarter, 3½d. (4d.). Day lighting supply—for first 300 units per quarter, 3d. (3d.); for any further quantity in same quarter, 2d. (2d.). Power supply—for first 300 units per quarter, 2d. (3d.); for any further quantity in same quarter up to 3,000 units, 1½d (2d.); where 3 000 units or over per quarter are used, after first 300 units, 1¼d. (1½d.). These charges are subject to 5 per cent. discount for prompt payment. On last year's figures, which showed a net profit of £10,789, these reduced charges would have decreased the receipts by about £9,750. The Council state that, having regard to the large payments for interest and sinking fund that will have to be met on increased capital expenditure now being incurred by the department, which expenditure cannot be expected to be remunerative for the next two or three years, there is no doubt that the revenue during this period will not be sufficient to fully meet the increased charges. It will be necessary, therefore, to draw upon the reserve fund, which has been accumulated to meet such an eventuality. This fund now stands at £49,393. 19s. 2d., and will be more than sufficient to meet any deficiency that is likely to arise on this account. The reduced charges, if approved, will take effect in the quarter commencing Jan. 1, 1906.

London County Council.—On Tuesday it was agreed to lend the Battersea Borough Council £10,891 for electric light installation, and the Southwark Borough Council £5,942 for electric lighting purposes. The Highways Committee recommended that the agreement with the London Electric Supply Corporation for the temporary use by the Council of the company's premises at Deptford, and for the supply of steam from the company's boilers for working the Council's plant installed there, be cancelled, and that an amended agreement be entered into with the London Electric Supply Corporation for the supply to the Council, for a period of three years, of electric power to the Greenwich electricity generating station, where it will be measured, with a minimum of 1,500,000 units a year, at a price for the first 2,000,000 units of 1d. per unit, and for any quantity beyond that amount of ·75d. per unit, and that the agreement be subject to the company holding sufficient plant at the disposal of the Council to allow of a maximum demand of 1,500 kw., and purchasing the plant installed by the Council at the Deptford station for the sum of £13,000. Notices under Electric Lighting Acts and Orders were agreed to as follows: from the Brompton and Kensington Electricity Supply Co., high and low tension mains along Courtfield-gardens; Charing Cross, West-end, and Electricity Supply Co., mains along and across a portion of Chancery-lane; County of London Electric Supply Co., high and low tension mains along New North-street and mains along Hotham-road; London Electric Supply Corporation, low-tension mains along a portion of the Strand and high and low tension mains in Evelyn-street, New King-street, and Prince-street; Metropolitan Electric Supply Co., low-tension mains along a portion of Sandland-street; Notting Hill Electric Lighting Co, mains along a portion of and across Boundary-road and across Latimer-road; South Metropolitan Electric Light and Power Co., low-tension mains along a portion of Hyde-vale and construct two transformer boxes at the junction of Wemyss-road and Montpelier-vale.

Torquay.—Proposals from the National Electric Construction Co., the contractors for the tramways, for leasing or purchasing the existing electrical undertaking of the Corporation have been referred to the Electric Lighting Committee. The Local Government Board have informed the Council, in reference to the recent inquiry into the application for sanction to borrow £9,500 for the extension of the electric lighting and power station, that they would sanction the borrowing of £8,099, and they had deducted the following sums: cost of taking down and removing 125 kw. alternator, £10; outstanding debt on such alternator, £1,356; cost of removal of 40-kw. alternator, £55—total, £1,401. As regarded the first and third deductions, the Board did not regard these items as suitable subjects for a loan. The deduction of the second item was made in accordance with the Board's usual practice in cases where works on which debt was outstanding were to be superseded. They raised no objection to the application of any sum received from the sale of the 125-kw. alternator in defraying the cost of the new plant. At the same time the Board pointed out the desirability of postponing for the present any extension of the system of public lighting by electricity. They gathered that this system was unremunerative, and, having in view the financial advantage of utilising the present generating station as long as possible, it was clearly inadvisable to increase the existing load for any unprofitable purpose. Moreover, the Board considered that, as the provision of a new generating station would, no doubt, ultimately be necessary, the Town Council should see that the undertaking was carried on with the greatest economy, and otherwise in such a manner that a substantial reserve fund might be built up to meet the anticipated large expenditure. The town clerk added that the loan had to be repaid in 15 years. Mr. Mortimer, in moving that the Local Government Board's letter be referred to the Electric Lighting Committee, said no doubt a certain amount of gratification was felt that the loan had been granted. At the same time, he thought, with those who advocated the larger scheme, that this scheme, with certain modifications, was preferable to the present one. The motion was adopted.

Dumbarton.—The contractors for the electricity works are now at work. The agreements entered into by the Electric Supply Corporation and Messrs. Crompton and Co. provide not only for a supply of electricity for lighting and power purposes throughout the town, but also for a system of electric tramways. The contract for mains has been given to Messrs. Callender's Cable and Construction Co. The Electric Supply Corporation have purchased a large plot of ground near the railway, and comprising an area of 1¾ acres, and the plans for the generating station have been passed by the Dean of Guild Court. The buildings will consist of an engine-room, boiler-house, battery-room, pump-room, stores, and offices. Provision is made for future extensions, and designs for the car-sheds, which will occupy a portion of the site, are now being prepared. The electric generators will consist of two 200 kw. and one 50-kw. Crompton dynamos, each direct coupled to a Belliss engine. The engines will be compound high-speed fitted with forced lubrication and working with superheated steam at a pressure of 180lb. per square inch. The auxiliary machinery will consist of automatic balancers and boosters, together with the necessary switchgear. For the tramway service a special Crompton-Mackintosh booster will be provided in order to work the tramway storage battery to the best advantage. Two A.B.P. accumulator batteries will be provided, one for the tramways and the other for the general supply. Each battery will have a capacity of 420 ampere-hours. The boiler-house plant will consist of two Babcock and Wilcox land-type boilers, each capable of evaporating 6,000lb. of water per hour under normal conditions. Provision is being made in the boiler-house for thermal storage tanks, but these will not be supplied in the first instance. The boilers will be fitted with mechanical chain-grate stokers, and the feed water will be driven by electrically-driven pumps. The supply will be continuous current at 240 volts for lighting and small motors, and 480 volts for large motors, etc. Current for private lighting purposes will be supplied at 4½d. per unit. The detailed survey and drawings of the tramways work have been completed, and the contracts for the work will be placed in the course of the next few days. They will be on the overhead system, and cars, etc., will be on the Glasgow model. The tramways in the burgh are the beginning of a larger scheme for carrying a through route from Balloch to Clydebank, for which the Electric Supply Corporation intend to obtain parliamentary powers.

Leicester.—An interesting report on the Leicester gas and electric light undertakings, their history and remarkable progress, by Councillor E. Edwards (chairman of the Municipal Gas and Electric Light Committee), appeared in the *Leicester Daily Post*, in which the author deals with the latter undertaking as follows: "The Leicester Corporation Act of 1879 authorised the Town Council to apply £20,000 of

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gas capital during a period of five years, to be repaid within 10 years of borrowing, to the lighting by electricity of streets and places of public resort. No action was taken under this authority, and it was not until the year 1889 that the Leicester Town Council decided to apply for a provisional order to empower them to supply electricity under the Electric Lighting Public Act of 1882. The Electric Lighting Orders Confirmation Act of 1890 gave the necessary permission. The whole borough was described as the area of supply, with a 'limited area,' comprising the centre of the town, duly set out. In July, 1892, schemes and tenders were invited for the electric lighting of the 'limited area.' Twenty-five tenders were submitted to the Gas Committee, and the engineer and manager, Mr. Alfred Colson, M.I.C.E., was instructed to report upon them. He was unable to recommend any for adoption; but competitors were allowed to modify and improve their scheme upon lines placed before them. Two which most fully embodied the conditions with which he considered any selected scheme should comply were recommended to the committee. Of these, that of the Brush Electrical Co. was accepted. On April 25 the Town Council unanimously adopted the recommendation of the Gas Committee. The system decided upon was the high-tension alternating current, with street transformers and low-tension distribution, and with the central station placed on the Aylestone-road gasworks. Generating plant capable of producing 875 kw. was erected there. Current was first supplied to the town on Dec. 19, 1894. The undertaking developed, and its business steadily increased. The consequence was that in 1897, 1900, and 1904 application had to be made for further capital. In 1897 the induction type of alternator was adopted, with the most satisfactory results. The capacity of the central station has been increased until it is now equal to 4,400 kw. The price charged for current at first, 6d. per unit, was reduced in 1897 to 5d., and in 1899 4½., 2d. per unit being charged for power purposes. The length of cable laid is 85 miles, 36 of which are high-tension and 49 low tension. The total expenditure on capital account to June 30 last was £254,915. Care is taken to maintain the plant and cables thoroughly up to date. The sum of £40,900 has been paid in interest; £35,000 to sinking fund account, and the balance of net profit in hand at June last was £14 515. There are 2,537 consumers, with an installation equivalent to over 215,000 8-c.p. lamps. Many thought that street-lighting by electricity would be undertaken by the Corporation. But the Gas and Electric Lighting Committee have been strongly opposed to it, believing that incandescent gas is far superior both as regards efficiency and cost. The wisdom of the policy has been thoroughly justified, not only by the fact that the authorities of most Continental cities are now adopting the same policy, but by the circumstance that the city of London authorities have decided to substitute incandescent gas lighting in even those streets where electric lighting has been in use for a considerable number of years. When the electric light was first introduced some thought gas was doomed. Instead of this, electricity has been the best friend gas ever had, because it has been put upon its merits. It has thus improved its lighting capacity, has sought other spheres of usefulness, such as cooking, heating, and power. The result has been that wherever the electric light has been introduced, the consumption of gas has increased by leaps and bounds. The Leicester Town Council were wise in placing the development of both illuminants in the hands of one committee, thus preventing friction that might otherwise have arisen. The committee also are fortunate in having in their service an official who is not only in the front rank as a gas engineer, but also an exceedingly capable electric engineer. The great success of the combined undertaking has thus been due to one master mind that has directed the whole. It is my sincere hope that this happy combination will always continue."

Durban.—The report of Mr. John Roberts, the borough electrical engineer, for the municipal year ending July 31, 1905, states that, notwithstanding the commercial depression, which, as reflected in the business of the department, has been more severe than in any previous year since the commencement of the undertaking, last year's working showed satisfactory results. The following shows the extension which the business has undergone: number of private consumers of electric light—year ending July 31, 1905, 2 936 (year ending July 31, 1904, 2,441); number of private consumers of electric power, 171 (140); number of street arc lamps, 255 (230); number of street incandescent lamps, 1,240 (802); number of units sold, 4,419,651 (3,787 675); total revenue, £76,702 (£69,052). During the year the price was reduced by 10 per cent. in the form of discount for prompt payment, and this substantial discount has been the means of bringing the revenue in very promptly, and this is well illustrated by the fact that on July 31 last the amount of outstandings was £3,152, as compared with £4 735 at the end of the previous financial year. He strongly recommends that future reductions be made in the form of increased discounts, and that the figure of 8d. per unit be kept as a standard on which all future reductions should be made. This course is rendered advisable, if not absolutely necessary, by the fact that as the number of connections increases, and as the electric light extends into the residences of the poorer classes, the average account will continue to decrease, and the work of collection of the large number of small accounts every month will become so troublesome and expensive that, at the low price at which it is hoped to supply current, every means must be taken to induce customers to pay promptly, and reduce the labour and expense of dealing with arrears, and reduce the loss from bad debts. The power business has suffered most from the depression in industrial undertakings, and the revenue from this source has actually decreased, although the department has made a gain owing to the demands which have been made by other departments, chiefly the water department. So successful have been the results of the application of electric motors to the work of sewerage and water pumping that the borough engineer is shortly to convert the existing steam pumping plant at Florida-road reservoir to electricity, and it is expected that greater efficiency and economy will result. The greatest increase in street-lighting has taken place on the Berea and other residential parts, and there are now few thoroughfares of any importance which are not illuminated. The work is still going on, however, and during the present year Mr. Roberts hopes that most of the remaining oil lamps will be superseded, and that it will be possible to reduce the charge for these incandescent lamps from £3 per annum each to £2. 10s. The net profit account shows profits as follows: street-lighting, £244; motive power supply, £794; private lighting, £13,335—making a gross total of £14,374; subtracting a loss on tramway current supply, £622—total profit, £13 752. The following table gives a comparison of the cost per unit generated in the power station for the years 1903 4 and 1904-5: units generated year ending July 31, 1905, 5 157,135 (year ending July 31, 1904, 4,348 914); coal £15 491, ·72d. (£14,151, ·77d.); oil and waste, £773, ·04d. (£762 ·04d.); water, £670, ·03d. (£750, ·04d.); wages, £4,548, ·21d. (£5,055, ·28d.); repairs, £2,201, ·10d. (£2,318, ·13d.)—totals, £23,683, 1·10d. (£23,036, 1·26d.). Mr. Roberts promises still further reductions in the cost of production, and says: "A large expenditure may be necessary to effect the economies I look forward to. These economies lie chiefly in the direction of saving coal. The expenditure account shows that this item amounts to nearly half the total cost of production, and the labour in handling over 42 tons per day cost almost exactly £1,000 per annum. I am now carefully experimenting on mechanical stokers, and the results so far obtained seem to show that it will be profitable to add them to all the boilers as soon as possible, and to put in a conveyor to automatically carry the coal to these machines. I hope, therefore, to ask your permission to purchase this plant and instal it without delay. The following is a list of the amounts spent under the various chief items of capital expenditure: power station, wages £1 639, material £ 0 453—total, £12,093; underground mains, £679, £3,646—£4 325; overhead mains, £830, £2 681—£3,511; sub stations £480, £956—£1,176; house services (chiefly meters), £1,196, £1,874—£3 070; street-lighting, £345, £803—£1,148; sundries, £116, £258—£374; totals, £5,026, £20,671, £25,697. The principal works involving the above sums are enumerated and described as follows: The power station—the purchasing and fixing of a large battery from the Tudor Battery Export Syndicate absorbed approximately £4,000 of the amount under power-station construction. This battery was erected very expeditiously, and has so far given very good results; and by its use great economy in coal is expected to be obtained. A large item of £2,166 was paid to Messrs. Dick, Kerr, and Co. as a final payment on their contract with us, which has extended over three years, and was paid for machinery actually supplied during the previous year. A proportion of the payment on two large boilers and two chain-grate stokers is also included. The remainder has been spent on completion of building, fixing of new economiser, improvements in the boiler-room, improvements on the switchboard, etc., which have been made with a view to increase economy of operation. Underground mains—The following list shows the number of miles of mains laid during the year, and also the total to date: cable for motive power, total miles on July 31, 1904, 11·372, miles added during year ·420; cable for tramways, 17·223, ·002; street arc lighting, 15·000, ·030; high-tension cable for private lighting, 41·292, 1·358; low-tension cable for private lighting, 24·007, 1·698—total, 1904, 108·894, total added 3·488. Total miles on July 31, 1905, 112 382.

PROVISIONAL PATENTS, 1905.

Nov. 20.

23863. An advertising device for electrical station indicators. Josef Esser, 51, Hohenzollernring, Cologne s/Rh., Germany. (Complete specification.)

23878. Locking device and electric coupling for arc lamps and the like. Johann H. Bastians, Crest, Kenley, Surrey. (Date applied for under Patents Act, 1901, Jan. 6, 1905, being date of application in Germany.) (Complete specification.)

23889. Improvements relating to automatically cutting off the current from electrically heated furnaces, stoves, or other apparatus at any desired temperature. Henry Edward Newton, 6, Bream's buildings, Chancery-lane, London. (Klewe und Co. G. m. b. H., Germany.

23894. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, and John Malcolm Wallace, 83, Cannon-street, London.

23904. Improvements in connection with monophase electric motors. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Nov. 21, 1904, being date of application in Germany.) (Complete specification.)

23934. Improvements in or relating to electrical distribution systems. Alfred Julius Boult, 111, Hatton-garden, London. (J. Lester Woodbridge, United States.) (Complete specification.)

Nov. 21.

23976. Improvements relating to combined electric motors and air compressors. The Phœnix Dynamo Manufacturing Company, Limited, and Robert Pohl, 322, High Holborn, London.

23997. Improvements in electric telegraphs. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

24024. Improvements in means for controlling self-exciting generators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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24025. Improvements in and relating to vapour electric apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 22.

24058. Improvements in elastic suspension devices for the electric motors of tramcar and like trucks. Montague Brown Mountain, Godfrey Maesien Gibson, and Arthur Falkland Howard Head, 55, Market-street, Manchester.

24061. Improvements in electric arc lamps. Henry Bevis and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

24106. Improvements in operating rotating apparatus by means of single-phase commutator electric motors supplied for polyphase circuits. Rudolf Braun, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London.

24139. Improvements in magneto or dynamo-electric machines. Henri Guillon, 40, Chancery-lane, London.

24141. Improvements in dynamo-electric machines. The Hon. Charles Algernon Parsons and Alexander Henry Law, 18, Southampton-buildings, Chancery-lane, London.

Nov. 23.

24158. A prepayment mechanism and switch in connection with the prepaying of rentals or instalments for hire purchase, in respect of apparatus or wiring in connection with installations of electric light, heat, or power. Francis Henry Merritt, Acristo, Wells-street, Ryde.

24162. Improvement in obstruction removers applicable to electric tramcars or the like. John Richard Hudson, 17, Haymarket, Sheffield.

24178. Improvements in ships' telegraphs and like instruments. James Eggleshaw, 65, Chancery-lane, London.

24183. Improved controller finger contact for electrical work. Francis Ernest Imeson, 8, Wilson-street, Thornaby-on-Tees, York.

24184. An automatic life-guard or cut-out for overhead wires. James E. Newton, 42, Raphael-street, Halliwell, Bolton.

24187. Improvements in apparatus for the control of electro-magnetic power hammers, drop stamps, presses, and the like. Thomas Henry Large, 154, St. Vincent-street, Glasgow. (Complete specification).

24189. An improved means and apparatus therefor for preventing the hoisting rope or wire from damaging the electric cables in an arc lamp column or the like. Ernest Charles Lea, 18, Fulham-place, Paddington, London.

24197. Improvements in or connected with the control of electric motors used in connection with secondary or storage batteries. Willis Nelson Stewart, Alderman's House, Alderman's-walk, Bishopsgate-street, London.

24200. Improvements in devices for electrically lighting inverted gas-burners. Paul Benard, 65, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 26, 1904, being date of application in France.) (Complete specification.)

24213. Improvements in make and break apparatus suitable for induction coils. Frederick George Loring, 24, Southampton-buildings, Chancery-lane, London.

24235. Improvements in electric motor-controlling devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24236. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24240. An improved bracket for supporting electric lights and the like. John Dingle Adams, 28, New Bridge-street London.

Nov. 24.

24249. Improvements in and relating to electrical contact breakers of explosion engines of motor vehicles. Walter Joseph Charles and Alfred Watson, 11, Burlington-chambers, New-street, Birmingham.

24268. Improvements in the section and form of conduit in the method of laying it in connection with tramway rails and placing within it an electric conductor and in the manner of applying a brush or pulley from a car to the said electric conductor. Henry James Peddle, 14, Fountainhall-road, Edinburgh.

24280. Improvements in electric interlocking of railway signals with block telegraph instruments. William Robert Sykes, jun., Frederick Thomas Hollins, and Frederick William Leake, 96, Fillebrook-road, Leytonstone.

24281. Improvements in electrical block indicators for railway gate crossings. William Robert Sykes, jun., Frederick Thomas Hollins, and Frederick William Leake, 96, Fillebrook-road, Leytonstone.

24293. Improvements in contact-breaking devices for magneto-electric ignition apparatus. Willy Roos, 65, Chancery-lane, London. (Complete specification.)

24316. Improvements in electrical generators or motors. Samuel Jevons, 77, Colmore-row, Birmingham.

24302. Improvements in mechanism for automatically actuating electric switches or contacts or apparatus for regulating the supply of electricity at different rates or for similar purposes. John Meany Tourtel, 146A, Queen Victoria-street, London.

24303. Improvements in switch-releasing mechanism for coin-freed electricity meters. John Meany Tourtel, 146A, Queen Victoria-street, London.

24323. An improved mechanical and electrical register counting entries through turnstiles and the like and recording them at a distance. Alfred Laurence Penniket, 39, Holford-square, London.

24325. Improvements in or relating to electric conductors. Alfred Julius Boult, 111, Hatton-garden, London. (Harry E. Knight, United States.)

24339. Improvements in junction boxes and similar apparatus for the connection of electric cables or the like. Arthur Trevor Dawson and Albert Periam Pyne, 7, Southampton-buildings, Chancery-lane, London.

Nov. 25.

24383. Improvements in electric switches. John Arthur Hirst and Percy Smith Brook, Northgate Electrical Works, Victoria-road, Chester.

24403. Improvements in apparatus for controlling electric circuits. The British Westinghouse Electric and Manufacturing Company, Limited, The Westinghouse Patent Bureau, Westinghouse-building, Norfolk-street, Strand, London. (The Westinghouse Electric and Manufacturing Company, United States.)

24421. Improvements in dynamo-electric machines. Ludwig Torda, 40, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 14.

1904.

22443. Combined telephone and sounding telegraph. Andersson.

25026. Electric switch-operating mechanism. British Thomson-Houston Company, Limited. (General Electric Company.)

25027. Electric switch-operating mechanism. British Thomson-Houston Company, Limited. (General Electric Company.)

25370. Method of utilising the live wires of an electric lighting and like circuit to convey signals by the aid of electric waves. Lee and Bottone.

25519. Electric incandescent candle lamps. Dafforn.

25645. Space telegraphy. Stone. (Date applied for under International Convention, Nov. 25, 1903.)

25682. Arc lighting lamps. Andersson. (Date applied for under International Convention, Nov. 30, 1903.)

25784. Means for regulating electric circuits. Leitner and Lucas.

26169. Fusible electric cut-outs. British Thomson-Houston Company, Limited. (General Electric Company.)

27869. Construction of lock and electrical contact maker and breaker for lifts. Burnett and Richmond.

28546 Protected or armour-clad electric switch fuses. Berry.

28840. Self-acting electric motor-starting rheostat. Hirst and Brook.

29607. Liquid resistances for controlling the current in electromotors and the like. Bruce Peebles and Co. Limited, and Peebles.

1905.

3171. Electric motors and dynamo-electric machines. Vickers, Sons, and Maxim, Limited, and Williamson.

4166A. Improvements in induction coils. Bines. (Date applied for under Rule 5, Patents Rules, 1905, Feb. 28, 1905.)

4273. Apparatus for automatic electric advertising and like purposes. Fricker.

4715. Electric insulators. Cushing.

7591. Alternating-current dynamo-electric machines for synchronising and connecting them with distributing conductors. Johnson. (Voight und Haeffner, Akt.-Ges.)

8652. Plug boxes and the like for the connection of electric conductors to the main supply cables. Kirk and Corlett Electrical Engineering Company, Limited.

9344. Electric current motor. Kruyswijk. (Date applied for under International Convention, May 5, 1904.)

11441. Device for limiting the speed of compensated single-phase alternate-current motors. Elektrizitäts Akt.-Ges. vorm. W. Lahmeyer und Co. (Date applied for under International Convention, July 30, 1904.)

13327. Responders for wireless telegraphy. Hancock.

13570. Electric switches for coin-freed mechanisms, time switches, or the like. Siemens Bros. and Co., Limited. (Siemens Schuckertwerke G. m. b. H.)

13703. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

13953. Electrical recording devices. Harrison. (Electric Railway Improvement Company.)

14314. Microphone apparatus for telephone and other circuits. Majorana.

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14222. Suspension of electric motors of locomotives and other electrically-propelled vehicles. British Thomson-Houston Company, Limited. (General Electric Company.)

15055. Process for extracting metals from ores and other metalliferous material by electrolytic means and apparatus therefor. Garz und Co., Eisengiesserei und Maschinen-Fabriks Act.-Ges. (Date applied for under International Convention, Aug. 26, 1904.)

15836. Electric wiring. Yorke.

16024. Telephone office systems and methods of establishing connections therein. Lean. (Deutsche Telephonwerke R. Stock und Co. G. m. b. H.)

16357. Arc lamps. Blondel.

16397. Disengaging mechanism for the controlling devices of shunt circuit arc lamps. Efrém and Sidler.

17032. Electrically-operated fans. Thompson. (Firm Reiss und Klemm.)

17084. Electric train lighting systems. Siemens Schuckertwerke G. m. b. H. (Date applied for under International Convention, Aug. 25, 1904.)

17243. Electricity meters. Aron.

18401. Continuous-current dynamo-electric machines. Siemens Bros. and Co., Limited. (Siemens Schuckertwerke G. m. b. H.)

19116. Machine for electrically welding metal wires, cables, hoop-irons, and the like. Rolland.

20058. Method of winding revolving field magnets. Siemens Schuckertwerke G. m. b. H. (Date applied for under International Convention, Nov. 12, 1904.)

20100. Rontgen-ray tubes. "Polyphos" Elektrizitäts-Ges. m. b. H. (Date applied for under International Convention, Oct. 5, 1904.)

20898. Electrolytic apparatus. Rüber. (Date applied for under International Convention, Oct. 15, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price. £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	7/16-9/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	2-2⅜
—— 4 per cent. Mortgage Debenture Stock	100	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	⅛-¾
—— Non. Cum., 6 per cent. Pref.	2	1-2
—— 4½ per cent. 1st Debenture Stock	100	93-97
—— 4½ per cent. 2nd Debenture Stock	100	78-81
Callender's Cable, Debentures	100	109-111
—— Ordinary	5	11-12
—— 5 per cent. Pref.	5	5⅛-5¼
Crompton and Co.	3	1¼-2¼
—— 5 per cent. Debentures	100	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	1⅛-1⅜
—— "A" Shares, 01-017,139	5	2-2¼
—— 5 per cent. Debentures	100	92 97
—— 4 per cent. Deb. Stock, Red.	100	85-90
Electric Construction, Nos. 1 to 112,100	2	⅛-¾
—— 7 per cent. Cumulative Pref.	2	1⅛ ⅝
—— 4 per cent. Perp. 1st Mort Deb.	100	92-96
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	96-100
W. T. Henley's Telegraph Works, Ordinary	5	12½-13¼
—— 4½ per cent. Preference	5	5¼-5⅜
—— 4½ per cent. Debentures	100	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	16-17
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	10-10¼
Telegraph Construction and Maintenance	12	32-34
—— 5 per cent. Bonds	100	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10	12½-12⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	10½-10⅝
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	11½-12⅛
—— 4½ per cent. Debenture Stock, Red.	100	107-109
Bromley (Kent) Electric Light and Power Co.	5	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	9¼-9⅜
—— 7 per cent. Preference	5	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	9-9¼ xd
—— Nos. 60,001-80,000	5	9 9¼ xd
Cambridge Electric Supply Company, £10 Ord.	8	12½-13
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	104-107
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	6-7
—— 4½ per cent. Cum. Pref., 1-80,000	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	4⅜-5
—— ditto (1903) 40,001-80,000	5	4⅜-5
Chelsea Electricity Supply	5	5⅜-6¼
—— 4½ per cent. Debentures	100	110-112
City of London, Ordinary	10	11½-12¼
—— 6 per cent. Cumulative Pref.	10	13¼-14¼
—— 5 per cent. Debenture Stock	100	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	104-106
County of London Electric Supply, Ordinary	10	9¼-9⅞
—— 6 per cent. Cum. Pref.	10	12⅜-12⅞
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	112-115
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	102-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	5¼-5⅜
—— 6 per cent. Cum. Pref.	5	5⅞-6¼
—— 4½ per cent. First Mort. Deb.	100	108-110
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	2¼-3
—— 5 per cent. Debenture Stock, Red.	100	85-90
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	101-104
Havana Electricity, 1-15,000	10	9-10
Hove Electric Lighting, Ord., 1-13,000	5	8¼-8⅜
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	⅝-1
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	10¾-11⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10¼
London Electric, Ordinary	3	1⅜-2¼
—— 6 per cent. Pref.	5	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	99-102
Metropolitan Ordinary, 100,001-300,000	5	10-10¼
—— 4½ per cent. First Mortgage Debenture Stock	100	109-113
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	99-102
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	8-8¼
—— do., 57,001-75,000	5	8-9¼
—— 5 per cent. Pref., 1-57,000	5	6¼-6⅜
—— do., 57,001-75,000	5	6¼-6⅜
Notting Hill Electric Lighting	10	14-15
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,510	5	6⅜ 6⅝
—— 4 per cent. Debenture Stock	100	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5	2-2¼
—— 4 per cent. Debenture Stock	100	76-80
South London, Ordinary	5	3¼ 3⅜
South Metropolitan Electric Light and Power, Ord.	1	13/16- 15/16
—— 7 per cent. Cum. Pref.	1	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	105-108
—— Ditto, June, 1904	—	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	13 14
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	£8 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	4¼-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5¼
Westminster, Ordinary	5	12 12¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6¼
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	5¼-6¼
—— Ord.	5	8 9/16-8 13/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	142-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	105-107
Barcelona Tramways, Ord., 1-20,000	10	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	9-10
—— 5 per cent. Deb., Red., 1-600	100	98-101
—— 4½ per cent. Red Deb. Stock	100	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd.	100	96-98
British Columbia Electric Railway Co., Ord. Def.	100	124-127
—— Ord. Pref.	100	113-116
—— 5 per cent. Cum. Perpetual Pref. Stock	100	106-109
—— 4, per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11-11½
—— 5 per cent. Perpetual Debenture Stock	100	121-123
—— 4½ per cent. 2nd Deb. Stock	100	98-100
Buenos Ayres and Belgrano Trams.	5	3¼ 3⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	107-109
—— Prov. Cert., all paid	100	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	98-100
Calcutta Tramways, 1-102,268	5	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	107-108
Cape Electric Tramways, Nos. 1-480,000	1	¼-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¼-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	101-103
Cork Electric Tramway and Lighting Co., Ordinary	10	13¾-14¼
—— 6 per cent. Cum. Pref.	10	15-16
—— 4 per cent. Debentures	100	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13¾-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15¼
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100	94-97
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4, per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	2¼-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	83-88
Kidderminster and District Lighting and Traction, Pref.	5	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	10 10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	7/32-3/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-1¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10	12
—— 5 per cent. Cum. Pref.	10	9¼-9⅝
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	9¼-10
—— 4½ per cent. Debenture Stock	100	101-104 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,152 6 per cent. Preference	1	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	100 p.c.
Electric Railways.—		
Central London, Ordinary	100	93-96
—— 4 per cent. Pref.	100	101-103
—— " " deferred	100	85-88
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	110-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	105-108
—— 5 per cent. Pref. Stock '91	100	119-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	114-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	98-99
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99'-100¼
Waterloo and City, Ordinary	100	94-97

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	111-112
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1-1⅛
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 25	1,132	1,059	+ 73	- 1,453a	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 11	178	185	- 7	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 25	900	874	+ 26	- 758	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 25	372	312	+ 60	—	2	2	,, 31	17,133	4,709,738	265,525	·85	14·5	8,866	—
Blackburn Corporation	,, 22	867	707	+ 159	—	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	,, 2	340	350	- 10	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	,, 25	152	170	- 18	—	16½	16½	Dec. 3.	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 26	1,727	1 576	+ 151	—	40	38	March 31	95 766	20,235,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 22	1,121	742	+ 332	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 25	3 881	3,241	+ 639	+ 6,321	96	77	,, 31	230,085	47,108,000	5,053,392	1·172	10·927	2,396	—
Brighton Corporation	,, 28	719	669	+ 50	+ 432	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·3	8·014
Bristol Tramway Company	,, 24	4,310	4,354	- 14	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 25	1,034	512	+ 122	—	10 60	10·60	March 3	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 26	237	248	- 11	- 1,349	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 25	1,681	1,704	- 23	+ 109	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 25	151	161	- 10	- 613	8·5	8·5	Dec. 31	10,713	2,935,003	359,756	—	7·14	—	5·18
Central London Railway	,, 25	7,206	7,229	- 23	- 663	6	6	,, 31	347,588	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway.	,, 26	3,275	3,351	- 79	+ 203	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 23	383	331	+ 2	+ 631	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	Oct. 21	2·5	198	+ 7	—	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	Nov. 24	83	79	+ 4	- 264	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars Dublin S. District, Electric	,, 24	4,297	4,0 6	+ 271	- 898	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dundee City Tramways	,, 22	869	788	+ 91	+ 1,367	23	23	May 15	44,695	11,611,525	933,005	·90	11·49	1,943	7 13
East Ham Corporation	,, 25	712	547	+ 165	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6·79
Glasgow Corporation	,, 25	14,637	12,770	+ 1,867	+ 19,719‡	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 25	1,282	1,105	+ 183	+ 1,713	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 25	2,105	2,042	+ 62	+ 628	27	26	,, 31	112,651	27,102,921	2,910,693	1	9·29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 22	95	97	- 2	- 815	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Oct. 18	185	208	- 23	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Nov. 25	5,438	4,9'0	+ 468	—	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 25	1,863	1,532	+ 331	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 18	9 9:7	10,075	- 141	—	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 16	1,401	1,426	- 25	- 1,467h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 18	13,416	12,023	+1,393	+68,815	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 25	131	130	+ 1	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 23	75	91	- 16	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 25	11 957	10,420	+1,537	+18,033	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,399	6·99
Metropolitan District Railway	,, 26	8,088	7,451	+ 637	+ 2 410	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 26	17,275	16,866	+ 409	+ 1,520	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 25	115	97	+ 17	+ 435	—	2¾	,, 31	6,159	1,972,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 25	3,245	3,487	- 242	+ 2,612	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 26	1 523	1 278	+ 245	+14,982	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 25	1,321	1,229	+ 92	+ 1,020	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	,, 16	579	566	+ 13	- 480	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 25	750	335	+ 415	+19,161	6½	4½	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	,, 9	554	497	+ 57	—	9½	7½	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	,, 27	4,337	3,322	+1,015	+ 8,093	70½	—	,, 31	214,111	39,213,560	4,884,580	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 26	4,703	4,091	+ 609	+ 8 184	65¾	52½	,, 25	240,565	63,952 283	6,049 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 22	775	796	- 21	- 507	—	18	,, 31	49,365	9,294,772	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 24	490	408	+ 282	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 26	1,114	1,063	+ 53	+ 1,415	20	20	,, 31	64,858	15,364,463	1,495,685	1 004	10·36	—	6·37
Swindon Corporation	,, 22	148	142	+ 6	—	—	4½	,, 31	4,837	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D.C.	,, 25	652	585	+ 67	+ 777	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 23	1,670	971	+ 699	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	—
Wolverhampton Corporation	,, 22	697	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. ‡ Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Nottingham Guild.—Mr. G. Preece, of Manchester, has promised to read a paper on "Electric Cables" before the members of the Nottingham Guild of Mechanical and Electrical Engineers. The chair will be taken by Mr. H. Talbot (city electrical engineer). Among the papers arranged for the session is one on "Iron Manufacture" by Mr. J. Crawford, while other members of the guild have promised to contribute papers. The annual dinner will take place on March 13, 1906.

Milan Exhibition.—At a recent meeting of the British section of this exhibition the following gentlemen were elected on the commission: the Right Hon. the Earl of Glasgow, G.C.M.G., Sir Philip Watts (the Admiralty), Sir Alexander Binnie, Sir Thomas Wardle (Leek), and representatives of the Manchester Society of Engineers, the Iron and Steel Institute, and the British Chamber of Commerce for Italy (Genoa). The commission have appointed "Executive" and "Juries" Committees, and approved the Finance Committee previously formed.

Physical Society.—An exhibition of electrical, optical, and other physical apparatus will be held next Friday evening, Dec. 15, from 7 to 10 p.m., at the Royal College of Science, Exhibition-road, South Kensington. The meeting was originally arranged to take place this evening, but has been cancelled. Among the firms exhibiting apparatus will be Messrs. Crompton and Co., Messrs. Elliott Bros., Messrs. Everett, Edgcumbe, and Co., Messrs. James Pitkin and Co., Messrs. Nalder Bros. and Thompson, and others. Admission will be by tickets only, which may be obtained through any of the Fellows of the society.

New York Electrical Society.—The centenary of the birth of Benjamin Franklin (Jan. 17, 1906) is to be celebrated with much distinction in the United States. Owing to the number of functions on hand for the evening of that day, the New York Electrical Society (the oldest electrical society in America) has decided to hold its "Franklin Night" on the 16th. Mr. Marconi has expressed his desire to render his tribute to the memory of the great electrical inventor, and his address has, therefore, been fixed for that evening. The occasion should be of great interest, in view of the recent progress made in wireless methods in America.

Iron and Steel Institute.—The council have arranged that the annual general meeting of the institute shall be held in London on May 10 and 11, 1906. In place of the usual autumn meeting, a joint meeting with the American Institute of Mining Engineers will be held in London on July 23 to 28. It is intended during the week following to give the American visitors an opportunity of seeing some of the ironmaking districts. It is anticipated that the visiting party will include many of the leading ironmasters who entertained the Iron and Steel Institute in America in 1890 and 1904. The Lord Mayor of London has kindly consented to act as chairman of the London Reception Committee, and to give an evening reception at the Mansion House.

Siamese Tramway System.—On the occasion of the opening of this system, which took place in October last by his Majesty the King of Siam, the directors presented an address to his Majesty in which were given details of the work carried out. The overhead wire system has been adopted, with two trolley wires, on one of which runs the up car and on the other the down car. By the introduction of this feature the directors hope that wear and wear will be greatly reduced, and the possibility of breakdown and stoppage of traffic removed. The power station is fitted with the most modern plant, amply sufficient to deal with all the traffic that can come upon the line. The total length of the track is about 19·10 km., and has occupied 18 months in construction.

Witham Railway Disaster.—Lieut.-Colonel von Donop's report to the Board of Trade on the disaster which occurred on the Great Eastern Railway on Sept. 1 states that the cause was not any defect in the rolling-stock. Though the findings of the inquiry do not call for any special observations on our part, we think that the concluding sentence of the report is worthy of special attention. One of the carriages was destroyed by fire owing to the ignition of gas in the cylinder underneath the framework, and this occurrence, says the report, "points to the desirability of adopting some other source of illumination, probably electricity." The disastrous consequences of an accident cannot be but seriously aggravated when to it are added the horrors of fire, and, as a necessary precaution, the system of lighting by gas must yield to the safer system of electric lighting.

Teltow Canal.—Electric traction on the Teltow canal, which is one of the principal canals in Germany, is about to be applied on a large scale, in accordance with a programme formerly decided upon. It will be remembered that a number of experiments with different forms of tractors were made along the canal, and these showed that the electric system offered many practical advantages. A large central station for supplying the current has been erected, which contains a 400-h.p. dynamo and engine group and two large steam-turbine and dynamo sets of 700 h.p. each. The station is now prepared to furnish current. The extensive system of locks will first have an electric system for operating it. The rails for the electric locomotives have been laid along the canal in the eastern section between Grünau and Britz, on both banks. The overhead wires and the poles are being put in place, so that it will not be long before the locomotives will be ready to haul the canal boats.

Engineering Standards Committee.—This committee, acting at the request of the Secretary of State for India, instructed the Locomotive Committee to consider the questions of the most suitable designs of locomotives for use on the railways of India and the standardisation of their component parts. The report of this committee, signed by Sir Douglas Fox, chairman, and Mr. Leslie S. Robertson, secretary, has just been issued, and contains a list of instructions to designers, based upon the findings of a conference of consulting engineers and locomotive builders. A number of plates are given describing the design of the proposed passenger engine and tender and goods engine and tender for the 5ft. 6in. gauge and metre gauge. The committee have also been requested to consider the advisability of standardising three more types of broad-gauge locomotives of a heavier class than those dealt with in the present report, and they are now giving their consideration to this request. The report may be obtained from the secretary, Mr. Leslie S. Robertson, at the offices of the committee, 28, Victoria-street, Westminster, S.W., at the price of 10s. 6d. net.

Pacific Cable.—The present position of the negotiations in connection with the Pacific Cable indicates a deadlock. At the Imperial Conference which was held in London four or five months ago a committee was appointed to see if a pooling arrangement with the Eastern Company was possible, on the understanding that the agreement with New South Wales, which is held to operate against the Imperial undertaking, is modified in some way. The

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terms of the company were obtained and submitted to the Governments of the various countries concerned—namely, Great Britain, Canada, Australia, and New Zealand. It is understood that New Zealand has declared against any pooling arrangement, and so far the other Governments have taken no steps towards coming to an arrangement, Australia having not officially ratified in any way the action of Lord Jersey, its representative at the conference. There the matter rests, and at present there is little prospect of anything further being done. In the event of the position remaining unchanged by next month, the Pacific Cable Board, it is understood, proposes to open new offices in Australia, thus coming into direct competition with the private concern.

Obituary.—We regret to record the death of Sir Henry Charles Fischer, C.M.G., late controller of telegraphs, which took place on Thursday of last week at Southover, Bromley, Kent, in his seventy-third year. Sir Henry was born and educated in Germany, and in 1852 entered the Hanoverian Government telegraph service. He came to England in 1856 and entered the service of the Electric and International Telegraph Company. At the transfer of the telegraph to the State in 1870, he was deputed by the Postmaster-General to organise the staff and other arrangements of the Central Telegraph Office of the General Post Office, and he was for many years controller of the department before his retirement in February, 1898 In 1877 he went to America with Sir William Preece, then engineer-in-chief to the Telegraph Department, and they brought back with them the first pair of telephones. Another result of their visit was the introduction into this country of reading by sound as well as of quadruplex telegraphy, by means of which four messages could be sent simultaneously over the same wire in opposite directions. In 1898, the year of his retirement, he received a knighthood, while decorations in recognition of his services were conferred upon him by various foreign monarchs. He also received the Diamond Jubilee medal in recognition of special services in connection with the arrangements for the transmission of Queen Victoria's message to all parts of the world on Diamond Jubilee Day. Sir Henry was a director of the Eastern Telegraph Company.

Indian Telegraphs.—The record of the Indian Telegraph Department for 1904-5 is very satisfactory from every point of view. The administration report announces that the receipts from all sources exceed those of the previous year, whilst the number of departmental offices has also considerably increased. During the year, 1,992 miles of line and 15,419 miles of wire were added, making the length in all 61,684 miles of line and 227,419 miles of wire. It is of interest to learn from the report that communication by means of wireless telegraphy was established in October, 1904, between Diamond Island and Port Blair. The first two months were spent in erecting 150ft. masts and installing the oil-engines and dynamos at Diamond Island, Upper Island, and Port Blair—a distance approximately of 300 miles—on Feb. 10, 1905, since which date communication between those places was maintained regularly, with a few brief interruptions, to the end of the year. The installation is now working perfectly. The report further states that Wheatstone's automatic apparatus was installed in the Mandalay office, raising the number of offices with this apparatus to 15, three of which are translation offices only. Arrangements have practically been completed for fitting up new storage cells and motors in the Bombay central office, and for refitting the office with electric lights and fans to be operated by current supplied by the Brush Company. The installation in the Allahabad office of oil-engines, dynamos, and accumulator cells was commenced in March of this year, and has now been completed. The whole of the work of the department during the year was admirably carried out and gained approval.

Books Received.—We have received from Messrs. Archibald Constable and Co., London, a copy of Mr. J. D. Henry's history of "Baku" (12s. 6d. net). The author describes the origin, early history, progress, and condition of the Russian oil industry up to the time of the massacres in September. The book contains a mass of statistical, trade, and technical information of unquestionable value to oil men, and at the same time is sufficiently general in its scope to be of interest to all who are attempting to follow the sensational events at Baku and other parts of the Caucauses. Sir Boverton Redwood contributes an introductory note to the book, which contains numerous illustrations and a map of the oil fields.—"Alternating Currents," by Alfred Hay, D.Sc., M.I.E.E. (Harper and Bros., London. 6s. net.) In this work Prof. Hay attempts to furnish a general account of the principles, construction, and use of alternating-current measuring instruments, generators, motors, and transforming machinery. Special attention is devoted to methods of testing. The book contains a large number of diagrams and a copious index. The *Proceedings* of the American Institute of Electrical Engineers (vol. xxiv., No. 11, November, 1905) contains a paper by Mr. N. J. Neall on the "Performance of Lightning Arresters on Transmission Lines" and a discussion on "Air-Gap Flux in Induction Motors."—The November issue of the *Journal* of the Chemical Society contains contributions by Dr. J. Wade on the "Influence of Water and Alcohols of the Boiling Point of Esters," and by Mr. H. O. Jones on the "Stereoisomerism of Substituted Ammonium Compounds," together with other papers and abstracts.

Electric Brakes.—On many street railways it has been found that the hand-brake does not satisfy all modern requirements, and the question arises as to the most efficient braking system with which it may be superseded. Some have advocated the adoption of electric brakes, whilst by others preference is shown for use of air-brakes. Advocates of these types took the opportunity of expressing their views as to the merits of their respective systems at the tenth annual meeting of the German Street and Interurban Railway Association, when papers were read by Mr. Scholtes, manager of the Nürnberg Street Railway system, in favour of the use of electric brakes, and Mr. Bjorkegren, whose paper dealt with the subject of air-brakes. Mr. Scholtes pointed out that, as a result of several years' experience, definite conclusions had been arrived at which proved the superiority of the electric brake. Statistics were produced which showed that in Germany 49 per cent. of the street cars were equipped with electric brakes, 31 per cent. with hand-brakes, and 20 per cent. with air-brakes. Of the railway companies who expressed themselves as opposed to electric brakes, it was found that the electrical equipments were not suited for electric braking, though the difficulty could be avoided by selecting apparatus of larger capacity. The maintenance charges of the electric brake per car per annum amount to £2. 10s. The cost of maintenance per car per annum of air-brakes for motorcar and trail car amounts to about £10. The first cost of the electric brake is even less than that of the air-brake, which is £4. 5s. per car per annum. The average additional cost of a larger controller and more closely graduated resistances required by electric braking is about £14 for motorcars and £18 for trailers. As a result of extensive inquiries Mr. Scholtes has ascertained that the solenoid brake is now considered preferable to the disc type.

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Electrolytic Oxidation of Hydrocarbons.—An abstract of the observations of Mr. Herbert Drake Law and Mr. F. Mollwo Perkin on the electrolytic oxidation of the benzene series is contained in the November issue of the *Journal* of the Chemical Society. The chief product obtained by the oxidation of ethylbenzene in sulphuric acid solution containing acetone, using a current density at the anode of 1·3 amperes per square decimetre was phenylmethyl carbinol; phenylethyl alcohol was also found in small quantity, and benzaldehyde made its appearance when the number of ampere-hours was more than sufficient to oxidise the whole of the hydrocarbon to alcohol. When oxidised under the same conditions, cymene gave rise to cuminaldehyde and a mixture of mono- and di-hydric alcohols. The carbazone derived from the aldehyde was prepared; it crystallises in pearly plates, melting and decomposing at 206deg. to 208deg. When cumene boiling at 155deg. to 158deg. was oxidised with an anode density of 1·66 amperes per square decimetre, a mixture of cuminaldehyde and hydratropaldehyde and a mono- and a di-hydric alcohol was obtained. These experiments confirm the results of earlier experiments carried out with toluene and the xylenes, and indicate that certain groups, for example, the aldehyde group, are relatively stable when acted upon electrolytically. The protective action exerted by a negative group is illustrated by the oxidation of cymene, the *iso*propyl group not being attacked to any appreciable extent until the methyl group has been completely converted into the aldehyde group. The conclusion is drawn that the active oxidising agent in the electrolysis of dilute acid and alkaline solutions is the hydroxyl group and not oxygen. Even in acid solution, in consequence of the greater mobility of the hydroxyl ions, there is a tendency for these to concentrate around the anode.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday, Sir James Crichton-Browne, M.D., F.R.S. (treasurer and vice-president), in the chair. Lieut. E. P. C. Amphlett, Mr. F. Bailey, Mr. H. Behrens, Mr. J. Kennedy, Mr. J. N. Kerr, and Dr. E. M. Modi were elected members. The special thanks of the members were returned to Dr. Ludwig Mond, Ph.D., D.Sc., F.R.S., for his donation of £500 to the fund for the promotion of experimental research at low temperatures. It was announced from the chair that the managers had elected Prof. William Stirling, M.D., LL.D., D.Sc., Fullerian professor of physiology. The following are the lecture arrangements at the Royal Institution before Easter: a Christmas course of six illustrated lectures, adapted to a juvenile auditory, by Prof. H. H. Turner, on "Astronomy"; Prof. E. H. Parker, three lectures on "Impressions of Travel in China and the Far East"; Prof. William Stirling, six lectures on "Physiology," subject; Dr. J. E. Marr, three lectures on "The Influence of Geology on Scenery" (the Tyndall lectures); Rev. Canon Beeching, two lectures on "Shakespeare"; Mr. Benjamin Kidd, two lectures on "The Significance of the Future in the Theory of Evolution"; Mr. H. B. Irving, two lectures on "The English Stage in the Eighteenth Century"; Mr. Francis Darwin, three lectures on "The Physiology of Plants"; Prof. B. Hopkinson, three lectures on "Internal-Combustion Engines" (with experimental illustrations); Mr. J. E. C. Bodley, two lectures on "The Church in France"; Mr. J. W. Gordon, two lectures on "Advances in Microscopy"; Mr. M. H. Spielmann, two lectures on "George Frederick Watts as a Portrait Painter"; and Prof. J. J. Thomson, six lectures on "The Corpuscular Theory of Matter." The Friday evening meetings will commence on Jan. 19, when Prof. J. J. Thomson will deliver a discourse on "Some Applications of the Theory of Electric Discharge to Spectroscopy." Succeeding discourses will probably be given by Prof. S. P. Thompson, Mr. H. F. Newall, Mr. W. C. D. Whetham, Dr. R. Caton, Dr. Hutchison, Sir Andrew Noble, Bart., Prof. P. Zeeman, Mr. W. B. Hardy, and other gentlemen.

Society of Arts.—The second of a series of four Cantor lectures on "The Measurement of High-Frequency Currents and Electric Waves," by Dr. J. A. Fleming, F.R.S., was delivered at the society's rooms on Monday, Dec. 4. The lecturer said he had lately been considering a new method of representing and delineating an oscillatory spark. A number of photographs had been taken by that method, which showed the details of the oscillatory discharge. One of the points to be noted in connection with the subject, which had an important bearing on wireless telegraphy, was the "decrement," which expressed the rate at which the oscillations in a circuit died away. For all practical purposes the oscillations might be considered to be concluded when the amplitude of the oscillations had fallen to 1 per cent. of the initial value. Another important factor was the damping factor—*i.e.*, the ratio of the resistance to twice the inductance of the circuit. In an ordinary Marconi aerial oscillations were damped out so completely that they died away at about 20, whereas in other circuits there might be hundreds of oscillations. He and other investigators had used a hot-wire ammeter for measuring currents and trains of oscillations whose mean square value ranged from ¼ ampere up to 15 to 20 amperes. For measuring still smaller high-frequency currents a satisfactory method had been designed by Duddell. It was also necessary to investigate the spark voltage. When this final factor was ascertained it was then possible to work out accurately the details of the discharge of a condenser. Turning to the consideration of methods of determining decrement, Dr. Fleming said it was necessary to distinguish between the radiation and the resistance decrement. In the case of wireless telegraphy, the damping of the oscillations was primarily due to the radiation decrement. The subject of determining decrement had been studied by Rutherford and Bjerknes, and a method adopted by Drude capable of application to both open and closed circuits, was based upon the use of a resonance curve. These investigations had a great bearing on the efficiency of a Marconi aerial. The problem in connection with the efficiency of a wireless telegraphy transmitter was to find an improved method of charging. He was inclined to believe that the coil would be given up before long and superseded by some form of electrostatic instrument. At present there was a large dissipation of energy in the coil itself.

Royal Society.—Following an old-established custom, the Royal Society met on St. Andrew's Day (Thursday, Nov. 30) to hold its anniversary meeting and to elect a president and council. Sir William Huggins delivered his valedictory address as president, which dealt largely with the influence which the discoveries of science had conferred upon the general life and thought of the world during the last 50 years. Some instructive and stimulating observations were also made with reference to the place of science in general education. The president then proceeded to the award of the medals. The Copley medal was awarded to Prof. Dmitri Ivanovitch Mendeleeff, F.M.R.S., for his contributions to chemical and physical science. A Royal medal was awarded to Prof. John Henry Poynting, F.R.S., on account of his researches in physical science, especially in connection with the law of gravitation and the theories of electro-dynamics and radiation. The other Royal medal was awarded to Prof. Charles Scott Sherrington, F.R.S., for his work on the central nervous system, especially in

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relation to reflex action. The Davy medal was awarded to Prof. Albert Ladenburg on account of his researches in organic chemistry, especially in connection with the synthesis of natural alkaloids. The Hughes medal was awarded to Prof. Augusto Righi for his experimental researches in electrical science, including electric vibrations. Prof. Righi had been for many years a prominent and active worker in the sciences of light, electricity, and magnetism. He was the first to announce the very interesting and still imperfectly explained phenomenon that the ultra-violet rays of the spectrum, when they fell on a piece of electrified metal, were capable of causing a discharge of that electricity. The following were elected to serve on the council for the ensuing year: president, Lord Rayleigh; treasurer, Alfred Bray Kempe, M.A.; secretaries, Prof. Joseph Larmor, D.Sc., and Sir Archibald Geikie; foreign secretary, Francis Darwin, M.A.; other members of the council—Shelford Bidwell, Sc.D., Sir T. Lauder Brunton, M.D., Prof. J. Norman Collie, Ph.D., Prof. Wyndham R. Dunstan, M.A., Prof. John Bretland Farmer, M.A., Prof. Francis Gotch, D.Sc., Sidney Frederic Harmer, Sc.D., Sir William Huggins, K.C.B., Prof. Edwin Ray Lankester, M.A., John Edward Marr, Sc.D., George Ballard Matthews, M.A., Hugh Frank Newall, M.A., Sir William Davidson Niven, K.C.B., Prof. John Perry, D.Sc., Prof. Ernest Henry Starling, M.D., and Prof. William Augustus Tilden, D.Sc. In the evening a banquet took place at the Hôtel Métropole, where there were assembled some of the most distingnished representatives of science, jurisprudence, and literature, and over which the new president (Lord Rayleigh) presided.

High-Tension Lines.—The Missouri Power Company claim to have operated a high-tension service of the highest voltage over the longest time. The length of the line extends from the company's power station at Helena to Butte, Mont., a distance of over 65 miles, and during the past 2½ years it has been continuously operating at 55,000 volts. An inquiry into the operation of the system has been made by Mr. Chas. F. Scott, who, in the *Electric Journal*, asserts that the record of the plant for the year has been a remarkable successful one. The service is for 24 hours a day, seven days a week, and the power delivered at Butte for mining and smelting operations shows a very high load factor. The success of this plant is proved by the present plans for extension. A new dam and power-house will be constructed a few miles below the Canyon Ferry plant. The old and new power-houses will be operated in parallel over the present lines to a new sub-station at Butte, and an additional sub-station at Anaconda. The transmission voltage will be increased to 70,000 volts, and the maximum distance of transmission will be approximately 100 miles. The new power-house will contain three banks of raising transformers, each consisting of three 2,000-kw. units. An important adjunct to the system will be a steam-turbine auxillary plant at Butte. During seasons of low water the steam plant will be used to supply power; at other seasons when water power is abundant, the limit of the amount of power transmitted is the capacity of the generators and transmission circuits, the turbo-generator will be uncoupled from the turbines in order that they may run as idle synchronous motors for increasing the power factor of the current from the transmission lines. A brief description of the insulators and pole construction was communicated to the International Electrical Congress by Mr. M. H. Gery, jun. The line cables are composed of seven strands, and have an area of 106,000 circular mils. They are carried along insulators mounted on cedar poles and fir cross-arms. The cross-arms, braces, and pins are held in place by means of through bolts. The pins are prepared by being first dried and then tested in paraffin, until all moisture is removed. The glass sleeves are not fastened to the insulators, and merely rest on a shoulder of the pins. The circuits are transposed five times, making two complete turns between the generating station and the sub-station. The switching operations are such that the circuits may be operated either singly or in multiple. A telephone circuit is located on one of the lines, and gives good results in service. The poles are from 35ft. to 75ft. in length, and the pole tops are from 9in. to 12in. in diameter. The poles are set from 6ft. to 8ft. in the ground, according to height, and the standard spacing is 110ft., with a maximum spacing of 150ft.

Traction Systems.—Traffic conditions on electrically-equipped railways may be divided into three broad classes—viz., short-haul service, long-haul service, and grade work—and their influence on motor specifications was pointed out by Mr. A. H. Armstrong in a lecture at the Brooklyn Polytechnic Institute. In dealing with the relative values of the different types of railway motors, Mr. Armstrong said that the direct-current series motor, though satisfactory, was not as good as one specially designed to fulfil special conditions. The installation of the direct-current shunt motor might be warranted under conditions where its ability to return energy on down grades would be an important factor. The two important characteristics which the three-phase motor has in common with the direct-current motor are that it runs at constant speed and returns energy to the line. In general, however, the three-phase motor possesses qualities which under certain conditions make it preferable to the direct-current series motor. In certain classes of work the single-phase motor is a strong rival of the direct-current series motor. This rivalry is not due to superiority in design, performance, lesser cost, or weight, but because the first-mentioned motor effects certain fundamental changes that greatly reduce the cost of the distribution system and line. Mr. Armstrong mentioned another method of electric operation—namely, by motor-generators, which scheme allows the use of large induction or direct-current motors carried either on the locomotive or in a tender behind. A field for motor-generator operation has been opened up by the application of electricity on the steam trunk lines, necessitating the employment of very heavy and bulky apparatus which cannot be placed under standard passenger cars. Mr. Armstrong then discussed hand, multiple-unit, and alternating-current potential control systems. Hand control, he said, practically reaches its limit when a larger equipment than four 50-h.p. motors is used, mainly because the controller becomes too heavy and bulky for the car platforms. Hence for equipments above this capacity it is better to subdivide the control system, placing the main apparatus under the car, and to actuate the motors through a series of contactors, which may be electrically or pneumatically operated. Alternating-current potential control is becoming the recognised method of controlling single-phase railway motors, the speed depending upon the potential supplied. This method is very economical and simple, the speeds being varied by changing the connections of the car transformer taps. For motor-generator work direct-current potential control is used. A typical speed time run, Mr. Armstrong said, can be considered in several different ways. Taking it up in its fundamental state, it consists of a period of acceleration, a certain amount of free running, and a period of braking. Given intervals must intervene between acceleration, running, and braking, and the all-day duty of the motor consists of a repetition of similar runs.

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REVIEWS.

Electric Railways Theoretically and Practically Treated. By SYDNEY W. ASHE B.Sc., and J. D. KELLY. D. Van Nostrand, New York; Archibald Constable and Co., London. Price, 10s. 6d. net.

We are afraid that this book is not suitable for the English market. The publishers' note practically confirms this when it tells us that throughout the American ton = 2,000lb. is used instead of the English ton = 2,240lb. Thus it happens that there must be hardly a single calculation but requires translation. A man has not time in the ordinary way to have to worry out things that are not foot-tons, or tons weight, or pounds per ton tractive effort in his own sense. Nor, again, do we agree with the authors as to the absence of "a modern text-book." That may be so in America, but it does not hold in Europe. We also object to the use of *I* for C. The latter is almost universally used in this country, and it is time that notation and nomenclature used here be standardised. However, if it were not for the continual bother of translating from unfamiliar to familiar, there is much in this book that is excellent.

Telegraphy: A Detailed Exposition of the Telegraph System of the British Post Office. By T. E. HUBERT, A.M.I.C.E. With 509 Illustrations. Whittaker and Co., London. Price, 6s. 6d.

The *Times* mentions the size in inches of, say, the covers of a book. Macaulay in some of his essays mentions dimensions, not from the flattering point of view, but otherwise. If, however, Macaulay had had this book before him, probably the size as well as the contents would have in the flattering sense been pronounced prodigious—prodigious. Over 900 pages of good, solid, scientific, and practical matter. Evidently the book is understood to be so good that its circulation must be extraordinary, and from every point of view it deserves all the success that can come to it. We have often declaimed against examinations being made an end instead of a means. Of course, examinations are necessary, but as usually understood they are to be condemned absolutely. If a master requires a man to take any responsible position, he probably sees a man or men, and puts him or them through their facings to find out if they are competent to undertake the responsibility. The Post Office authorities have to do something of the kind with its would-be employés—hence its examinations. This book is directly practical, and, carefully studied, will fit anyone to face with equanimity the ordeal of showing his fitness for a position in the telegraphic service. At the same time, it is the best text-book we have seen for such as are studying for the City and Guilds Institute examinations. The book is excellently arranged, each chapter exhaustively dealing with its particular subject, the earlier chapters giving the information required to understand the later chapters, which deal with more complicated pieces of apparatus. There is, of course, little new in the purely scientific work, but the whole value of the book

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Mechanics for Engineers: A Text-Book of Intermediate Standard. By ARTHUR MORLEY, M.Sc., Senior Lecturer in Engineering in University College, Nottingham. With 200 Illustrations and Numerous Examples. Longmans, Green, and Co., London. Price, 4s net.

If we were asked what was the ideal to be attained by a student in physics, we should probably reply, accuracy of measurement. All books on mechanical subjects treat of measurement, and that which assists the student to gain greater expertness and accuracy is the best. We should give Mr. Morley's book a high position among similar books, in that his definitions are exact, his descriptions accurate, and his examples numerous, and not so much of the catchy character in which some authors seem to delight. Students do not want training in mathematical conundrums, but in plain, straightforward work. When the conundrum comes, they form an exception to the rule, and must be tackled as exceptions. The aim of a good book is to assist the student to employ the information therein in his practical work, and not to make him a clever juggler with figures. We commend this book from another point—"the gravitational system of units has been adopted in the English measures." If a man is going to work in a shop, he is better if familiar with the tools and measures used in that shop, although some idealists may think he ought to know nothing about them, but about something else he is not likely to see or use in practice. Again, we commend the chapter on the elements of graphical statics. Many a man can solve a hard practical problem graphically that would be utterly at sea with any other method. Lastly, we are glad to find Messrs. Longmans have not yet descended to the use of wood pulp paper, which is cheap and nasty, while their productions are of such high quality as will well stand the hard usage of student life.

Elementary Electrical Calculations. A Book suitable for the Use of First and Second Year Students of Electrical Engineering. By W. H. N. JAMES, A.R.C.Sc. (Lond.), A.I.E.E., Lecturer and Demonstrator in the Electrical Department of the Municipal School of Technology, Manchester, and D. L. SANDS, Assistant Lecturer, etc., as above. London: Longmans, Green, and Co. Price, 3s. 6d. net.

A Guide to the Electrical Examinations. By FREDERIC H. TAYLOR, A.M.I.E.E., etc. London: Percival Marshall and Co. Price, 1s. net.

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The Law and Practice relating to Patents, Trade Marks, and Designs. By DAVID FULTON, Barrister-at-Law. Jordan and Sons, Limited. Third edition.

The third edition of the above work, which has recently appeared, maintains the same high standard of practical utility which characterised the previous editions. The work is divided into three parts—Part I. dealing with patents, Part II. with trade marks, and Part III. with copyright in designs. The statutes between 1883 and 1902 have been codified and consolidated, and any alteration in the earlier Acts is shown in the text by the use of different type—an arrangement which will commend itself to the practitioner by reason of the fact that it will save him considerable time and labour. A similar course has been adopted with regard to the new rules. The work seems to have been very carefully revised since the second edition appeared, and, so far as we have been able to ascertain, no case of importance has been omitted. Although the book is by no means bulky, the index, one of the most important parts of a work of this nature, contains no less than 120 pages, and is divided into three parts to correspond with the three divisions of the subject-matter. The only improvement we can suggest is that in future editions the author should give all the references to a case, instead of one only, as practitioners may not be all possessed of the report cited.

Practical Electric Wiring for Lighting Installations. Illustrated with over 130 Original Drawings, Diagrams, and Plans. By CHARLES C. METCALFE, A.M.I.E.E., Electrical Engineer to the Education Committee, Manchester; Lecturer and Instructor in Practical Wiring at the Municipal School of Technology, Manchester. Harper and Bros., 45, Albemarle-street, W. Price, 5s. net.

This little book, as its title indicates, is a practical treatise on electric wiring, a subject which in the past has not always been given that serious attention which its importance warrants. The difference between good and bad wiring is the margin which separates perfect safety from constant danger. To borrow a phrase: "Bad workmanship cannot be redeemed by the use of good materials, but good workmanship can to a great extent redeem inferior material." Good workmanship and material should, therefore, be inseparable. Then, as the author points out, the use of higher pressures than formerly, with the correspondingly increased fire risks incurred by bad workmanship, make it imperative that the wireman of to-day should be a really skilled workman.

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Further he must, especially if he desires to take charge of a job, possess a good general knowledge of practical wiring, have a more than nodding acquaintance with the internal arrangement of buildings and their construction, and be well up in the various rules issued by the fire insurance companies, the Institution of Electrical Engineers, and the supply companies in his immediate neighbourhood.

Unfortunately, in wiring installations the bad work that really matters is nearly always concealed from view. Wood casing and steel conduits are cloaks for weak spots. But it cannot be expected that wiremen will be infallible if their foremen are not themselves sufficiently alive to the importance of good workmanship. True, there are many wiring contractors who know their business and can be relied upon, but it is equally certain that this branch of electrical engineering still lends itself to the display of crass ignorance of the fundamental rules for safe work. The book which we have before us is well calculated to raise the general level of wiring work. It is suitable alike for foremen, wiremen, students, and for all those who wish to acquire a practical knowledge of wiring, jointing, and fitting for the installation of the electric light. The series of suggestions which it contains are based upon practical experience extending over some 17 years, being accompanied by plain instructions and diagrams for carrying them out. Chapters I. to IX. inclusive cover the whole range of work falling to the wireman's lot to execute, those on jointing and the insulation of joints being especially noteworthy. The remaining chapters should be of great use to architects and others practically concerned with electrical installations. They include a specification for a complete installation of electric lighting, and a description of the installation, with plans and sections of the building, etc. To conclude, "Practical Electric Wiring" is a book we can confidently recommend. It contains a mass of useful information which we do not remember having previously seen given in the same lucid manner.

National Engineering and Trade Lectures. Edited by BEN. H. MORGAN. Vol. III.: "British Progress in Gasworks Plant and Machinery," by C. E. Brackenbury, A.M.I.C.E., etc. Illustrated. London: Archibald Constable and Co., Limited. Price, 6s. net.

In these days when some local authorities are inclined to revert to gas as a street illuminant, and when gas interests are thus made jubilant, it behoves every responsible electrical engineer to keep himself thoroughly acquainted with the progress made in all that concerns gas. Electrical engineers must not imagine that their library is complete if it contains only works upon their own subject; it should contain whatever gives them information upon competing subjects, and in this book on gas they will find the latest information on the present position of gas production and the appliances used therein. The best and the most recent appliances for production this book describes and illustrates, but it does not deal to any extent, if at all, with that important matter—usage. It is not so much how produced as how used that interests electricals, and the most modern types of burners, their peculiarities and their efficiencies, is what the electrical engineer wants to know. Gas has gone ahead in its burning; electricity has not progressed quite so rapidly, and no doubt a glamour has been thrown around gas which acts upon the consumer to the advantage of gas.

The Use and Care of Chains for Lifting and Hauling. HENRY ADAMS, M.I.C.E., M.I.Mech.E. Second edition. 1s. 60, Queen Victoria-street.

This is the second edition of a paper which was first read at a meeting of the Civil and Mechanical Engineering Society in April, 1887. The author is an expert on chain work, and when the Home Office recently prepared a series of draft regulations for docks and wharves much opposition was aroused, and he was called in to give the authorities the benefit of his long practical experience in connection with dock machinery and cranes, with the result that the regulations finally issued were considerably modified, and the dock owners relieved from what would have been onerous restrictions upon the carrying out of their work, particularly as regarded the testing of their chains and machinery.

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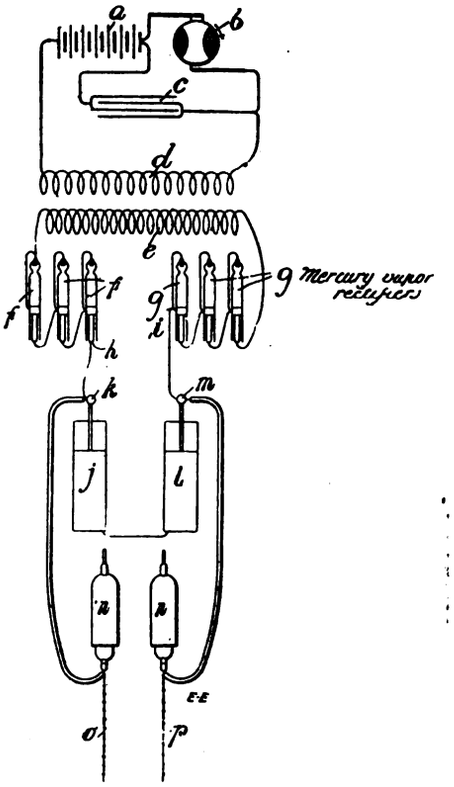
Charing Cross Disaster.—The collapse of the glass roof which spans the southern portion of Charing Cross Station, without the slightest warning, cannot but evoke expressions of sympathy with the sufferers and the directors and officials of the South-Eastern Railway Company. It is impossible to say at present whether the accident was due to subsidence or to the breaking of a stay-rod (which are the most probable theories), but technical investigations and a Board of Trade examination will locate the cause. At present men are engaged in clearing away the *débris* and strengthening the remaining portion of the roof. These operations have been considerably expedited by the excellent work performed by the Electrical Engineers Volunteer Corps, the value of whose services is worthy of the highest appreciation. At 6.30 p.m. on Tuesday evening a message was received at headquarters, where some of the men had gathered for drill, asking for assistance. Colonel Crompton immediately gave orders for the dispatch of men and apparatus to the scene of the disaster. Fortunately, Captain J. H. S. Phillips (machinery officer) was present at the time, and under his direction two searchlights with all the gear were got ready and transferred from the drill hall to Charing Cross. Primitive resistances, consisting of a combination of old iron wire and wheel trucks, were fitted up by the men, and the projectors mounted on two horse-boxes covered with tarred canvas; current was obtained from the Charing Cross Company's mains, and within two hours after having received the first call the projectors were in working order, lighting up the operations on the roof. The complete transfer of the gear and its erection at the station was entirely effected by the officers and men of the corps in so remarkably short a time, and this notwithstanding the fact that some little delay was occasioned in connecting the supply and adapting the 80-volt gear of the corps for the 200-volt current of the supply company's mains, which necessitated the bringing of a great deal of additional gear. Until the arrival of the Electrical Engineers work on the roof was at a standstill, as it was impossible to use torches on that class of work. The men consequently have been employed with their searchlights every night this week from dusk till 8 a.m. on the following morning, and they are ready to give their services for any length of time. Captain J. H. S. Phillips has been in attendance during practically the whole of the time since the installation of the apparatus, and under the directions of this capable officer, ably supported by Captain W. Bunn and Lieutenant E. G. Sheppard, the men have bravely carried on their valuable work. This is the first occasion on which volunteers have been called upon to do work of an indispensable character under such circumstances as the present, and the feat of the Electrical Engineers serves to show that, although their work is carried on quietly and unobtrusively, it is of the utmost value to the country.

Dispersement of Fog.—At a time of the year when the atmosphere is charged with aqueous vapours and impure emanations, and when the City is for the greater part wrapped in dense fog, it is singularly appropriate to turn attention to devices which have been introduced with the object of dispelling fog. Experiments with high-potential discharges for fog condensation were formerly carried on by the aid of Voss or Wimshurst electrostatic machines, but the apparatus was found too delicate for use on an extensive scale. Sir Oliver Lodge has given close attention to the subject for a great number of years, and his studies have culminated in the invention of a high-potential discharger for dispelling fog, for which a patent has just been granted in the United States. The present contrivance, which is described in the *Western Electrician*, is such that the current from a dynamo, either continuous or alternating, is so transformed and treated as to give a practically continuous high-potential discharge in one direction only. Further, the invention consists in combining high-potential rectifiers in such a way that, instead of reverse pulses being suppressed, they are redressed to form positive and negative discharging streams required for deposit purposes. In the accompanying diagram there is a



battery, *a*, in circuit with an intermitter, *b*, and the primary of a large Ruhmkorff induction coil. A condenser may be placed in parallel with the intermitter. The secondary of the Ruhmkorff coil is connected through two series of high-potential mercury vapour rectifiers to the terminals, *k*, *m*, of the insulated coatings of Leyden jars whose outer coatings, *j*, *l*, are in electrical connection. To the terminals are also attached the leads or discharging wires, which are supported by insulators, *n*. In the operation of the apparatus the current generated in the battery or dynamo is interrupted by the intermitter, and induces intermittent pulses of violently high potential in the secondary coil of the Ruhmkorff coil. These pulses are transmitted through the rectifiers—positive pulses through the series *f* and negative pulses through the series *g*—to the insulated coats of the two Leyden jars. The object of each series of rectifiers is to transmit a current easily in one direction and to strongly oppose a passage of current in the opposite direction. By this means the intermittent supply from the induction coil is enabled to maintain the jars steadily charged. The higher the potential desired the more numerous are the rectifiers required in each series. It has been found that six in each series is a convenient number to use where it is required to keep up a practically continuous discharge between the dischargers. By suitable arrangement of the discharging means, the invention can be applied to various purposes in which continuous high-potential discharge in one direction is required, such as, for example, where it is desired to utilise the high-potential discharge in causing the deposit of lead fumes in the manufacture of white lead by furnace processes, and in the depositing of valuable factory dust by means of a combination of the electrical discharge apparatus and a centrifugal settling chamber.

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BELFAST ELECTRIC TRAMWAYS.

The first tramways in Belfast were laid under the Act of 1872 by the Belfast Street Tramways Company, and were altered and extended under subsequent Acts and orders until the lines owned and worked by the company consisted of 35 route miles. From the commencement until the present time the tramways have been worked by horses, but in February of this year the Corporation proceeded to relay, extend, and electrify the tramways, having acquired the undertaking from the company under an Act passed during the session of 1904. The amount paid by the Corporation to the Belfast Street Tramways Company for their undertaking was settled by arbitration, and the amount awarded by the arbitrator, Mr. L. L. Macassey, LL.D., C.E., including the value of three years' unexpired lease, compensation to officers, and £60,000 debentures (to be paid off by the Corporation), was £364,448.

In July, 1904, Mr. Henry A. Cutler, M.I.C.E., the city surveyor, and Mr. V. A. H. M'Cowen, M.I.E.E., the city electrical engineer, reported to the newly-formed Tramways Committee of the Corporation on the various systems of electric traction, in which they set forth the merits and cost of the different systems, having regard to local conditions, and strongly recommended the adoption of the overhead trolley system. The committee adopted the report of their engineers, and instructed Mr. Cutler to prepare drawings, specification, and quantities for the permanent way and the buildings required for the generating plant; Mr. M'Cowen to prepare a scheme for the electrical operation of the system, including specifications for the generating plant, cables, and overhead equipment; and Mr. Nance, who had for many years managed the horse tramway system under the old company, and had been appointed manager for the Corporation, to prepare a specification for new rolling-stock and to make the necessary alterations and additions to the car-sheds and depôts, so as to make them available for the new undertaking. Mr. Nance has supervised the construction and equipment of the cars and carried out the whole of the work in connection with the depôts by administration, and what drawings were necessary were prepared by the city surveyor. After the specifications had been submitted to Messrs. Lacey, Sillar, and Leigh for expert advice, tenders were invited for the work of reconstruction and electrification of the tramways, excluding the buildings, in six different sections, which led to a very keen competition,

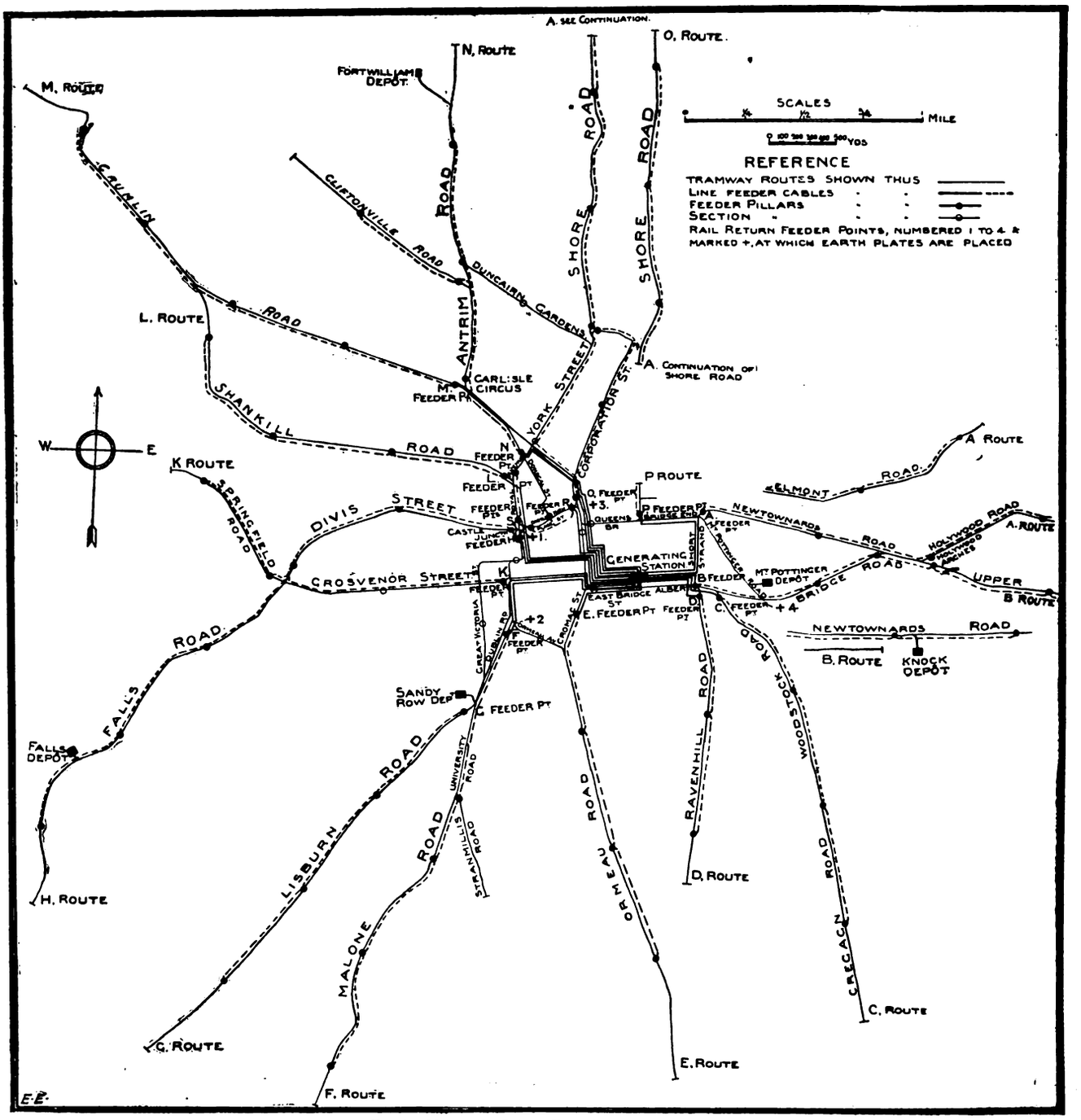

FIG. 1.—Map of the Belfast Electric Tramways.

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and eventually the tender of Messrs. J. G. White and Co., of London, for the whole of the six sections, amounting to £543,404, was accepted.

Permanent Way.

The reconstruction of the permanent way was commenced last February under the superintendence of Mr. E. S. Pinkerton, A.M.I.C.E., who acted as resident engineer, and Mr. F. Lewis, who acted as clerk of works. All the routes were laid as double line to a gauge of 4ft. 9in., and the work now completed consists of about 80 miles measured as single track. Sixteen single-track miles of the tramways were laid only five years ago, and as this portion of the work was in fair condition, the renewal of the special work, bonding, and general repairs was the only work necessary in connection with them. British standard sections were adopted for the rails and fishplates used in the new track, No. 4 section, weighing 105lb. to the lineal yard, being used on the straight and flat curves, and No. 4c section, weighing 111lb. to the lineal yard, on curves of 66ft. radius and under. The rails were manufactured to the British standard specification by the North-Eastern Steel Company, Middlesbrough. The rails (Figs. 2 and 3) are anchored at the joints with Cooper anchors, consisting of 2ft. lengths of rail inverted and riveted to the under flange of the rails with 12 rivets at each joint. Attached to the rail between the joints are intermediate anchors spaced about 11ft. apart, consisting of sections of steel joists 8in. long, riveted

MR. HENRY A. CUTLER, A.M.I.C.E., CITY SURVEYOR, BELFAST.

transversely to the under flange with four rivets to each anchor. The tiebars, which are of mild steel, 2in. by ¼in., are Bayliss's patent, with lock nuts at both ends. The joint bonding has been executed with 0000 B. & S. gauge copper bonds of the protected type, two bonds being fitted to each joint under the fishplates. Solid crown cross bonds have been put in at 40-yard intervals in the tracks, and 80-yard intervals between the tracks.

The whole of the special work (Figs. 4 and 4A) was manufactured and supplied by the Lorain Steel Company. The points to junctions are made to a radius of 150ft, and are armoured with manganese steel insert pieces. The crossings are of iron-bound type with steel-armoured centres. The whole of the special work was manufactured and fitted together at the company's works in America, and delivered on the ground ready for laying. The care with which the work had been designed and manufactured enabled it to be put together on the site without the slightest trouble. Owing to the close spacing of the rail anchors, it was possible for some modifications of the usual method of tracklaying to be made and do away with the necessity for removing temporary rail packings after the concrete had been put in. The method adopted was as follows: When the necessary excavation had been completed, the rails were put in position, the fishplates, anchors, tiebars, and bonds fitted, and the rails packed temporarily in the usual way, leaving sufficient space underneath for the proper thickness of the concrete bed; then, when the platelaying had been completed, plastic concrete packing was put under the anchors and left for about 24 hours to set. The concrete bed was then put in in the usual way and packed tight under the rails while in a plastic state, the temporary packing being drawn in front of the concrete gang, leaving the track supported on the permanent anchor packing instead of relying upon the temporary packings, which usually have to be withdrawn after the concreting has been completed. The concrete bed (Fig. 5) under the rails consists of broken stone, gravel, and cement, mixed in the proportions of 6 of the aggregate to 1 of cement. Its normal thickness was 7in., and the upper surface was finished 1in. above the rail bed. Where the foundation was considered unreliable the thickness of the concrete was increased, in some places to as much as 12in. The paving has been executed with granite setts

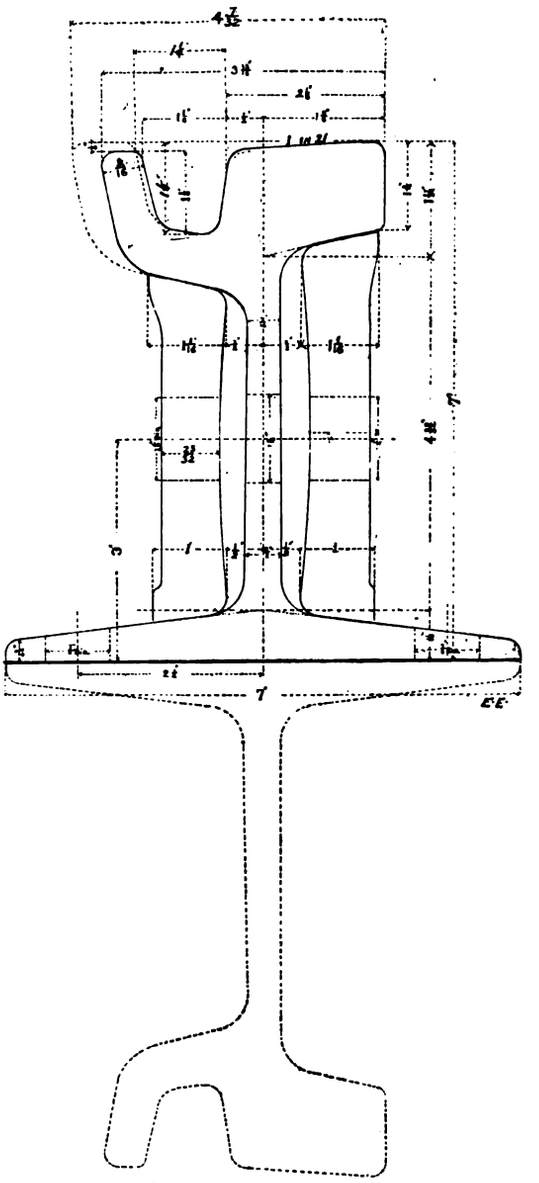

Fig. 2.—Section of the Rails used at Belfast.

5in. to 5½in. deep and 3in. to 4in. wide. The setts were laid on a dry compo bed mixed in the proportions of 4 of sand to 1 of cement, which was thoroughly wetted after the paving had been laid, and the joints were then grouted up with 3 to 1 compo, and back washed after the setts had been rammed. In the bulk of the work the rails were not parged, as the grouting was found to properly fill the space between the setts and the web of the rail, and to make a more satisfactory job. In some places, where it was necessary to turn the traffic on the road immediately after completion, such as at road crossings, the rails were parged, the setts bedded on sand, the joints racked up with chippings and grouted with pitch and creosote oil.

The work in connection with the permanent way was started in February, and has been completed in a record-breaking time, which speaks well for the organisation and

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energy of the staff of the contractors. In carrying out the work numerous alterations had to be made to sewers, gas, water, and other mains, and in two places roads had to be lowered to provide the proper headway under bridges.

Power Station.

The contract for the new power station necessary for the generating plant for the tramway undertaking was let to Messrs. M'Laughlin and Harvey, of Belfast, whose tender of £19,690 was accepted by the Council. The site of the building (Fig. 6) adjoins the electric light station and is very centrally situated close to the bank of the River Lagan, which is navigable for barges to the site of the works, and will provide an unfailing supply of water for condensing. The building was designed by Mr. Cutler in such a way as to make it possible to instal the plant during the erection of the building. The work was commenced in April last, and owing to the soft nature of the ground some 1,750 piles had to be driven through 30ft. of river mud down to the rock. The foundations on top of the piles are formed with cement concrete, in which is embedded a steel grillwork made of old tramrails. The framework of the building is made of steel, and the roof and floors were erected before the brickwork was commenced, which enabled the coal bunkers, boilers, and engines to be installed during the time the building was being erected. This arrangement afforded the only possible way of having power available for running the cars in such a short time as was allotted for the completion of the work. As a result of the preparation made in designing the structure, the engines are now running and current being generated although the building is not completed. The new building is designed to harmonise with the existing electric light station. It has a frontage of 180ft. to East Bridge-street and 138ft. to the Lagan Bank-road. It is faced with red brick with stone dressings. The floors in the basement of the building are formed of concrete rendered with cement, and the stoking floor and switch gallery floors

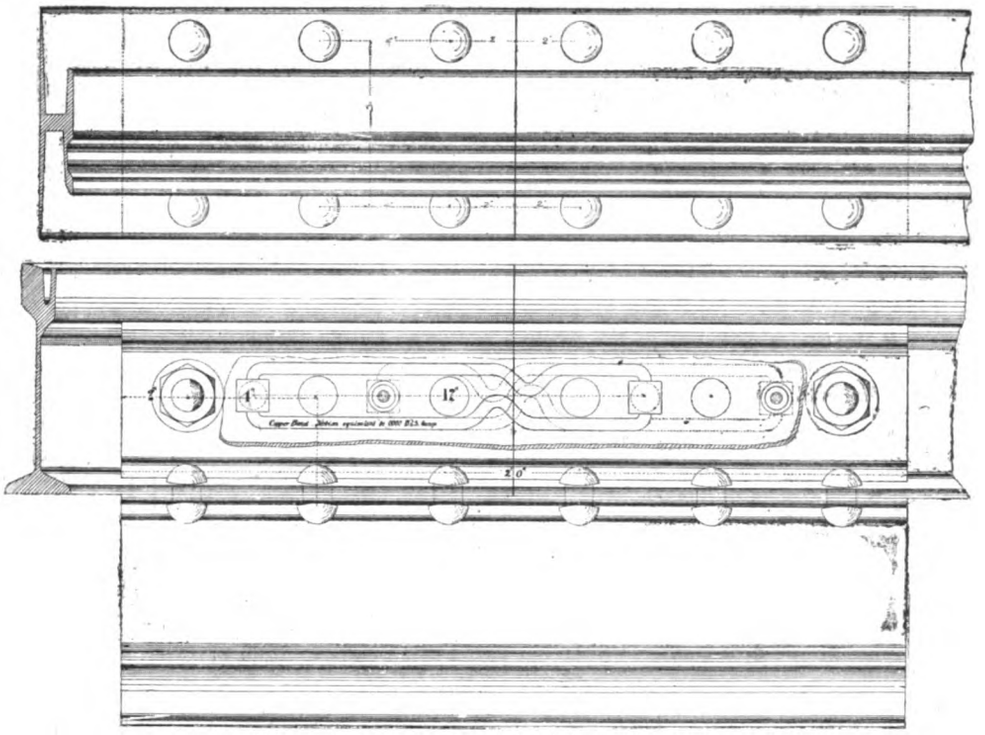

Fig. 3.—Details of Rail Joint.

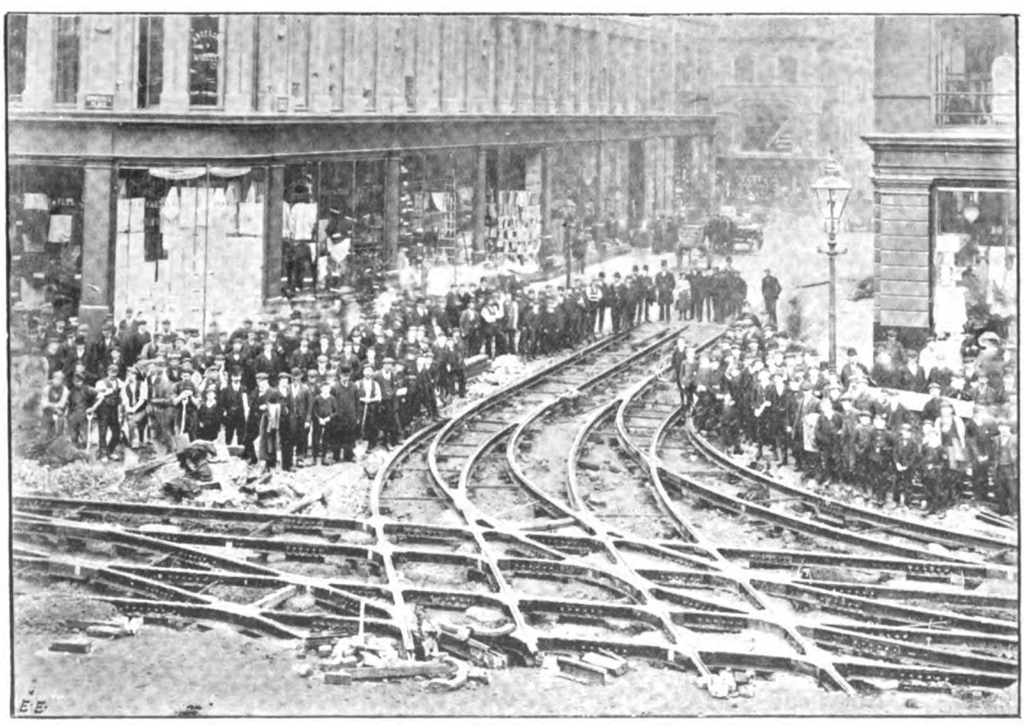

Fig. 4.—Special Work at Belfast.

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are formed with concrete on steel joists. The stoking floor is finished with Staffordshire blue paving bricks, the switch-gallery floors with vitreous glass mosaic, and the floor of the engine-room with encaustic tiling. The skylights for lighting the engine-room and boiler-houses are glazed with Helliwell's patent glazing, and the walls of the engine-house and switch galleries are faced with glazed tiles. The great care and energy which have been displayed by Messrs. M'Laughlin and Harvey in carrying out their contract have been no small factors in the expeditious completion of the work, and they are to be highly commended for the facilities they have afforded other contractors working in the building.

Pump-House.

The contract for the pump-house, in which the condensing water pumps are erected, was let to Messrs. Courtney and Co., of Belfast, whose tender amounted to £6,281. The pump-house is situated on the bank of the River Lagan, and a cofferdam along the river front and two sides had to be constructed before the work was commenced. The pump-house is 68ft. long and 16ft. 6in. wide, and is built of red brick with stone dressings. The pump wells are built in concrete faced with blue brick, and the openings to the river are protected with movable screens to prevent foreign matter entering the wells. The pumps are carried over the pump wells on steel joists, and the floor is constructed of concrete and paved with tiles. Considering the risk natural to the work, and the conditions under which it had to be executed, the contractors are to be complimented upon the expeditious manner in which they have carried out their contract. In designing and supervising the construction of the power-house and pump-house, Mr. Cutler was very ably assisted by his chief architectural assistant, Mr. J. C. M. Browne, C.E., and by Messrs. J. Trotter and F. Byers, who acted as clerks of work.

Generating Station.

The generating station (Figs. 7 and 8) forms an extension of the central electricity works which was erected in 1898, this site at the time being recommended by Mr. M'Cowen as a suitable point for distributing energy for the city's requirements both for lighting and traction purposes, and all the plant installed has been arranged for both lighting and traction supply, the generators being provided with compound windings for tramway supply at 550 volts, the lighting pressure being 440 to 500 volts on the outers of the three-wire system. The plant in the original works consists of high-speed steam dynamos having a total capacity of 3,400 kw.; the engines throughout are of Belliss and Morcom's make, the dynamos being by Mather and Platt, Parker, and Johnson and Phillips. The boiler-house plant consists of six Lancashire and six water-tube boilers, together with economisers and steam and electrically driven feed pumps. The condensing plant is of the Wheeler combined type, with steam-driven horizontal air and circulating pumps placed below the condenser, cooling water being obtained from Wheeler and Klein cooling towers. Owing to the large developments in

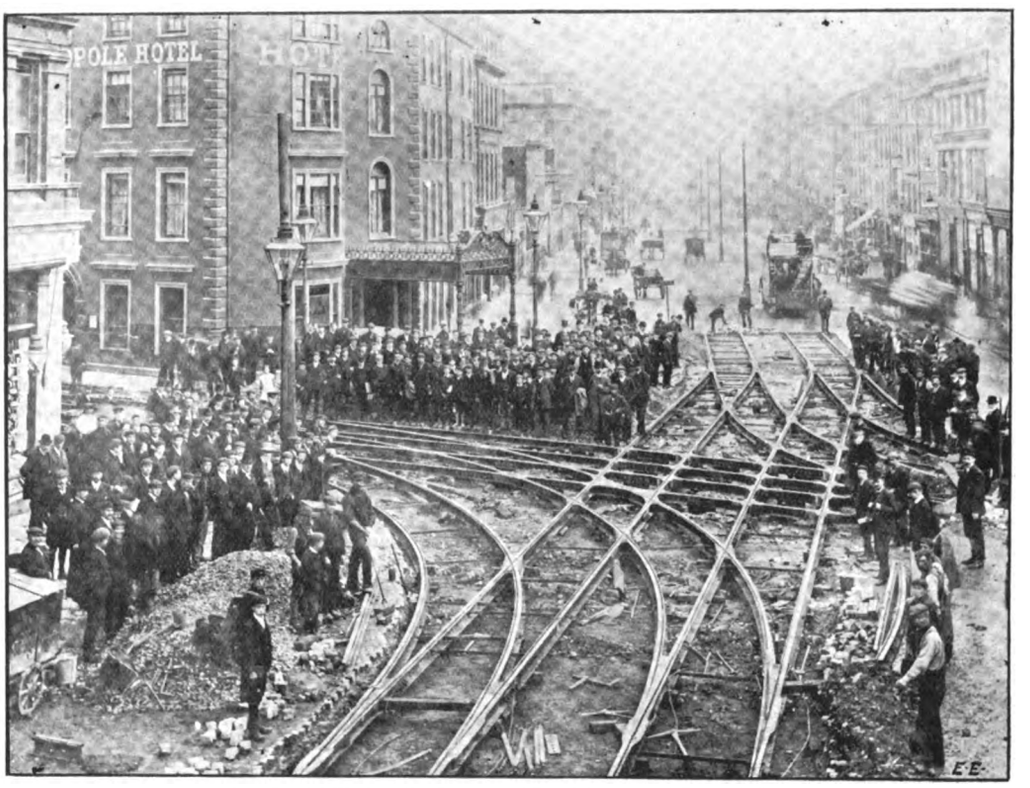

Fig. 4A.—Special Work at the Junction of Royal Avenue and Donegal Street.

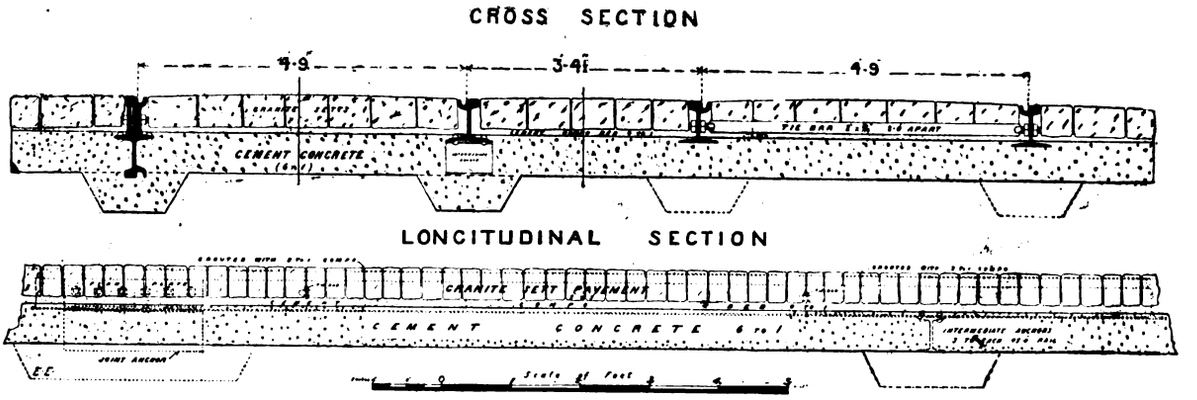

Fig. 5.—Section of the Belfast Track.

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the lighting and power demand, it has been found necessary to extend the building and instal further plant. Provision, however, is made for running three of the large lighting generators on the tramway system if required. The power station is situated close to the River Lagan, and the position is convenient for obtaining condensing water and delivery of coal by barges.

Coal-Handling Plant.

Fig. 8 shows the general arrangement of the coal-conveying scheme. The coal is brought alongside the quay in

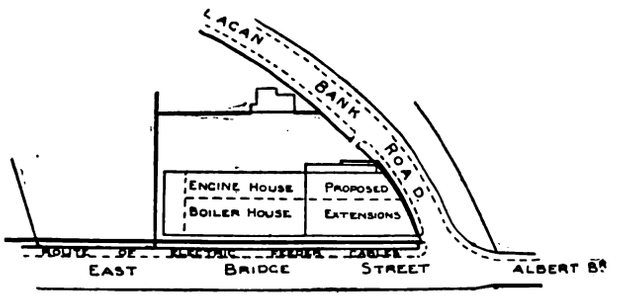

Fig. 6.—Block Plan of Site.

barges, and there discharged by means of a grab operated by an electric locomotive crane, which deposits it into the hopper of an "Ingrey" automatic weighing and recording machine, which discharges it into a receiving hopper underneath. From this hopper the coal passes by means of a shoot, with regulating valves, into an automatic filler, which fills the buckets of the conveyor without spilling. The coal is then elevated vertically (by means of the conveyor, which is of the continuous gravity bucket type) to a suitable height to cross the public road through a covered way into the building, above the ashes can be discharged at suitable times by means of a shoot with regulating valves into either carts or barges underneath. It will thus be seen that the conveyor can be employed for both the delivery of the coal and the removing of ashes at the same time. The conveyor is of the endless-chain pattern, with buckets of the gravity type, and is capable of handling from 40 to 50 tons of coal per hour with a speed of the conveyor chain of 40ft. to 50ft. per minute. The conveyor chain is driven by a special driver with pawls which engage the link studs in each part of the chain on both sides of the bucket. This driver is direct coupled through suitable spur and pinion gear to a 9-h.p. motor of the enclosed type. A movable filler is also provided in the basement for facilitating the trimming of the coal from one bunker to another, and in connection with the removal of the ashes. The "Ingrey" patent automatic weighing and recording machine registers in tons and decimals each charge of coal as it is delivered by the grab, and the total quantity of coal delivered at any time can be ascertained by reading the index. The accuracy is guaranteed to within ½ of 1 per cent

Steam-Raising Plant and Auxiliaries.

Boilers.—The lay-out of the boiler-house is shown in Fig. 7, the arrangement being a single row of boilers placed in batteries of two. Each boiler is provided with its own economiser immediately at the back, and this opens direct into the main flue. By this means the economisers receive the full heat value of the waste gases before cooling due to radiation or leakage can take place. Four Babcock and Wilcox water-tube boilers are erected under this extension. Each boiler is composed of 20 sections of 13 tubes, 4in. diameter and 18ft. long, connected at the ends by staggered headers to the steam and water drums, which are each 25ft. long and 54in. diameter. Each boiler has a heating surface of 5,764 square feet and a grate area of

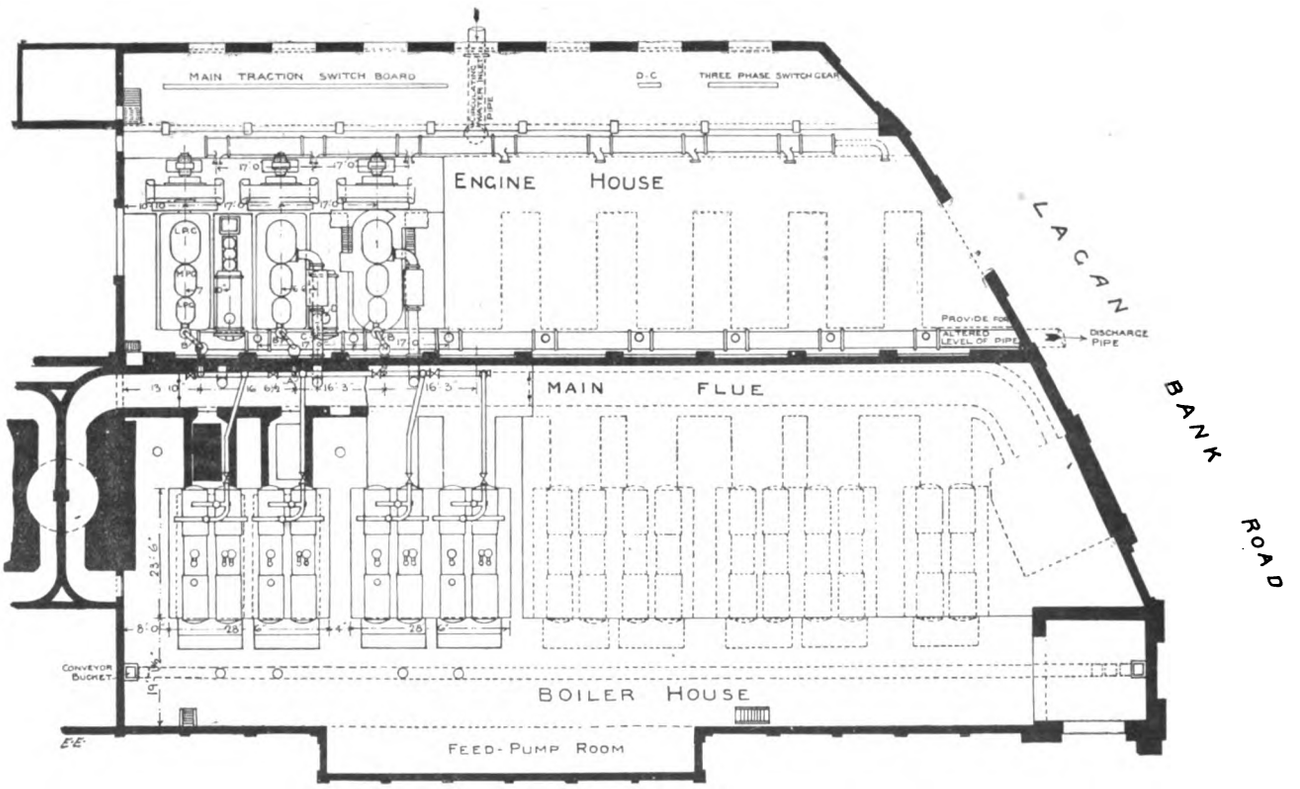

Fig. 7.—Generating Station Extensions required to meet the tramway load.

level of the overhead bunkers, each bunker being provided with a pair of suitable dumping cams, so that the coal can be deposited where required. The overhead bunkers are of steel construction throughout, and are situated over the boiler stoking floor, and have a capacity of 1,000 tons. The conveyor runs above the bunkers the whole length of the boiler-house, and descending at the end wall passes through the basement, where it is again employed for removing the ashes from below the boilers. It then re-ascends at the other end of the boiler-house, and re-crosses the road through the covered way, and deposits the ashes in the ash hopper on the riverside. From this hopper the 100 square feet, and is capable of evaporating from 20,000lb. to 25,000lb. of water per hour from and at 212deg. F. Each boiler is fitted with a Babcock and Wilcox patent superheater having 900 square feet of heating surface, and capable of imparting a superheat of 150deg. F. to the steam produced by the boiler. Each boiler is provided with a double 5ft. by 10ft. Babcock and Wilcox patent mechanical chain-grate stoker. The grate of same consists of an endless chain of short cast-iron bars linked together and actuated by passing over drums at the front and rear, the front drum being revolved by a worm-wheel; gearing is also provided to enable the whole stoker to be brought

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out clear of the boiler. These stokers are of the coking type; the coal is fed over the whole width of the grate, the thickness of the layer of coal being regulated by the vertically sliding fire-doors. The speed of the travel of the grate can also be varied between wide limits, so as to meet any variable demand for steam on the boiler. The ashes and clinkers are dropped over the end of the grate into a clinker pit in the basement, from which they are removed by the conveying plant. The whole of the stokers are driven by a line shaft placed beneath the stoking floor, and connected by clutch gear to duplicate electric motors geared by means of worm reduction gear. The economisers are of Green's well-known make, 128 pipes to each boiler; these are of the latest construction and design, constructed for high-pressure working. The scraper gear of each economiser is driven through a worm gearing by means of an electric motor, and very complete provision is made for removing soot from both the boilers, economisers, and flue and depositing same in the basement, where it can be removed by means of the conveying plant.

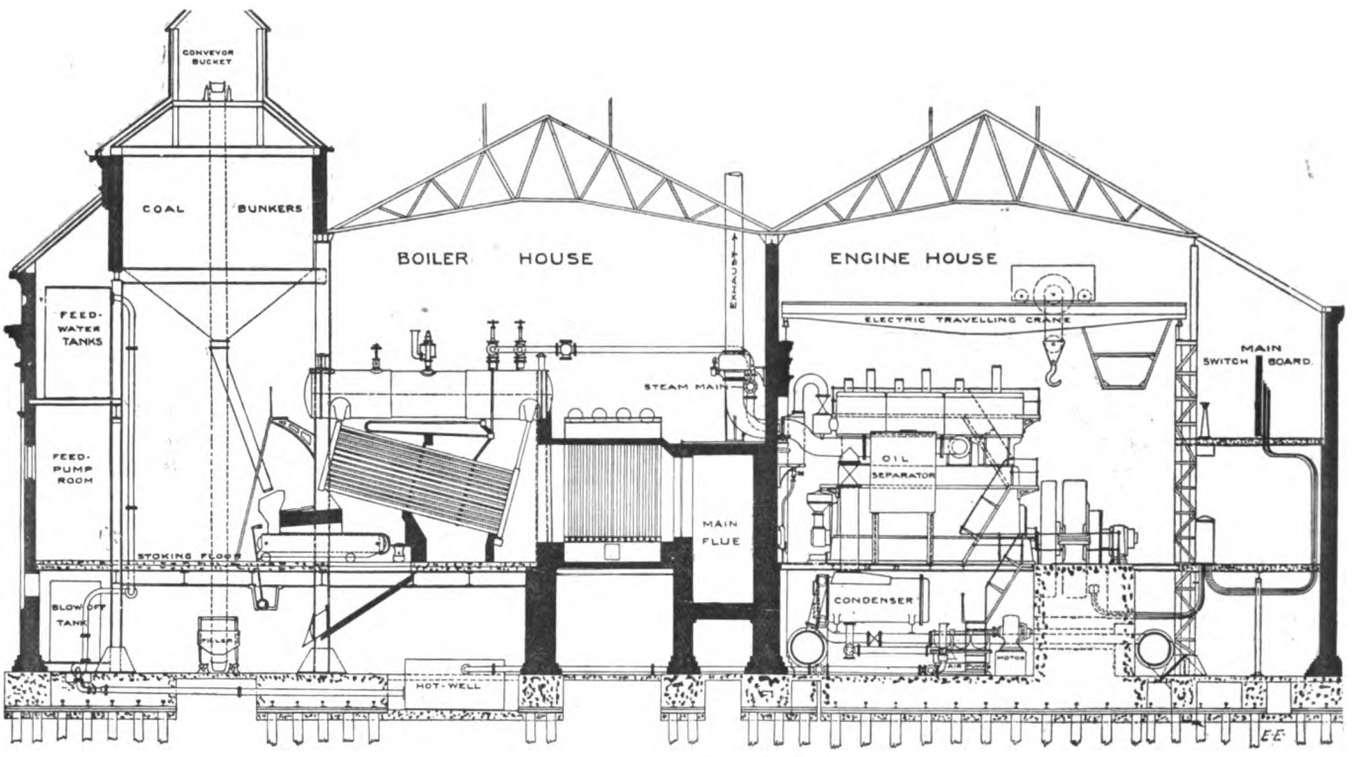

FIG. 8.—Section of the Generating Station.

Pipe Work, Feed Pumps, etc.—The arrangement of steam-pipe work is extremely simple, as can be seen in Fig. 8. Each boiler, economiser, and steam dynamo forming a unit, and are connected by means of an 8in. steam-pipe, the 10in. main steam-pipe in the boiler-house simply acts as an equaliser between the various units. Each unit, therefore, can be separated from its neighbour by means of a valve on the main steam-pipe placed between the unit branches, so that each unit can be run quite independently from each other if necessary. The pipes are arranged to obviate the undesirable necessity of steam-traps, each section of pipe work draining to its own engine separator, which is protected by a trap. The steam-pipes are of weldless mild steel having a tensile strength of 24lb. to 27lb. per square inch with an elongation of 20 per cent. in a length of 6in., no cast iron or copper being employed. All pipes up to 6in. diameter have wrought-steel flanges screwed on, and the pipe afterwards carefully expanded into the flanges; for pipes above 6in. in diameter the flanges are riveted on. The branch connections are formed by means of mild-steel nozzles riveted to the pipe. The valves on the boiler are arranged so that either "raw" or "superheated" steam can be taken. A duplicate system of feed is provided throughout; supplies are taken from two of the Water Commissioners' mains, and are connected to the overhead storage tanks and the hot-feed tank through

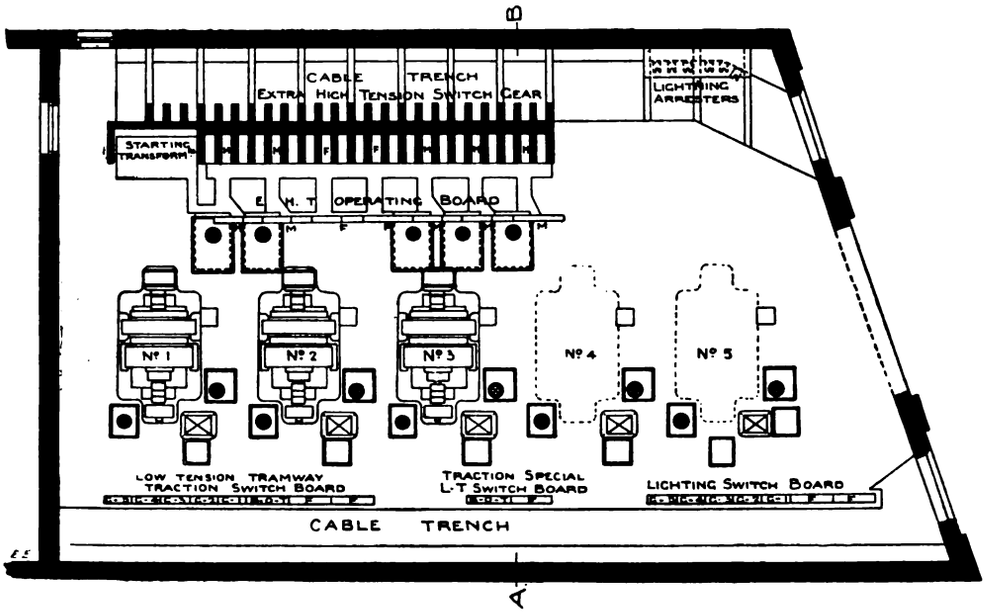

FIG. 9.—Plan of the Fortwilliam Sub-Station.

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ball equilibrium float valves. Duplicate sections are connected from these tanks to the pumps, and duplicate deliveries are run between the pumps and the boilers, one of the deliveries being connected through a 6in. Railton and Campbell pressure feed-water filter, a 6in. Kennedy water-meter, and an auxiliary heater, which takes the exhaust from the steam-pumps to the economiser and thence to the

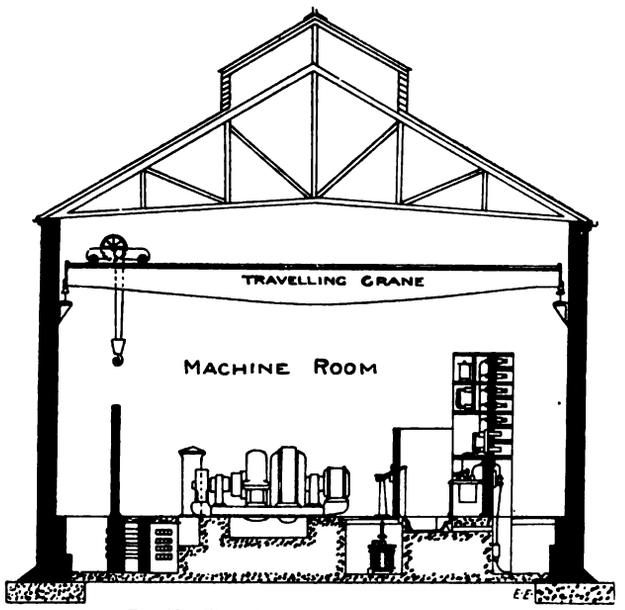

FIG. 10.—Elevation of the Fortwilliam Depot

boilers; the other delivery, which is only used in case of emergency, being connected direct from the feed pumps to the boilers. The feed pumps consist of one Hall compound vertical steam-pump capable of delivering to the boilers 8,000 gallons of water per hour with and against 170lb. to 200lb. pressure per square inch, at a speed of 12 double strokes per minute; two Hayward-Tyler "Sinclair's" electrically-driven variable-stroke pumps, each capable of delivering to the boilers 8,000 gallons of water per hour against the boiler pressure. The variable-stroke feed pump has several advantages that are not possessed by pumps controlled by any other method. Among these may be cited the following: The pump can always be started at "no stroke," thus avoiding heavy starting current. No variation in speed is required. No electrical complications are introduced, and variations in delivery are made while the pump is running without interrupting the feed supply, and by the simple movement of a small hand lever, which is held in position until the required rate of delivery is obtained. An infinite number of rates of working is provided, as the pump may be set for any capacity between zero and the full output. When the pump has been set to work at any particular output, and the voltage of the supply remains constant, the rate of discharge will also remain constant. After the pump is started no further manipulation of electrical gear is necessary, thus enabling the pump to be left safely in the hands of the ordinary boiler attendants. In order to enable the attendant to regulate the pump to the requirements of the boilers, an automatic indicator is fitted to the end of the shaft, which shows either the stroke in inches or the equivalent discharge in gallons per hour. The following are the guaranteed figures for the feed pumps: steam pump, 110lb. of water pumped per pound of steam; electric pumps, 3,600lb. of water pumped per Board of Trade unit. The valves employed throughout are of Hopkinson's own make for a working pressure of 200lb. per square inch with outside screw spindles. The boilers and all steam and feed pipes are covered with non-conducting material to a thickness of 2½in, the pipes in the engine-room being further finished with a covering of planished steel. The boiler-house is provided with an "Ados" flue-gas recorder and a steam-pressure recorder.

ENGINE HOUSE PLANT.

The generating plant erected under this extension consists of three 1,000-kw. direct-current steam dynamos. The engines are of the vertical inverted three-crank triple-expansion enclosed type with forced lubrication, by Messrs. Combe-Barbour, Limited, and constructed to run at a speed of 180 r.p.m. with steam pressure of 170lb. per square inch and 150deg. F. of superheat, the cylinder dimensions being 22in., 33in., and 50in. by 24in. stroke. The steam consumption at full load condensing under the above conditions of steam pressure and temperature, and with

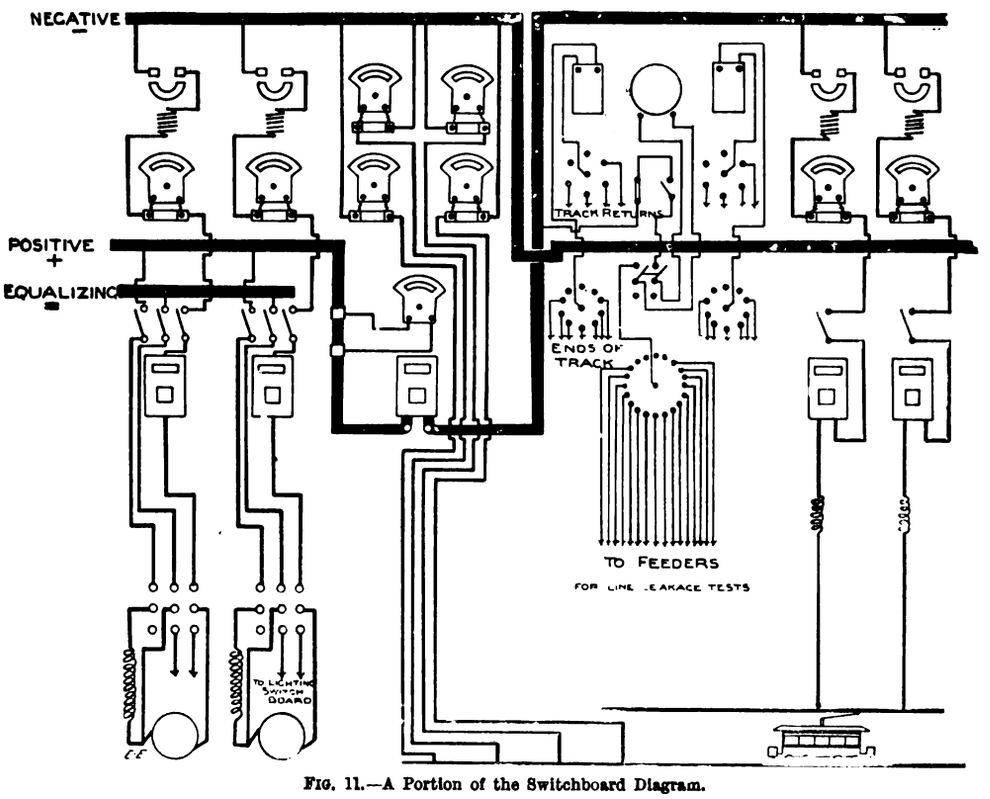

FIG. 11.—A Portion of the Switchboard Diagram.

25in. of vacuum, is guaranteed at 16¾lb. per kilowatt-hour, subject to additions or deductions of £250 per engine for every pound of steam per kilowatt-hour below or above that figure. The generators are of the Westinghouse 16-pole type 1,000-kw. sets, wound for a constant voltage of 550 when connected as compound for traction purposes and 450 to 500 when connected as shunt

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for lighting purposes. These sets are capable of standing 25 per cent. overload for short periods, and 50 per cent. overload momentary.

Condensing Plant.

The condensing plant is of the counter-current surface type, with three-throw Edwards air-pumps, manufactured by Messrs. Mirrlees-Watson Company. The circulating water is obtained from the river by means of electrically-driven centrifugal pumps, arranged in a pump-house on the river bank. Three Gwynne electrically-driven centrifugal pumps are at present erected—two 12in. and one 15in.—and provision is made for the erection of two more when required. The 12in. pumps are each direct-coupled to a 30-b.h.p. motor, and will deliver 150,000 gallons of water per hour. The 15in. is coupled to a 50-b.h.p. motor, and will deliver 300,000 gallons of water per hour. The height of lift varies about 9ft. with the state of the tide, but the maximum is not greater than 15ft. A 36in. steel pipe is laid between the pump-house and the generating station, connections being provided for the ultimate requirements of about 12,000 h.p. The discharge pipe, which is of similar size and material, is brought back to the river higher up, the discharge being brought below low-water level to get the benefit of the siphon action. Two sets of Gwynne-Sargent motor-driven patent charging apparatus are also provided in the pump-house for priming the pumps. Each main engine is provided in the basement with a separate condenser having 2,350 square feet of cooling surface, and an electrically direct-driven three-throw Edwards air-pump. The discharge from the air-pump gravitates into a large cast-iron tank in the boiler-house basement, and is lifted from thence to the hot well over the feed-pump house by means of electrically-driven centrifugal pumps. An exhaust steam grease separator is placed between the engine and the condenser, each engine being also provided with an atmospheric exhaust controlled by an automatic valve, which opens in the event of the vacuum failing, so that the sets can run non-condensing.

Three-Phase Plant.

Energy is transmitted at 6,000 volts three-phase to a sub-station at the Fortwilliam depôt (Figs. 9 and 10) for operating portion of the system in that district, and for the supply to the Cavehill and Whitewell Tramway Company for their line. Two 250-kw. three-phase synchronous motor-generators are at present erected in the power station. These machines are supplied with continuous current from either the traction or lighting switchboards at a pressure of 500 to 550 volts, and generate three-phase current direct at 6,000 volts, 50 cycles. The alternating-current three-phase generators are of the Westinghouse 12-pole revolving-field type. The direct-current motors are six-pole coupled to the generators on a compound bed-plate. An exciter is provided on one end of the shaft for supplying the alternating-current field current; the speed of the set is 500 r.p.m. Three 125-kw. three-phase synchronous motor-generators are erected in the sub-station. These are similar to the 250-kw. sets, with the exception that each is provided with a small three-phase induction starting motor mounted on the other end of the shaft. The efficiencies guaranteed for these machines are as follows, the efficiency being taken as the ratio of the direct-current input to the alternating-current output:

Load.	250-kw. set.	125-kw. set.
1	87 per cent.	83½ per cent.
¾	86 ,,	82 ,,
½	82 ,,	78 ,,

The three-phase switchgear is of the Westinghouse well-known type. The chief feature of the high-tension portion is that all live parts are isolated from the operator, and fire risk is reduced to a minimum. All metal conductors are entirely enclosed in masonry cubicles, so that in the case of fire originating in one of these cubicles it is entirely confined to it. The oil switches are of the remote-control type, with a separate double-break switch in each phase. Each switch is entirely enclosed in a masonry structure, this separating it from adjacent phases. The switches are automatically opened by means of a trip coil, energised by means of series transformers placed in the main circuit. Duplicate three-phase 'bus bars are provided, to which the various generators and feeders are connected through selector switches, so that either 'bus bar can be made dead for cleaning or other purposes. Provision is also made for starting these motor-generators from the direct-current side. The sub-station is situated about three miles from the generating station, and is connected by means of a duplicate extra high-tension three-core trunk main, the section of each core being 0·075 square inch. These are lead-covered and armoured, and laid in earthenware troughs filled in with solid bitumen.

Switchgear.

The main traction switchboard and the three-phase operating switchboard are erected on a gallery which runs the full length of the engine-room at a height of 12ft. above the main floor-level. The main traction switchboard consists of three 500-kw. and three 1,000-kw. generator panels; one totalising panel; one Board of Trade panel; eight feeder panels, each for two feeders; one auxiliary power and lighting panel. The panels are of white Sicilian marble 2in. thick, the over-all height being 92in., the total length of the traction board being 50ft. Each generator panel is provided with a Bertram Thomas magnetic blow-out circuit breaker, a Weston illuminated-dial ammeter, three generator switches, and a Thomson integrating wattmeter. The totalising panel has mounted on it one Thomson integrating wattmeter (10,000 amperes), one Weston illuminated ammeter (10,000 amperes), four Weston illuminated ammeters for rail returns, two extra large Weston illuminated voltmeters on swing brackets for indicating the 'bus-bar and machine voltage. The Board of Trade panel has mounted on it one Elliott recording ammeter (10,000 amperes), one Elliott recording voltmeter (750 volts), two Elliott recording voltmeters (0 to 10 volts for rail drop), one Elliott recording ammeter (0 to 10 amperes), one Weston ammeter with double scale 0 to ·05 and 0 to 5 amperes; also the necessary multiple-contact switches for taking the line leakage tests on the various routes and multiple-contact switches for getting the rail drop between any of the four earthed points of the track and any of the route termini. Each feeder panel has mounted on it two Bertram Thomas magnetic blow-out circuit breakers, two Weston illuminated ammeters, two single-pole quick-break switches, two Thomson integrating wattmeters, and two Wurtz lightning arresters and kicking coils. As each route is supplied by a separate feeder, the energy used from day to day on any route can be ascertained, and valuable information obtained regarding the operation under different conditions. A main three-pole throw-over switch in the circuit of each generator is mounted on a pedestal on the floor below the switch gallery for connecting generators to the traction switchboard as compound machines, and to the lighting switchboard as shunt machines. The shunt resistances are mounted below the gallery floor, and are operated by means of hand-wheels erected in convenient positions in front of the switchboard.

Overhead Equipment.

The overhead equipment was carried out by Messrs. J. G White and Co., and the greater portion is of span-wire construction, with the exception of 2½ miles of side bracket, on outlying districts, and 2¾ miles of centre-pole construction in the wide main thoroughfares in the centre of the city. The poles are of lap-welded mild steel of the sectional type to the British standards specification. The pole fittings are of pressed steel, all straps, bolts, and nuts being galvanised. The poles are planted at the usual distance of 40 yards apart, the holes being filled in with 5 to 1 Portland cement concrete to a radial depth of not less than 8in. around the pole. The trolley wire is of hard-drawn copper 0·4in. diameter, with a breaking strain of 24 tons per square inch. The trolley wire, which is double throughout, is fixed at a height of 22ft. above the track, flexible suspension being adopted in all cases, and it is arranged for centre running on all span work, the maximum deviation allowed in any case being 6ft. from the centre of the track. On curves the wire in no case assumes an angle of less than 160deg.; 18in. ears are employed on the straight, and 30in. and 33in. ears on

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curves. The sectional curves are of the straight under-running air-gap pattern, and are capable of standing a strain of 4,000lb. The span wires are of $^{7}/_{12}$ S.W.G. galvanised steel, with a breaking strain of not less than 4,000lb. Duplicate insulation is employed throughout. The insulator bolts are ¾in. diameter, and both insulators and Brooklyn strains are capable of withstanding a strain of 6,000lb. Guard wires are of $^{7}/_{16}$ S.W.G. galvanised steel with a breaking strain of 2,500lb. Guard wiring, however, has been reduced to a minimum, owing to the Corporation, on the advice of Mr. M'Cowen, having required the Telephone Company to put all their telephone wires on tramway routes underground. This, it is expected, will considerably minimise troubles with the overhead equipment. Section feeder pillars are placed half a mile apart on all routes, and at shorter distances in the centre of the city to suit local conditions. The section and feeder pillars are arranged for double insulation, and are provided with the following switchgear: two 400 and four 200 ampere quick-break switches, one 'bus bar of one square inch section, one lightning arrester and kicking coil, one terminal board for telephone and test wire terminals, and one telephone plug box. The current density for all switches and connections is 500 amperes per square inch. A small separate door is provided for getting to the telephone plug boxes, and owing to trouble from damp experienced with telephone instruments placed in pillars, the usual method has been departed from, and plug boxes only are provided in the pillars. The instruments themselves are provided with an induction coil in the handle, and an instrument is taken on each car, which can be plugged on to any pillar, and communication made with the power-house or car-sheds as desired. The centre poles are lighted by means of two incandescent lamps fixed on each pole at a height of about 12ft. from the ground; these are simply for the purpose of indicating the position of the poles at night, and not for street-lighting: they are supplied from the lighting mains. Provision was made for erecting arc lamps on the centre poles for street-lighting, but this matter has been deferred for the present. The overhead equipment in the six car-sheds and the approaches to same has been carried out by Mr. M'Cowen's own staff. Mechanical ears have been employed throughout this work, which has resulted in a considerable saving in cost, and gives excellent running. In some of the larger sheds one trolley wire is arranged to serve two lines of track. This method has been adopted with a view to reducing complications in the overhead special work, and as in one case as many as 17 tracks are taken off the two approach tracks, and in another 20 tracks are taken off a single track, the possible complications of overhead equipment can be imagined. The overhead wiring of each shed is separated from the street wiring by sectional insulators, and the supply of energy to each shed is controlled by a circuit breaker and wattmeter, so that the energy used in the sheds can be carefully watched and the outside lines protected from interruptions due to faults in the car-sheds. The approaches to each shed are brilliantly lighted by means of arc lamps supplying from the lighting mains where these are available, and in the other case from the tramway supply.

Underground Feeders.

The feeder cables are of Callender's well-known bitumen insulated type, laid in earthenware troughs run in solid with bitumen, the troughs being covered with hard-burnt tiles. Two cables only are laid in each trough, the arrangement throughout being the feeder together with the telephone and test wire for the same route placed in the same trough. There are 16 line feeders and four return feeders, the system of distribution being a line feeder for each route and two line feeders to the central district of the city. The rail return feeders are taken to four of the principal junctions, and are connected to the rails at these points through special switch pillars provided with a maximum demand indicator to register the earth-plate current, and an ammeter, together with the necessary switchgear and battery for testing the condition of the earth-plates which are placed at these four points. The rails are not earthed at the generating station, and neither positive nor negative boosters are at present employed in connection with the distributing system. The length of the feeders vary from 1,500 yards to 7,500 yards, and the section varies from one square inch to ·15 square inch of copper. The section of the rail return feeders varies from 2½ square inches to 1½ square inches, depending on the load in the various districts. All cables were subjected to the specified pressure test of 2,500 volts, and short lengths after being submitted to the usual bending tests failed to break down with 30,000 volts. These tests were carried out in the presence of Mr. M'Cowen at Messrs. Callender's works. Spare ways, "Sykes conduits," have also been laid to various junctions throughout the system, with a view to increasing the feeder capacity at a future date should the development of the undertaking require it. The supply and laying of the feeder cables were carried out by Messrs. Callender's Cable and Construction Company.

The contract for the whole of the work, with the exception of the buildings, was placed with Messrs. J. G. White and Co., London, on Dec. 1, 1904, the sub-contractors being: rails, North-Eastern Steel Company; special track-work, the Lorain Steel Company; feeder cables, Callender's Cable Company; engines, Combe, Barbour, and Combe; electric generators and switchgear, Westinghouse Company; boiler-house plant, Babcock and Wilcox; car bodies, Brush Company; car electrical equipment, Westinghouse Company.

In the supervision of the electrical equipment of the system Mr. M'Cowen was ably assisted by his deputy (Mr. Bloxam) and his tramways distributing assistant (Mr. Croft). The total cost of the undertaking, including cost of works, award of arbitrator, and expenses, is close on £1,000,000.

TORQUAY ELECTRICITY SUPPLY.

Local Government Board Muddle.

The following correspondence will, in our opinion, show to any intelligent electrical engineer the hopeless muddle that the Local Government Board has made over the Torquay applications for loans for extensions. Our conclusions as amplified in our leading article are as follows:

1. That the Local Government Board after all these years of experience has acquired no knowledge whatever as to the effect of load factor on the cost of production.
2. That it wants business men as inspectors, rather than engineers with only sufficient knowledge of the subject as to be examples of the old proverb.
3. That the Local Government Board fancies itself above Parliament, whereas it is only a branch department, not entitled to reverse parliamentary decisions.

The letters are not the complete correspondence, but suffice to show the trend of the same. The net result is an immediate loss of over £1,000 to the Torquay Corporation, a further loss of £3,000 when the new plant has to be moved, and a further loss most difficult to estimate, due to the fact that no new consumers of any magnitude can be connected for some years to come.

"Local Government Board,
"March 21, 1905.

"Sir,—I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the inquiry held by him with reference to the application of the Town Council of Torquay for sanction to borrow £42,000 for purposes of electric lighting and power supply.

"The Board are advised that the present proposals of the Town Council would probably involve a serious loss to the borough for, at any rate, the first few years. Apart from this, the proposals involve the supersession of works at the existing power station and at the destructor, on which there is an outstanding debt of more than £8,700, and if the scheme were to proceed, the amount of this debt would have to be provided out of the current rates for the year.

"In these circumstances, and having regard to the present high rates in the borough, the Board think that the Town Council should seriously reconsider their proposals.

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"It appears from the evidence given at the inquiry that the profits on the existing works of electric lighting amounted to £1,096 for the year 1904, and the inspector reports that, although the site of the power station is cramped, improvements could probably be effected there which would render the station sufficient for the supply of energy for lighting purposes for some years to come.

"I am to remind you that the cost of obtaining the electric lighting provisional order must not be charged to the loan account.—I am, etc.,

"(Signed) NOEL T. KERSHAW,
"Assistant Secretary.

"The Town Clerk, Torquay."

"The Dolter Electric Traction, Limited,
"3 and 4, Great Winchester-street, London, E.C.
"March 23, 1905.

"Frederick S. Hex, Esq.,
"Town Clerk, Town Hall, Torquay.

"Dear Sir,—I am instructed by my directors to inform your Corporation that on the occasion of the visit of our chairman, engineer, and contractors to Torquay, they found that nothing further had been done towards the work of preparation to furnish the electrical supply agreed upon between the Corporation and the Dolter Company.

"I beg to inform you, on behalf of the Dolter Board, that final arrangements are now made by the Dolter Company for commencing work, that they have placed orders for materials, etc., and will push on with all possible speed, and, further, be ready to take current from you the first week in August.

"Further, I am instructed by my directors to inform your Corporation that under the provisions of their Act of Parliament they will hold your Corporation liable for any loss sustained after the line is laid.

"Trusting that you will kindly place this letter before your Corporation without delay—I am, etc.,

"(Signed) H. LANCASTER,
"Manager of the Dolter Electric
"Traction, Limited."

"3 and 4, Great Winchester-street,
"London, E.C.,
"May 1, 1905.

"Fredk. Hex, Esq.,
"Town Clerk, Town Hall, Torquay.

"Dear Sir,—I have been instructed by my directors to write and inform you that in consequence of not having received any reply to my last letter, they wish to urge upon your Corporation the importance of letting us have a definite decision in regard to the supply of current for our tramway undertaking.

"I write this letter without prejudice to any action which we might take under the existing agreement between my company and your Corporation. But it would facilitate our commencing operations if you would let me know on behalf of your Corporation whether, in the event of their being unable to obtain the necessary consent of the Local Government Board for the erection of a new power-house, they would be prepared to let their lighting undertaking to my company, who would make a fair arrangement for sharing profits, etc. (which I should be prepared to discuss with you), and would also undertake to pay all capital charges. They would also make arrangements as to obtaining a supply of current in conjunction with the lighting undertaking.

"Should this not meet the views of your Corporation, the question, then, is whether they will at once give consent for us to erect our own generating station. We, of course, recognise that this would be a great loss to the town; but your Corporation, as business men, cannot fail to see that it is difficult to commence an undertaking of this magnitude without receiving definite replies as to our position in regard to the supply of current.

"We may point out to the Corporation of Torquay that, while we have been delayed over this question, we have carried through and are just commencing an equally large scheme connected with the Sheffield tramways at Rotherham.

"This delay is very trying to my directors, who are occupied on several other important schemes at the present time, and it is suggested that a conference might be held in a fortnight's time, when a definite result as to the policy of your Corporation should be arrived at.

"Awaiting your reply, and trusting there will be no delay in placing this letter before the members of your Town Council.—I am, dear Sir, yours faithfully,

"(Signed) H. H. LANCASTER,
"Manager of the Dolter Electric
"Traction Limited."

Resolution passed June 2, 1905.

"That this Council having, in accordance with the letter of the Local Government Board of March 21, 1905, seriously reconsidered the proposals contained in the recent application to the Board for sanction to borrow £42,000 for purposes of electric lighting and power supply, begs respectfully to inform the Local Government Board that, having by Section 58, Sub-Section 9, of the Torquay Tramway Act, 1904, agreed to supply electric energy to the Dolter Electric Traction, Limited, cannot now see its way to modify its application to the Local Government Board for sanction to borrow the sum of £42,000 save as hereunder set out, for the purpose of enabling it to perform the said agreement, as in case of non-performance thereof on the part of this Council, the Council might be involved in litigation and possibly found liable to pay heavy damages to the Dolter Electric Traction, Limited, and this Council respectfully asks the Local Government Board to consider the position in which this Council is placed by reason of the said agreement, which was fully discussed and approved by the committees of both Houses of Parliament, and further asks the Local Government Board to grant the application of this Council with the omission of the sum provided for the erection of a combined chimney, so that, in addition to the agreement above referred to being performed, the increased accommodation for the purposes of electric lighting so urgently needed may be provided."

"Local Government Board, Whitehall, S.W.,
"June 28, 1905.

"Sir,—I am directed by the Local Government Board to acknowledge the receipt of your letter of the 23rd inst., with reference to the application of the Town Council of Torquay for sanction to borrow £42,000 for purposes of electric lighting and power supply, and to state that the Board have carefully considered the representations in the resolution of the Town Council passed on the 9th ult., and in your letters, but they adhere to the view that the proposals of the Town Council would probably involve a serious loss to the borough.

"The Board realise the difficulty in which the Town Council are placed in consequence of the agreement entered into with Dolter Electric Traction, Limited, but it would appear from the letter from the company to the Town Council of May 1, a copy of which has been forwarded to the Board, that the company might be willing to enter into arrangements with the Town Council, by which the latter would be relieved from their obligations under the agreement.

"The Board think that the Town Council should place themselves in communication with the company with a view to some arrangement with this object being made if practicable.—I am, Sir, your obedient servant,

"(Signed) JOHN LITHIBY,
"Assistant Secretary.

"The Town Clerk, Torquay."

"Whitehall, S.W., August, 1905.

"Sir,—I am directed by the Local Government Board to advert to your letter of the 19th ult. with reference to the application of the Town Council of Torquay for sanction to borrow £42,000 for purposes of electric lighting and

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power supply, and as regards your request to be furnished with particulars of the figures upon which the Board have arrived at the conclusion that the proposals would probably involve a serious loss to the borough, I am to make the following observations:

"At the local inquiry in January last the Council's electrical engineer submitted an estimate of the probable receipts and expenditure during the first year's working at the proposed new power station. The following is a summary of this estimate:

	£	s.	d.	£	s.	d.
Revenue—						
Lighting	7,493	8	6			
Tramways (based on 106 hours per week per car)	3,572	18	4			
				11,066	6	10
Expenditure—						
Interest and sinking fund charges	5,049	7	3			
Working expenses (based on an average cost of 1·38d. per unit sold)	5,694	0	0			
				10,743	7	3
Estimated surplus				322	19	7

"As regards the estimated revenue from tramways, the Board are advised that the basis of calculation—*viz.*, 106 hours per week per car—is excessive, and that the more probable figure for a place like Torquay would be 80 hours per week per car. Taking the latter figure as the basis of calculation, and allowing a corresponding saving in fuel, the estimated revenue from tramways would be, say, £2,858, or a reduction of 20 per cent. on the estimate submitted.

"As regards the working expenses, the Board are advised that the estimate of 1·38d. per unit, which is little more than one-half the actual cost at the present time, is too low. They find that at seven other towns in England of about the same size as Torquay, which supply power for traction purposes as well as for lighting, the average total works cost per Board of Trade unit is 2·15d., and some of these towns are better situated for obtaining cheaper coal.

"The Board think, therefore, that in order to arrive at a fairly accurate estimate, the average cost per unit sold should be taken at not less than 1·82d., which would then be a distinctly low figure for a place like Torquay, and a reduction of 41 per cent. below the present cost.

"Taking the amended figures for tramway revenue and working expenses as above suggested, the estimated revenue and expenditure would be as follows:

	£	s.	d.	£	s.	d.
Revenue—						
Lighting	7,493	0	0			
Tramway	2,858	0	0			
				10,351	0	0
Expenditure—						
Interest and sinking fund charges	5,049	0	0			
Working expenses	7,592	0	0			
				12,641	0	0
Estimated deficiency on first year's working				2,290	0	0

"I am at the same time to transmit to the Town Council the enclosed copy of a communication which the Board have received from the manager of the Dolter Electric Traction, Limited, and to inquire whether the Council concur in Mr. Mitchell's report. If so, the Board would be prepared to consider a scheme on the lines indicated, and I am to request that such a scheme may be submitted.—I am, etc.,

"NOEL T. KERSHAW, Assistant Secretary."

Report of the Torquay Council Meeting, Nov. 24, 1905.

The TOWN CLERK read the following important communication from the Local Government Board:

"Local Government Board, Whitehall, S.W.,
"Nov. 20, 1905.

"Sir,—I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Mr. Hooper, after the inquiry held by him with reference to the application of the Town Council of Torquay for sanction to borrow the sum of £9,500 for purposes of electric lighting and power supply. The Board has decided to comply with the application so far as it relates to the borrowing of the sum of £8,099, and their formal sanction is forwarded to you herewith. In arriving at this amount the Board have deducted the following sums:

(1) Cost of taking down and removing 125-kw. alternator	£10
(2) Outstanding debt on such alternator	1,336
(3) Cost of removal of 40-kw. alternator	55
	£1,401

"As regards deductions (1) and (3) I am to explain that the Board do not regard these items as suitable subjects of a loan. Deduction (2) is made in accordance with the Board's usual practice in cases where works on which debt is outstanding are to be superseded. The Board will raise no objection to the application of any sum received from the sale of the 125-kw. alternator in defraying the cost of the new plant.

"The Board direct me at the same time to point out to the Town Council the desirability of postponing for the present any extension of the system of public lighting by electricity. The Board gather that this system is unremunerative, and, having in view the financial advantage of utilising the present generating station as long as possible, it is clearly inadvisable to increase the existing loan for any unprofitable purpose. Moreover, the Board consider that as the provision of a new generating station will no doubt ultimately be necessary, the Town Council should see that the undertaking is carried on with the greatest economy, and otherwise in such a manner that a substantial reserve fund may be built up to meet the anticipated large expenditure.—I am, Sir, your obedient servant,

"NOEL T. KERSHAW, Assistant Secretary."

Councillor MORTIMER, in moving that the communication be referred to the Electrical Committee, said no doubt there would be a certain amount of congratulation that the loan had been granted, but he felt that the larger scheme, with certain modifications, would have been much the better one.

Councillor KENNY seconded.

Alderman RUTLAND asked how the £1,400 was to be made up.

The TOWN CLERK: That is a matter for the Electrical Committee to report upon.

The motion was carried.

Councillor ROCKHEY said there was a rumour about that there had been an offer made to purchase the electrical undertaking. Was it correct?

The TOWN CLERK: If you have patience, you will hear something about it at a future meeting.

Councillor ROCKHEY: I have patience, but I wish to know if it is correct.

Alderman PEARSON: Yes.

ELECTRIC LOCOMOTIVE FOR UNDERGROUND RAILWAY.

The electrification of the Underground Electric Railway Company's line has been extended as far as Earl's Court

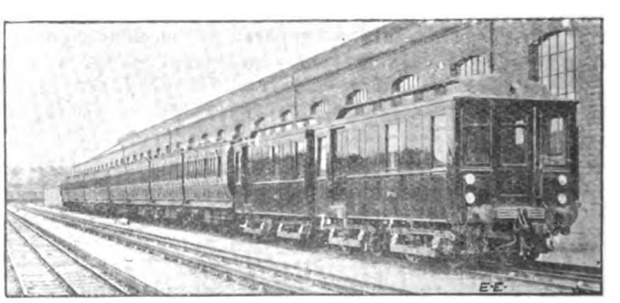

FIG. 1.—L. and N.W. Train with Electric Locomotive.

and on Saturday the new electric locomotives for drawing the London and North-Western trains were introduced for the first time. The trains are now driven electrically from the Mansion House to Earl's Court, at which place the electric locomotive is shunted (the train proceeding on its

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journey with a steam locomotive), and used for driving another train to the Mansion House on the return journey.

simply taking one of the B.T.H. standard equipments supplied for their underground trains and applying it to

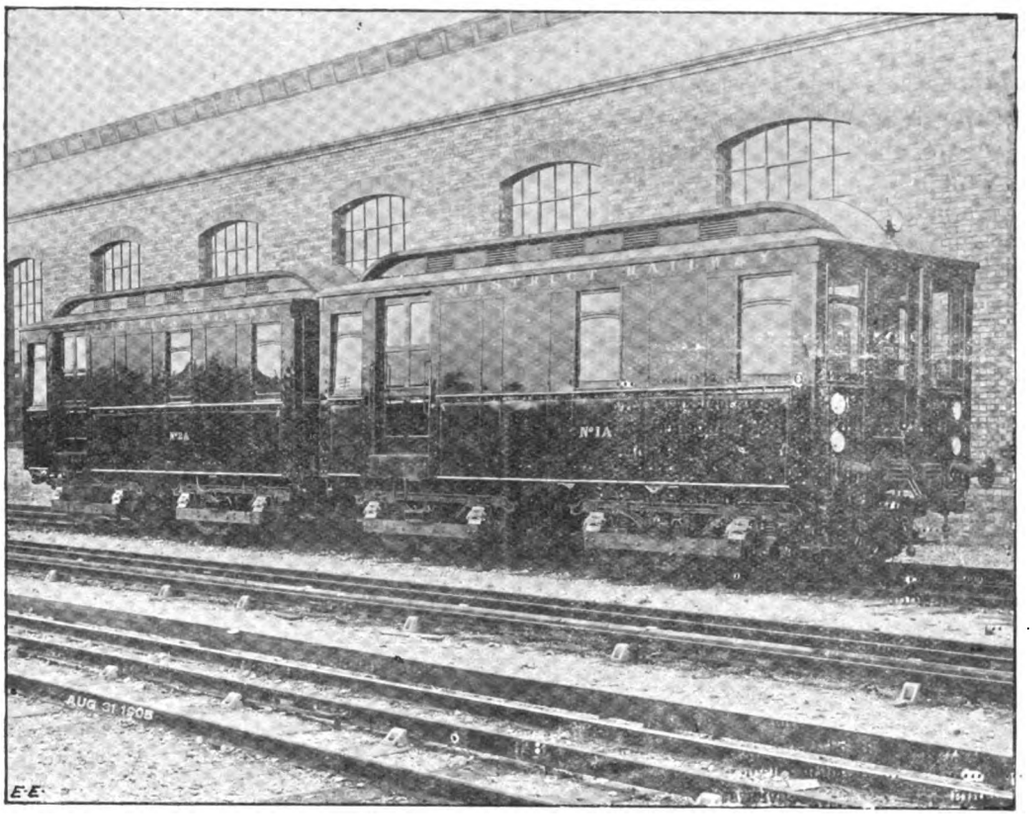

FIG. 2.—District Railway Company's 800-h.p. Electric Locomotive for hauling L. and N.W. Trains.

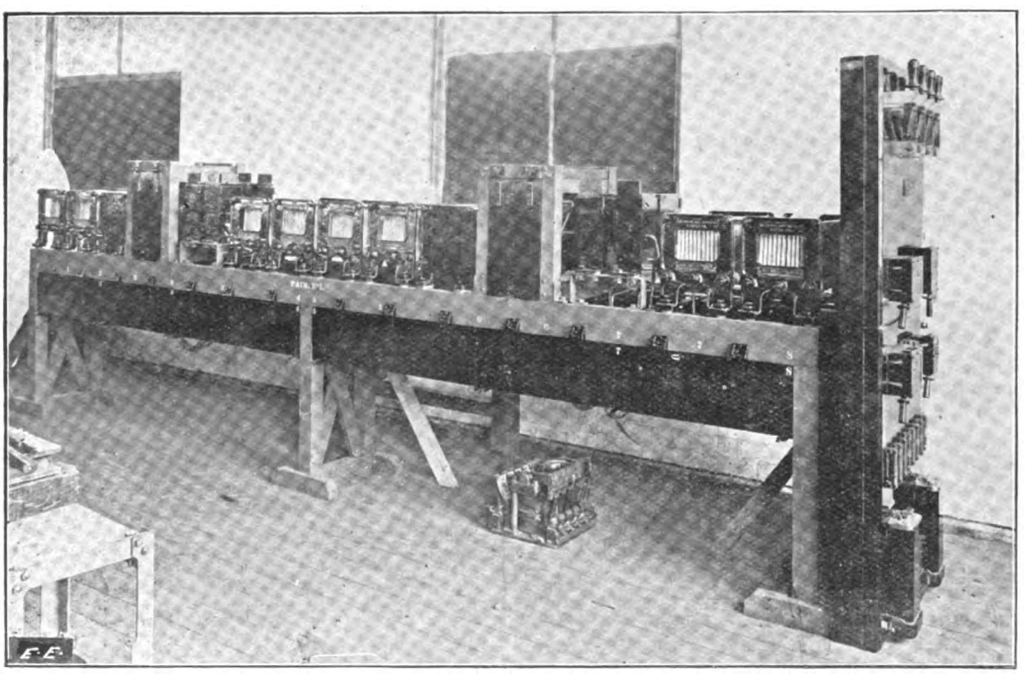

FIG. 3.—Arrangement of Contactors, Switches, Circuit Breakers, and Reversers.

The locomotives were built by the Amalgamated Railway Carriage and Wagon Company, Limited, of Saltley Works, Birmingham, and each is provided with motors of 800 h.p., the weight of the London and North-Western train with load being 140 tons (Figs. 1 and 2). There are four 200-h.p. motors of the B.T.H. G.E.-69 type on each locomotive, similar to those used on other underground trains. The Sprague Thomson-Houston system of train control is in operation, and each locomotive is furnished with a double equipment, consisting of two sets of contactors, circuit breakers, reversers, etc. The photograph (Fig. 3) shows the arrangement of the open equipment. This is the same as has been in operation for some time, the Underground Railways Company of London, Limited, the locomotive. The combined weight of each locomotive is about 56 tons, or seven tons on each driving axle.

Hydro-Electric Plant.—The *Diario Official* of Mexico of Oct. 30 notifies an application by Señor Salvador Gambino for an appropriation of 10,000 litres of water per second from the river San Pedro, in the State of Chihuahua, for the purposes of irrigation and production of motive power. The *Diario* of Oct 31 notifies an application by Señor Felix Araiza for an appropriation of water from the river Bolaños situated between the State of Jalisco and the territory of Tepic, for the production of motive power. The *Diario* of Nov. 2 notifies an application by Señor L. del Paso for an appropriation of 9,000 litres per second from the waters of the rivers Chinipas and Septentrión, in the States of Sonora and Sinaloa, for the production of motive power.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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POOR TORQUAY.

The Torquay Corporation, and, unfortunately, the Torquay ratepayers also, are to be commiserated with in the straits to which the Local Government Board have brought them. We believe it was Sydney Smith who said, "A corporation has neither a body to be saved nor a soul to be damned." Whether we are correct or not in our quotation, it is certainly the case with the Local Government Board, because the Board, although powerful in doing mischief, has no existence. As it is impossible, therefore, to libel a Board which does not exist, we feel quite free to express our strong opinion on the decisions issued in the name of that Board. If certain of the permanent officials, or even the outgoing political chief, should take these remarks as personal, we shall be exceedingly vexed. If, however, they will induce the permanent officials to study the subject which their very appointments suppose them to be expert in, our object will have been gained. Certain of our readers may not have followed our leading articles on the procedure of the Local Government Board when considering electric lighting loans. We would ask them to read the three leading articles for Nov. 3, 10, and 17, entitled respectively "The Local Government Board and Electrical Undertakings," "Local Government Board Loans,' and "Engineering Estimates and the Local Government Board." They would also do well to read the letters which have passed between the Board and the Corporation of Torquay which appear in this issue, together with a few letters from the Dolter Electric Traction Company, Limited. We took care that the leading articles above referred to should be brought to the notice of the chief of the department of the Local Government Board dealing with the Torquay matter, and we also sent the papers to Mr. Ross Hooper, the inspector who held the two Torquay inquiries. We are somewhat surprised, therefore, to find that the final decision of the Board should be such as to perpetuate for a time at least an inefficient station for the generation of electricity. After the letters in question will be found a report from the *Torquay Times* of the last meeting of the Council. It was asked what the Electricity Committee proposed to do as to that portion of the loan which the Board would not sanction—*i.e.*, one thousand four hundred and one pounds. We can answer this question. This sum, less any moneys received for the old machinery sold, will have to be borne out of revenue. This looks like an immediate loss of about one thousand pounds for the removal of machinery which if left in its present position would continue to earn profits until such time as a new station can be erected. For this loss the Local Government Board are directly responsible because they have sanctioned the removal of the machinery. Further, they have granted a loan for eight thousand and ninety-nine pounds for new machinery and alterations to the old station to enable this to be put down. As we showed in our leader of Nov. 10, the Board had the evidence of the well-known expert, Mr. E Manville, that two or three years would be the probable time in which the load would outgrow the capabilities of the altered station. Hence, in, say, three years' time, as we then explained, some three thousand pounds worth of the present expenditure will become valueless, as the machinery now installed will then have to be moved into a new station elsewhere in the town, where economical running will be possible. The Local Government Board hides these facts away, and grants the new loan for fifteen years. At the end of three years it is true that the present expenditure will stand on the books at four-fifths of its present value. This depreciation, however, is required to meet the presumed

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replacement of the plant in fifteen years, and does not affect the three thousand pounds' loss in its removal in three years' time. The Local Government Board have, therefore, forced the Corporation to take one thousand pounds from revenue this year, and at the end of three years they insist, if they follow their unbroken precedent, in a further loss of three thousand pounds being met by revenue. This total loss of four thousand pounds is, however, a small matter compared with the other recommendation in the last letter sent to the Corporation. In it they are told not to extend their street-lighting because it is unremunerative, and, reading between the lines, the Corporation have little chance in extending their private consumption either, because the altered plant will not be capable of meeting much more load than that required for the tramways. The letters we publish will show that the Board and some of its inspecting engineers are as ignorant as even our gas contemporaries of the true method of ascertaining what it costs to supply any particular type of load. They are, therefore, quite incapable of saying what is and what is not a profitable price to charge either for street-lighting or tramway supply. They have not sufficient business knowledge to know that a parliamentary power supply company with a million pounds of capital on paper may not have enough money in the bank to meet their office expenses. Such lamentable lack of business capacity makes one wish that the late Sir Courtney Boyle could be again in charge of the Department. We remember that once a company promoter, wishing to get the transfer of the Fleetwood electric lighting order, sent a deputation of the Corporation to Sir Courtney Boyle, with the certificate of registration of the company as evidence of financial stability. He promptly requested them to "Take away that —— picture"—and we need hardly say that the application for transfer was not granted. We hope that with the change of Government the political head of the Board of Trade will not be the only change made in the personnel. It is quite time that such an important department was reorganised, so that at least there may be some chance of the staff understanding the subject with which the Department has to deal.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC FIRES (?)

SIR,—I notice in the newspapers this morning that the cause of the fire at the Shrewsbury Schools is put down to the fusion of the electric light wires. I have thoroughly investigated the matter both yesterday and to-day, and can say positively that this was not cause of the fire. The whole of the branch fuses were in order in the distributing boards (which were not damaged by the fire), showing that the damage to the wires was the effect of the fire, and was done after the main switches were turned off. The fire is supposed to have started some distance from any electric light wires, and close to the flue leading from the heating apparatus. The report in the newspapers has come from no reliable source.—Yours, etc.,

C. M. JOHNSTON, M.I.E.E., Borough Electrical Engineer.
Shrewsbury, Dec. 6.

EXCESS PRESSURE ARRESTERS.

SIR,—In reply to "G. M.'s" letter, the resistance of the jet (when used in combination with excess pressure arresters) should be such that about 500 watts flow to earth. These jets are frequently used as lighting arresters, in which case a constant current of 0·1 to 0·2 amperes is allowed to flow to earth during the thunderstorm. Used in this manner, in addition to the ordinary horn type arrester (the jet resistance being in this case in parallel and not in series with the horn arrester), these jets form one of the best protections against lightning. Indeed, they are the only forms that are really effective in such severe thunderstorms as are experienced in tropical countries.

Voltage.		Sections of jet.		Height of jet.
20,000	.....	150 square millimetres	.....	350 millimetres
12,000	.....	250 " "	.....	250 "
8,000	.....	300 " "	.....	200 "

I give a table showing section and height of jet to allow 0·1 ampere to flow to earth. The sections must not be reduced, or the jet will not satisfactorily take the flash to earth.—Yours, etc.,

ZODIAC.

Nov. 30, 1905.

THE NEW BOSS: AN OLD, OLD TALE.

The Boss.
The new Boss.
What like is he?
And the answer was forthcoming:

> "Gin his breeks was red, and he'd no sic an awfy swelled heid, he'd be Mephisto. Black een, black whiskers, sallow, dour, and sarcastic."

But
What *says* he?

> "Tae the Works Supt., 'Whit time d' ye start yersel?' 'Eight!!' 'Start wi' the men when the horn blaws'"!

Collapse.
Painful and speechless collapse.

> "Tae the ower-wrought Chief Drn., 'Ye're owerstaffed, and owerpaid. Sack the hauf, use apprentices, and consider yer screw doon fifty quid,' says he."

Horrors!!
What says he to
The outside erector?

> "'Stannin aroond watchin'? Ye re a' lazy thegither. Cud a fitter no dae this job?' And yon erector chap up and tells him, 'Just as pleases yersel: I didna *ask* for the d—— job'"!!

H'm. H'm. Things looking up a bit.
Then he hies him unto
The Works Draughtsman.

> "'Ma conscience, na wonder dividends is doon, makin' yer ain tools when ye cud get them for the hauf frae some ither fowk. 'Ye cudna, and onywey gin ye think ye cud dae the job better yersel, here's ma notice"!!!

?!! — — ?!!!
Oh rapture, oh ecstasy.

Moral!—It's a strong man who can run a shop single-handed.

ELECTRO-CHEMICAL DEVELOPMENTS.

In the *Electrical World and Engineer* are described some electrolytic processes which have recently been patented in America.

Metallic sodium is made commercially at Niagara Falls by the Castner process, which electrolyses caustic soda in a single cell. A patent recently granted to Mr. E. A. Ashcroft proposes the use of a double cell, which in some respects resembles the Castner-Kellner and the Acker cells for electrolysis of sodium chloride. As in the Castner-Kellner process, Mr. Ashcroft uses an intermediate bipolar electrode, which forms the connection between the two cells; but he electrolyses fused salt, and, therefore, cannot use mercury for the bipolar electrode, but uses instead fused lead, as is done in the Acker process. In this first compartment Mr. Ashcroft electrolyses fused sodium chloride. The sodium set free by the cathodic reaction alloys with

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the fused lead, and is transferred into the second compartment, where it passes again into the electrolyte, which is fused caustic soda. In this cell metallic sodium is then obtained as a cathodic product. Another process in which a fused electrolyte is employed is described in a patent of Mr. H. S. Blackmore. It may be best described in its application to the production of a copper-aluminium alloy. Copper aluminate is dissolved in a fused mixture of lithium and calcium oxides, and on electrolysis of this fused solution a copper-aluminium alloy is obtained. In all metallurgical processes, metals are purified by means of slags which combine with the impurities and thus remove them from the metallic bath. A modification of this method is proposed in a recent patent of Mr. H. M. Chance, who holds the metal in molten state in contact with an electrolyte which on electrolysis yields the purifying agent. Thus he proposes to purify molten iron by making it a cathode, in contact with fused calcium chloride as electrolyte; calcium is then set free by the current and serves as a purifying agent. Chlorates are made commercially by electrolysis of aqueous solutions of the chlorides in a cell without a diaphragm at a temperature of about 70deg. C.; this process is in use by the National Electrolytic Company at Niagara Falls. A process recently patented by Mr. A. E. Gibbs yields simultaneously chlorate and bichromate. It depends upon the reaction between chromate and chlorine gas, yielding bichromate, chlorate, and chloride. Either a stream of chlorine gas from a reservoir is pumped through a solution of chromate, or the chlorine is electrolytically formed in a cell itself. In the latter case the cell contains both chromate and chloride, and a diaphragm cell is employed.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Chairman's Address.

BY S. L. PEARCE, M.I E E.

(Concluded from page 778.)

Central-station engineers are gradually becoming to recognise more and more the value of steam-turbine plants. The more extensive adoption of these plants, the larger sizes of units used, on which so much emphasis has of late been laid in the technical Press, mark the chief progress of power station developments. An extended use of three-phase plants has been inevitable, and to these steam-turbines are particularly suitable. Of the many good qualities appertaining to the turbine it is unnecessary at this stage to refer, but mention may be made of some extremely good steam consumption tests that have recently been made. With units of 3,000 kw. capacity, 15lb. to 15¼lb. of steam per kilowatt-hour at full load and 16·75lb. at half-load have been obtained. It is interesting to note, further, that steam consumption trials conducted on turbines after having been at work for extended periods give results which show no falling off in efficiency from the results obtained on official tests. This is a point concerning which some doubts have been hitherto expressed. Reciprocating sets are still being built in large sizes, but it is not surprising to note that the general trend is all in favour of the adoption of turbines, especially for large units. The past year has, however, marked a real development in the design and manufacture of turbine-driven continuous-current generators. It is not so very long ago that the difficulty of solving in a satisfactory manner the commutation problem was considered a barrier to their adoption. With high speeds it is impossible to keep down the reactance voltage; with slow-speed sets, on the other hand, carbon brushes fulfil all the necessary requirements, and special means for counteracting the armature reaction are not necessary. Two methods are in vogue successfully to-day for compensating for armature reaction on high-speed sets: (1) compensating coils wound in slots in the pole-pieces, thus neutralising the armature effect on the field; (2) auxiliary or commutating poles arranged between the ordinary poles. Both systems have given satisfactory results in practical operation, and whilst the latter is the more mechanical arrangement, the former has advantages from an electrical point of view. Another departure from generally accepted practice has been made recently in the use of carbon brushes for turbine-driven generators. Engineers have been generally familiar with the wire brushes and serrated commutators hitherto considered to give the best results, but it must be allowed that the smooth surface commutator and carbon brushes form a far more mechanical piece of work, and it is hoped that equally good results may be obtained from an electrical point of view. Such continuous-current sets provided with carbon brushes are in operation now for the first time in this country on lighting and traction circuits. Towards this improvement the present manufacture of carbon brushes has contributed considerably. The introduction of copper, either mixed with or graded with the carbon, give to the brush those qualities which facilitate commutation.

The gas-engine has hitherto found little favour for central-station work in this country, and the threatened supersession of steam plants has still to come, and, until put forward in the form of the gas-turbine, is not likely to oust the steam-turbine, in view of the very large units being adopted in central stations to-day, and the uncertainty that prevails on the score of satisfactory parallel running with gas plants coupled to alternators. Much, however, has been done recently in the development of gas-engine building, and units of 3,000 h.p. have been constructed. Electrical engineers are not unmindful of the main economy that is possible with the use of gas plant as compared with steam plant, and of the many improvements that have brought the gas-engine to a much greater degree of perfection, but it cannot be said yet that the day of large power gas-engines—*i.e.*, engines of 2,000 h.p. to 3,000 h.p.—has fully come. However, the outlook for their use is more favourable to-day, but we still appear a long way off from the time, so often prophesied, when the gas-engine will completely supersede the steam-engine as a prime mover. The conditions which militate against the adoption of gas plants for large power stations as compared with turbine plant may be briefly stated as follows: (1) The higher initial capital outlay. Taking a station of 20,000 h.p. to 30,000 h.p. gas plants could not be installed under £18 per kilowatt, exclusive of buildings. A modern steam plant could be put down for two-thirds of this amount, and, in fact, a figure of £8 has been taken in one notable instance. (2) Increased floor space required. (3) Probably higher rate of depreciation and increased maintenance costs. Against these may be put in favour of producer gas plants: (1) The saving in actual fuel, which, of course, varies under different conditions, but is not likely to be less than 15 to 20 per cent. (2) The saving due to the recovery of the sulphate of ammonia. The combination of the latter, however, with high-tension plants is not one that commends itself to electrical engineers.

As illustrating the growth of electricity supply stations, it may be of interest to state that the total capital invested has increased from, roughly, £8,000,000 in 1896 to £62,000,000 at the end of last year, represented by 183 companies and 262 municipalities, the total capital being approximately evenly divided between the two classes of undertakings. Whatever the critics may have to say on the subject of municipal trading, it is evident that the electrical industry is, at any rate, indebted to it. Of this £62,000,000 some 42 per cent. has been spent on the engine and boiler house equipments of the generating stations, and some 35 per cent. on the feeding and distributing systems. These figures indicate the very great importance of electricity supply, in regard to which no signs of diminution are manifesting themselves. An increase in the last decade of nearly 800 per cent. in capital, of 1,000 per cent. in lamp connections, and of 1,500 per cent. in the number of units sold, are figures which will speak for themselves.

In the domains of the electro-chemical and electro-metallurgical industries, reference should be made principally to the improvements that have been made in the methods of iron and steel production. The earlier attempts to substitute purely electrical methods in the reduction of the iron ores for the more usual process of smelting have not been very successful, and at present the electrical furnace cannot be considered a serious rival to the blast furnace. The trend of events has, however, been towards improvements in the furnaces and methods for producing steel and alloys from pig iron and scrap. It is possible that in the near future the combination of blast furnaces with electric steel refining furnaces will be considered indispensable to all up-to-date steelworks. The opinion of the commission appointed by the Canadian Government as far as they are capable of application to this country is worth quoting: "That pig iron can be produced from iron ore, and steel of all grades can be produced in the electric furnace from pig iron, scrap, and ores as easily as by the customary methods, and that the high-grade classes of crucible steel and special alloys can be made with marked economy in several forms of electric furnaces.' The manufacture of pig iron in the electric furnace is of little interest to electrical engineers in this country, as with the cheap supply of fuel available here no electric furnace can compete with a modern blast furnace. It is not improbable that the electrical energy required for the electric furnaces will be obtained from gas-engines operated by gases from the blast furnaces. Probably only two of the modern electric furnaces are capable of adoption for English steel smelting, but it has been proved that either of these processes can compete successfully with the Sheffield crucible furnace with electrical energy

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at anything like a reasonable figure. Aluminium has had an extended use in connection with the "Thermit" process of welding tramrails, which is being successfully adopted by many of the larger municipalities.

In the telegraph world there is a growing tendency to introduce typewriting telegraphs and machine telegraphs which reproduce the written message in its original form. Electric signalling is being adopted by the principal railways, and during the year an important installation has been put down at Derby on the Midland Railway. The system is purely electrical, and not a combination of electrical and pneumatic devices. Both points and signals are operated by specially constructed motors. The system includes a mercury contact under the running rail, whereby a passing train puts a signal to danger after passing it. Automatic signalling systems are also finding favour on electric railways, where the presence of a live rail makes the provision of energy for the signals a simple matter. In the field of wireless telegraphy much useful work has been done in popularising the system by the acceptance of messages at post offices for transmitting to vessels at sea, and *vice versâ*. Licenses are now required for the setting up of stations to avoid interference with other stations which may be near. In certain cases these licenses are refused, but permission is given to erect elsewhere. The common battery system is now practically standard for all large telephone exchanges, and the National Telephone stations are being changed over to it. The chief event of the year is the ratification of the agreement between the Post Office and the National Telephone Company, whereby the former purchases the system of the latter in 1911. By this arrangement municipalities are prohibited from taking out further licenses, and the existing municipal systems can be purchased outright. Some interesting figures were produced in the hearing of the evidence before the Telephone Committee. At the end of March, 1905, the National Telephone Company had 1,139 exchanges, 320,017 subscribers' stations, and were handling 995 million messages per annum; 683,000 miles of wire were in use, of which 64½ per cent. were underground; 45,000 miles of underground wires were rented from the General Post Office. Important improvements have been made during the year in the manufacture of domestic and short-distance telephones. Intercommunication systems for office, warehouse, and works use can now be obtained at much lower prices than formerly, and a healthy competition has been the means of bringing the telephone within the reach of the smallest concerns. Continental communication is now possible, and steps are being taken to extend the lines into countries far inland.

From an electrical engineer's point of view, the last session of Parliament has not been remarkable for the legislation that has been enacted. The question of a cheap power supply for London in the form of the "Administrative County of London Power Bill" has been the predominating feature. With the details of the Bill many of you are no doubt familiar. The scheduled area of supply covered by the provisions of this Bill was no less than 600 square miles, and was divided into portions—the industrial and non-industrial. In the former, powers were sought to supply tramways, railways, docks, Government offices, etc., and also to individual consumers with the consent of the existing authorised distributor. In the event of that consent being withheld, an appeal to the Board of Trade was to follow. In the non-industrial area, powers to supply in bulk, and to tramways, railways, docks, etc., were asked for, but not individual consumers. The Bill, as amended, commended itself to a large proportion of the original opponents—viz., the supply companies—which is evidenced by the various agreements which were arrived at between themselves and the promoters of the Bill. Whatever views we may hold as to the fairness or otherwise of allowing a company armed with such powers as this Bill would have given it coming into competition under conditions favourable to themselves in the same areas with the existing pioneering supply companies and local authorities working under unfavourable conditions, we cannot but regret that this and similar measures should be prevented from becoming law simply by the elapsing of time, and that all the money and labour spent on their promotion should be lost. Evidently there is considerable room for improvement in the method of parliamentary procedure, and there does not appear any valid reason why the various Bills should not be taken up at the new session of Parliament at the stage at which they were left in the preceding session. The "Supply of Electricity" Bill has been introduced for the fourth occasion only to be dropped again. This is certainly a misfortune, as in its present form it is certainly more favourable as regards both powers and restrictions in so far as these apply to local authorities. In particular the provisions made (1) for the compulsory acquisition or use of land for generating stations allows of the operation of a generating station without unreasonable risk of being subject to a nuisance clause, and (2) the stand-by clause, under which a person is not entitled to demand or to continue to receive a stand-by supply unless agreeing with the undertakers to pay a reasonable return on the capital expenditure incurred, is one which is urgently required. Of equal importance to the Supply of Electricity Bill is some modification of the 1870 Tramways Act, which again was undealt with. It is, therefore, to be regretted that there has been no legislation this year which has in any way helped to improve the conditions of the electrical industry.

The past few months have witnessed considerable activity in the shape of electrical exhibitions in bringing home to the public the advances that have been made in the various applications of electricity. Keen competition in these various fields has shown the necessity for increased publicity if the present rate of progress is to be maintained, and such exhibitions as the one recently held on such an extensive and successful scale in London cannot but prove an immense stimulus to the industry generally. Seeing is believing, and the real value of exhibitions is in the educational effect that they have on the public generally, whereby the value of the various applications of electricity can be brought home more forcibly than by descriptive articles or in any other of the many ways adopted. Considering what an important centre Manchester has now become in the electrical industry, it is worth consideration whether in the near future a local exhibition might not be held with advantage to all concerned. During the last few years British manufacturers have undoubtedly made up a lot of lost ground. But a short time since it appeared that as a country we were not keeping pace with American and Continental firms, and that great enterprises were passing into the hands of competitors. Whilst admitting that low prices, brought about by over-production and industrial depression, had much to do with the placing of important works abroad, it cannot be said that British manufacturers were in such a strong position then such as they held to-day. A closer appreciation of the lines on which electrical enterprises are developing, coupled with improvement in designs and methods of manufacture, have placed manufacturers in a position fully equal to their competitors, and able to supply the demands of the country. Whilst the lessons of the past few years' experience have been for the most part turned to good account, British manufacturers have still, it is feared, to learn the meaning of "prompt delivery." It would be interesting if a return could be prepared of the large contracts made during the year and the number of those given that were completed within the specified time. Judging by results, it is apparent that only too often times and dates are given that cannot possibly be complied with, and without any serious attempt to compute the actual time required for their completion. The enforcing of penalties may have weight with the manufacturers, but it is no adequate compensation to the engineer who requires the plant, and from the latter's standpoint reliability for delivery will often weigh as much or more than lower first cost..

I have endeavoured to indicate briefly some of the advances that have been made in the various spheres of the application of electricity, and to point out some of the considerations which govern a solution of many of the problems of the day. Some of these appear considerably far off from being satisfactorily solved. Take the case of electrical storage. The development of storage is desired by all engineers, but all are not agreed that it is on the lines of the ordinary lead couple accumulator that perfection will be found. On the contrary, very strong views are entertained that something better than this method will have to be developed before electrical storage can on economic grounds be applied on anything approaching an extensive scale. We should not, however, be unmindful of the great improvements that have been made in recent years towards increasing the life of the battery, as a whole, by means of automatic "boosters," and improvements in the manufacture and formation of the plates, and a consequent reduction in the cost of upkeep. Whether in the present type of accumulator, improved as it undoubtedly may be from year to year, or in some form akin to that on which Edison has been working the final solution will be found, is a problem for the future. The recent experiments of Sir Oliver Lodge, employing high static charges for the purpose of dispelling fog from the atmospheres of our large cities and towns are worthy of note, as containing the possible fundamentals of future developments.

I do not propose to further trespass on your time. Enough has been said to show the value of electrical engineering progress to the community generally, and which has brought in its trail social changes of untold benefit to mankind. Of the electrical engineer may it not be truly said that he has been engaged "in directing the great sources of power in Nature for the use and convenience of man"? In conclusion, may I express the hope that the session on which we enter this evening may be as successful as those that are past, and that the discussions of the papers presented may be mutually helpful.

Mr. R. J. Roberts, of Merthyr Tydvil, has been appointed junior charge engineer at the borough of Cheltenham electricity works.

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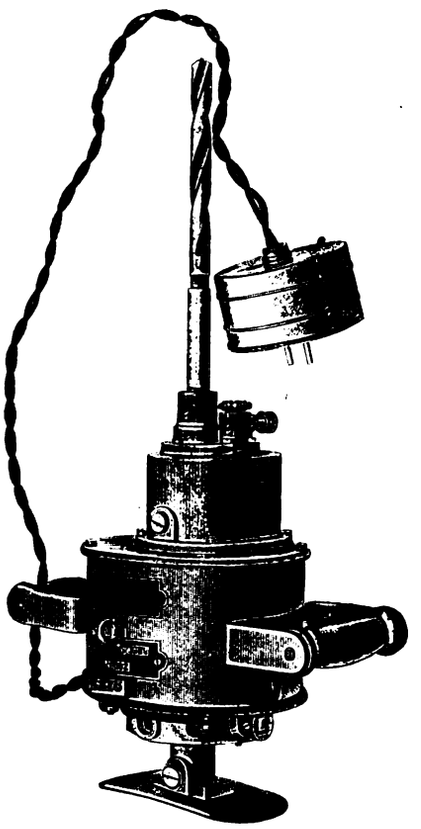
TRADE NOTICES AND NOVELTIES.

Variable-Speed Electric Drill.

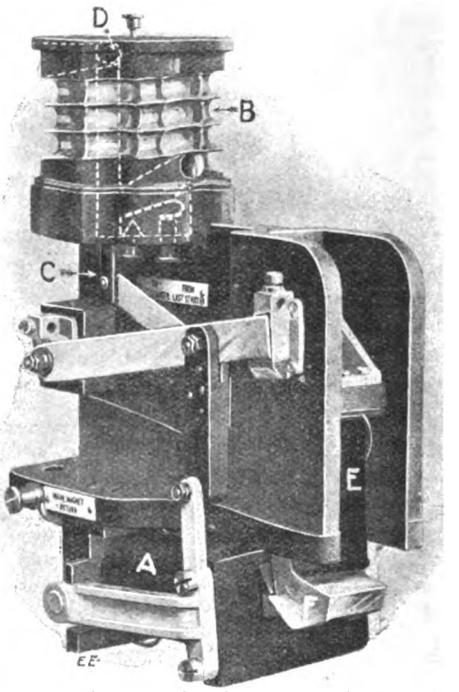
From the Armorduct Manufacturing Company, Limited, 6, Farringdon-avenue, London, E.C., we have particulars of their "Little Hustler" variable-speed electric drills for con-



tinuous and three-phase current. The accompanying illustration shows one pattern of this extremely useful type of drill, which can be adjusted to three speeds, according to the size of bore intended. The motor is shunt-wound, and gives its full power on the different speeds, the latter being obtained entirely by the agency of a special gear. There is no waste of energy. All non-magnetic parts are made of an aluminium alloy, so as to obtain lightness. A further noteworthy feature is that the plug-top attached to the flexible cord contains a maximum cut-out, which, in case of overload, stops the tool, the latter automatically restarting when the boring pressure is reduced to normal. This device makes it impossible for the motor to burn out due to overload, and renders the tool fool-proof.

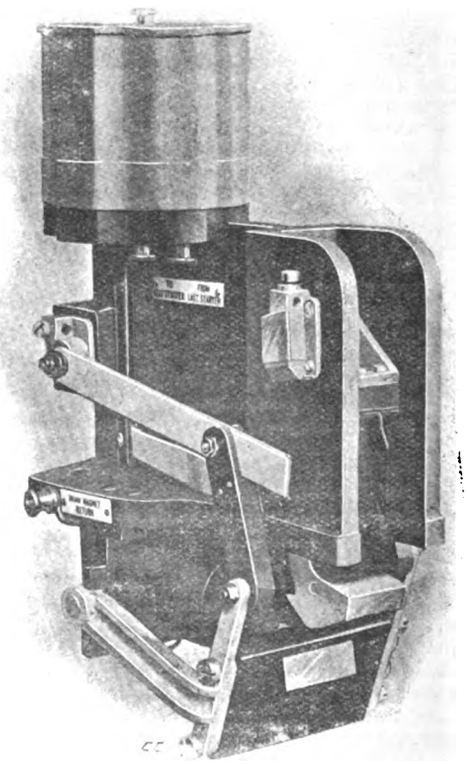
The Glasgow Arc Lamp Starter.

Many of our readers will be interested to learn that Mr. James Ferguson, late manager, electrical department, Kelvin and James White, Limited, has now started business on his own account at 61, Pollok-street, Pollokshaws, Glasgow, where he has put down modern plant for the manufacture of light electrical and mechanical apparatus generally. We are indebted to Mr. Ferguson for the following particulars of the "Glasgow" arc lamp starter (Lackie, Calderwood, and McEwen's patent), of which he is sole maker. A number of these starters have been in use, we understand, on the Glasgow Corporation street-lighting system for over eight months, giving every satisfaction. Regarding the identity of the patentees, Mr. Lackie is, of course, the chief electrical engineer to the Glasgow Corporation, while Mr. Calderwood and Mr. McEwen are well-known members of his staff. This apparatus has been designed for switching in street arc lamps with an interval of time between each group. Referring to the accompanying illustrations, it will be seen that the switch consists principally of two parts—viz. (1) a main switch proper controlled by an electromagnet; and (2) the time-element mechanism which closes a secondary circuit after a predetermined interval, thus actuating the main switch of the next switch in the series. From any central or suitable point a series of lamps may be switched into circuit, set after set of the series, with a time interval between the switching in of the various sets; on the last of the sets being switched in, contact is automatically made to indicate at the central switching point that the circuits have been completed throughout the entire series. The interval of time obtained between the lighting one set or group of arc lamps and another set or group of arc lamps permits of the electric current being steadied, to obviate flickering of the lamps of private consumers. The electromagnetic switch is actuated by a powerful electromagnet, A, rotating an armature which is pivoted by arms to the yoke. This armature is coupled by insulated connecting pieces at the sides to the double-pole switch, which is provided with suitable carbon contacts. One of the switch coupling pieces is fitted with an arm which is coupled to the plunger, C, which actuates the time-element mechanism. The whole apparatus is fitted on a base of insulating material with an insulating partition between the two switches, so that accidental contacts between



Arc Lamp Starter with cover of time element removed. The white dotted lines show the travel of the plunger and ball. One-quarter full size.

the positive and negative terminals, or between the positive or negative terminals and the middle-wire terminals, may be made difficult or impossible. The time-element mechanism consists of a wavy spiral, B, the axis of which is vertical, mounted on a



Complete Arc Lamp Starter in "Off" position. One-quarter full size.

platform forming part of the insulating base. Through the centre of both the spiral piece and the base is a hole large enough to allow a plunger, C, to pass freely up and down. The function of this plunger is to elevate a smooth spherical ball, D, from the bottom of the base to the top of the spiral. The ball then descends by travelling round the zig-zag till it reaches the base, where it rolls on to the top of the contact spring, pressing

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it down against the fixed contact and closing the circuit for the relay magnet of the next starter. The time taken for the ball to travel from the top till it closes the circuit for the next switch is 11 seconds, or sufficient to allow one group of lamps to be burning steadily before the next group is switched on. When the starter is switched out, the plunger drops to the bottom and the ball rolls off the contact spring on the top of the plunger ready for the switching-in operation. A clutch, F, which can be released by the electromagnet, E, holds the switch on. As soon as the "all on" lamp in the station lights up, indicating that all the groups of lamps in the series have been switched on, the switch for the electromagnet, A, may be opened and the switches are held on mechanically. To open the switches, the main magnet or "in" switch is first closed, thus relieving the clutches, F, which are withdrawn on closing the "off" switch which controls the circuit for the electromagnet. The whole apparatus is of the most substantial construction, and has been designed for fitting in section pillars or lamp pillar bases.

Saving in Cost of Arc Street-Lighting due to the use of Arc Starters.—Wages saved by using starter, taking 850 street arc lamps: Men employed without starters—11 men at 27s. per week, 1 man at 24s. per week, 11 men at 21s. 5d. per week = £27. 16s. 7d. per week, or £1,446. 16s. 6d. per annum. Men employed with starters—16 men at 27s. per week (average), £21. 12s. per week, or £1,123. 4s. per annum. Saving per annum in favour of starters, £323. 12s. 6d.

Units Saved by Using Starters.—The switching in need not be started so early or the switching out so late as when men have to go the round of lamps. Taking the time of burning on this account as half-hour less per day, lamps taking 500 watts, or half a Board of Trade unit per hour, the units saved will be $850 \times \frac{1}{2} \times \frac{1}{2} = 212{\cdot}2$ units. At 1d. per unit this would amount to, say, 17s. 8½d. Also 12 pairs of carbons would be saved. At 1s. 3d. per dozen pairs, this would amount, together with the cost of setting and trimming them, to 2s. 3d. per day.

Therefore, total saving is 17s. 8½d. and 2s. 3d. = 19s. 11½d.—*i.e.*, £364. 4s. 9d. per annum. Total saving: men's time, £323. 12s. 6d.; current, carbons, etc., £364. 4s. 9d.—total, £687. 17s. 3d., say £688. Allowing one starter to 10 lamps at £10 each installed, taking depreciation at 7½ per cent., interest 5 per cent., and sinking fund 2½ per cent. per annum, makes £127. 10s. on £850 capital. Deducting this annual amount from £687. 17s. 3d., leaves £560. 7s. 3d. net saving on 850 arc lamps, which is equivalent to 13s. 2d. per lamp per annum.

Catalogues, etc.

"WITTON" MOTORS.—The abbreviated price-list of "Witton" continuous-current motors just being issued by the General Electric Company, Limited, will be found extremely handy for reference. It can be carried in the pocket without inconvenience.

GILBERT ARC LAMP.—From the Gilbert Arc Lamp Company, Limited, Chingford, Essex, we have a copy of their new catalogue. This is a very comprehensive list of the company's manufactures, including every type of arc lamp and accessories for same.

DRY BATTERIES.—The Amalgamated Dry Batteries, Limited, 16-17, Devonshire-square, Bishopsgate-street Without, E.C., have recently issued a new catalogue of their specialities, all of which are manufactured in London, being of the highest quality throughout.

IGNITION BATTERIES.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, E., are issuing a new price-list of their specially-designed ignition batteries in celluloid boxes. We understand there is a very large demand for these batteries. Stock of all sizes is kept ready for immediate delivery.

FORTHCOMING EVENTS.

FRIDAY, DEC. 8.

Institution of Electrical Engineers (Manchester Local Section).—At 7.30 p.m., "Electrification of Existing Steam Railways," by Mr. W. H. M. Parr.

Northampton Institute.—At 8 p.m., Sir William Preece, K.C.B., F.R.S., delivers the prizes at the annual prize distribution and conversazione.

Institution of Electrical Engineers.—At 7 p.m., annual dinner at Hotel Cecil.

SATURDAY, DEC. 9.

Institution of Electrical Engineers.—At 10.30 a.m., students' visit to Bow Central Station.

Birmingham Electric Club.—At 7.30 p.m., annual meeting (Colonnade Hotel).

Northampton Institute.—At 6.30 p.m., annual conversazione.

MONDAY, DEC. 11.

Institution of Mechanical Engineers.—"Organisation in Small Engineering Shops," by Mr. A. W. Waddy.

Society of Arts.—At 8 p.m., "The Measurement of High-Frequency Currents and Electric Waves," by Dr. J. A. Fleming, D.Sc., F.R.S. (in continuation of previous courses on "Electric Oscillations and Electric Waves" and on "Hertzian Wave Telegraphy"). (Lecture III.)

TUESDAY, DEC. 12.

Society of Arts.—At 8 p.m., "Historical Pageants," by Mr. Louis N. Parker, F.R.A.M.

Institution of Electrical Engineers (Glasgow Local Section).—At 8 p.m., "Recent Advances in Wireless Telegraphy," by Dr. J. Erskine-Murray.

Institution of Electrical Engineers (Manchester Local Section).—At 7.30 p.m., "Street-Lighting," by Mr. Haydn Harrison.

Nottingham Guild of Mechanical and Electrical Engineers.—At 7.30 p.m., "Electric Cables," by Mr. J. Preece.

Institution of Civil Engineers.—At 8 p.m., "The Steam-Turbine," by the Hon. C. A. Parsons and Mr. G. G. Stoney.

WEDNESDAY, DEC. 13.

Society of Arts.—At 8 p.m., "The Commerce and Industries of Japan," by Mr. W. F. Mitchell.

Institution of Electrical Engineers (Birmingham Local Section).—At 7.30 p.m., "Two New Electricity Meters," by Mr. F. B. Holden.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., "Flame Arc Lamps," by Mr. L. V. Pumphrey.

Association of Engineers-in-Charge.—At 8 p.m., "High-Pressure Gas Illumination," by Mr. J. W. Blakey.

Wolverhampton Engineering Society.—At 7.30 p.m., "The Locomotive of To-day," by Mr. G. Bulkeley.

THURSDAY, DEC. 14.

Tramways and Light Railways Association.—At 3 p.m., visit to Lots-road Power station. At 8 p.m., "Improvements in Trucks," by Mr. E. Cook.

Institution of Electrical Engineers.—At 8 p.m., adjourned discussion.

Society of Arts.—At 8 p.m., "Glimpses of French Canada," by the Hon. Rodolphe Lemieux, K.C., Solicitor-General of Canada.

FRIDAY, DEC. 15.

Electro-Harmonic Society.—At 8 p.m., smoking concert.

Institution of Civil Engineers (Students' Meeting).—At 8 p.m., "Tests of Street Illumination in Westminster," by Mr. E. E. Mann, B.Sc., Stud.Inst.C.E. Mr. E. W. Monkhouse, M.I.C.E., in the chair.

Junior Institution of Engineers.—At 8 p.m., "Electric Mains for Power Transmission Work," by Prof. John T. Morris, M.I.E.E. (member).

Physical Society.—7 to 10 p.m., Exhibition, Royal College of Science, South Kensington.

Institution of Mechanical Engineers.—The seventh report to the Alloys Research Committee, "On the Properties of a Series of Iron-Nickel Manganese-Carbon Alloys," by Dr. H. C. H. Carpenter, Mr. R. A. Hadfield (member), and Mr. Percy Longmuir; paper to be read and discussed (if time permits), "Behaviour of Materials of Construction under Pure Shear," by Mr. E. G. Izod (associate member), of Rugby.

SATURDAY DEC. 16.

Junior Institution of Engineers.—At 10 a.m., visit to Messrs. Johnson and Phillips's works at Charlton.

Institution of Electrical Engineers (Manchester Local Section). At 2 p.m., students' visit to generating station.

PERSONAL.

Mr. J. H. Ferguson, at present stationed at Falkirk, has been appointed resident electrical engineer at Lanark District Asylum (Hartwood). There were over 300 applications.

The Gloucester City Council have appointed Mr. Leonard Johnston, of Blackburn, tramways manager at a salary commencing at £250, and increasing £25 a year up to £350.

The Dover Town Council have appointed Mr. R. E. Heygate as shift engineer, at a salary of £80 per annum, in place of Mr. Irish, resigned.

The St. Marylebone Council have engaged Mr. W. E. White, of the Brighton Corporation, at a salary of £3 per week, for the purpose of dealing with consumers' accounts generally, and the work in connection with the tariff of charges to consumers.

Mr. M. M. Gillespie, until recently a prominent member of the staff of the British Westinghouse Electric and Manufacturing Co., was on Friday last entertained to a complimentary dinner given at the Midland Hotel, Manchester, by his old friends and colleagues in the firm. The proceedings, which were of the usual informal and delightful nature, bore ample witness to the popularity of a gentleman who has been associated for over 17 years with the Westinghouse companies on both sides of the Atlantic. Mr. Gillespie has opened offices at Amberley House, Norfolk-street, Strand, W.C., where he will represent, among other firms, Messrs. Browett, Lindley, and Co. for London and the South and West of England.

The employés of the British Electric Plant Co., Alloa, have presented Mr. W. L. Spence, A.M.I.C.E., M.I.M.E., on the occasion of his retiral from the managing directorship of the company, with a testi-

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monial, which was subscribed to by every employé at the works. It consisted of a large combined filing and card indexing cabinet and a framed enlargement photograph of the staff and workmen. We are informed that Mr. Spence is now practising as a consulting electrical and mechanical engineer in Glasgow.

Mr. Henley L. Howard, A.M.I.M.E., A.M.I E.E., of the Manchester Corporation electricity works, has been appointed engineer and general manager to the Barking Town electricity and tramways department.

Mr. Joseph H. Bryan, of Messrs. Ferranti Limited, has been appointed meter inspector at the Croydon borough electricity works.

The following changes have been made in the staff of the Maidenhead electricity department: Mr. Aubrey Fletcher has taken up his appointment as assistant engineer from 11th inst.; Mr. J. A. Squire has left and joined Messrs. Oliver and Co., Woolwich; Mr. K. L. M. J. Schultz leaves the works next week; Mr. A. Stevens has been taken on for one month's approbation, and will then apply to the committee for permission to serve six months as a volunteer, or to be articled as an improver under the committee's usual conditions.

PORTSMOUTH ELECTRICITY ACCOUNTS.

The accounts of the Portsmouth electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £275,819. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	17,696	5	6
Distribution of electricity	1,176	0	9
Attending and repairs to public lamps	1,402	13	4
Rents, rates, and taxes	1,598	7	1
Management expenses, salaries, etc.	2,351	13	4
Special charges, insurances, etc.	496	10	3
Bad debts written off, etc.	95	0	2
Total expenditure	24,816	10	5
Balance carried to net revenue account	20,903	3	9
	£45,719	14	2

Cr. Income.	£	s.	d.
By sale of current, less allowances	39,022	9	3
Sale under contract	272	10	0
Public lighting	4,984	19	5
Slot meters	74	5	6
Rental of meters and other apparatus	1,189	3	5
Sale and repair of lamps, arc or incandescent	88	8	5
Rents receivable	4	0	0
Part fees from pupils	49	1	11
Charging accumulators	24	1	11
Sale of ashes	10	14	4
	£45,719	14	2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received, less repaid	251,680	13	9
Sundry creditors	2,908	18	3
Consumers' deposit account	444	4	8
Reserve for bad debts	184	7	0
Amount at credit of sinking fund	30,879	11	4
Redemption account	24,138	11	5
Balance at credit of reserve fund account	16,825	0	0
	£327,061	6	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	275,819	5	2
Stores—motors, lamps, etc.—on hand	4,460	12	7
Cash in hands of treasurer and engineer	890	1	2
Sundry debtors for current supplied	14,883	11	0
Other debtors and unexpired insurances	128	5	2
Sinking fund	30,879	11	4
	£327,061	6	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			3,442,660
Quantity sold	Public lamps	472,542	2,717,210
	By contract	2,120	
	Private consumers by meter	2,242,548	
Quantity used on works			178,290
Quantity used for magnetising current			357,500
Quantity used for motor-generators			23 430
Total quantity accounted for			3,286,428
Quantity not accounted for			166,232
Total maximum supply demanded (kilowatts)			2,343

Number of public lamps: 264 arcs, 146 incandescents.

BIRKENHEAD ELECTRICITY ACCOUNTS.

The accounts of the Birkenhead electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £118,172. We append abstracts of the revenue account and balance-sheet.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	2,888	12	11
Distribution of electricity	360	8	3
Attending and repairs to public lamps	346	12	8
Rent, rates, and taxes	497	13	4
Management expenses—salaries, etc.	762	19	2
Special charges—insurances, etc.	118	3	0
Treasurer's department—proportion of cost	100	0	0
Bad debts written off	39	3	1
Depreciation on motors	38	19	1
Balance transferred to net revenue account	8,169	17	2
	£13,322	8	8

Cr. Income.	£	s.	d.
By sale of current per meter	12,435	4	10
Rental of meters on consumers' premises	795	12	6
Rental of motors	48	11	4
Miscellaneous	43	0	0
	£13,322	8	8

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—loans outstanding	106,962	16	10
Sinking fund and stock redemption fund	10,437	3	2
Amount in hand to meet mortgages	235	11	8
Balance at credit of renewals fund	4,557	10	3
Sundry creditors and discounts	4,435	19	3
Amount retained for income tax	24	7	10
	£126,653	9	0

Cr. Assets.	£	s.	d.
Capital account—amount expended on works	118,171	17	5
Electric motors	350	11	9
Sundry debtors and discounts	5,198	12	1
Cash in hand	5	0	0
Cash at bank	2,927	7	9
	£126,653	9	0

HORSHAM ELECTRICITY ACCOUNTS.

The accounts of the Horsham electricity department for the year ended March 31, 1905, show a total expenditure on capital account of £23,862. Abstracts of the revenue account, balance-sheet, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	929	13	5
Distribution of electricity	37	1	8
Attending and repairs to public lamps	63	12	10
Rents, rates, taxes, and insurance	121	13	3
Management expenses, salaries, etc.	226	3	7
	1,378	4	9
Balance carried to net revenue account	1,018	16	8
	£2,397	1	5

Cr. Income.	£	s.	d
By sale of current per meter	1,489	4	3
Public lighting	828	11	0
Rental of meters (now discontinued)	13	3	4
Attending and repairs to public lamps	63	12	10
Charging accumulators	2	10	0
	£2,397	1	5

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Value of land appropriated	300	0	0
Outstanding on loan account	21,843	18	5
Treasurer	2,685	8	8
	£24,829	7	1

Cr. Assets.	£	s.	d.
Capital account—amount expended, less depreciation	22,499	17	6
Stores on hand	168	15	0
Sundry debtors for current supplied	576	7	4
Balance, being deficiency on net revenue account	1,584	7	3
	£24,829	7	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			142,106
Quantity sold	Private consumers by meter	65,252	114,965
	Public lamps	49,713	
Quantity used on works			14,713
Total quantity accounted for			129,678
Quantity not accounted for			12,428
Total maximum supply demanded (kilowatts)			140

Number of public lamps: 21 arcs, 403 incandescents.

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PHYSICAL SOCIETY.

At a meeting of this society on Nov. 24, Prof. J. H. Poynting, F.R.S., president, in the chair,

A paper on "*The Dielectric Strength of Air*" was read by Mr. A. Russell. The dielectric strength of air, at a given barometric pressure, is generally deduced from the results of experiments made on the disruptive voltages between equal metal electrodes at given distances apart. It is assumed that the electric field surrounding the two electrodes just before the disruptive discharge takes place is similar to that round the electrodes at low voltages. Schuster has shown that this assumption is untenable. The author has found that in certain cases the dielectric has broken down before the final discharge takes place. Hence the boundaries of the Faraday tubes are no longer the surfaces of the metal electrodes, but the boundary of that part of the dielectric surrounding the two electrodes which has ceased to insulate and has become a conductor. It is known that for various gases there are certain minimum sparking potential differences between the electrodes. The electrostatic equations fail to take this into account. The author, therefore, makes the assumption that for distances apart greater than about a millimetre when the disruptive voltage is V kilovolts the effective potential difference between the ends of the Faraday tube which is subject to the maximum stress is $V-\epsilon$, where ϵ is the minimum sparking voltage. Applying formulæ which he has deduced, using this assumption, to tests of Heydweiller, Steinmetz, Algermissen, etc., the author finds that they agree in making the dielectric strength of air 38 kilovolts per centimetre approximately. A knowledge of this quantity enables us to find not only the disruptive voltages between electrodes of many geometrical shapes, but it also enables us to find the "critical" pressure for overhead electric power transmission at high pressures. The author gives a complete proof by Kelvin's method of images of the Kirchhoff series formula, and shows how its numerical value can be readily found both by ordinary algebra and by elliptic function series.

Dr. H. A. Wilson expressed his interest in the author's explanation of the brush discharge and the formation of coronas. There were, however, one or two points in the paper which required some alteration. The author stated that according to Strutt the minimum sparking potential difference was 767 volts when the barometric pressure was 72·4cm. The pressure in Strutt's experiments was, however, 72·4mm. When the distance between the electrodes was not too small, it was known that the sparking potential difference could be expressed as $V=\alpha+\beta d$, where d was the distance between the electrodes and α and β were constants. This constant β the author had called the dielectric strength of air, but he did not think he was justified in doing so.

The Chairman, referring to Table V. in the paper, asked if the rise in value of the dielectric strength as the distance apart of the electrodes increased was due to the formation of coronas.

Mr. Russell, in reply, thanked Dr. Wilson for pointing out that in the paper the atmospheric pressures at which Mr. Strutt had obtained his results were quoted in centimetres instead of millimetres. Mr. Strutt had shown that the potential difference between the cathode and the negative glow was 341 volts whatever the atmospheric pressure. We were, therefore, quite justified in assuming that at ordinary pressures the electric pressure on the Faraday tube subject to the maximum stress is $V-\epsilon$, where ϵ is greater than 341. The experimental results analysed in the paper indicate that ϵ is 0·8 of a kilovolt. In answer to Prof. Poynting, he stated that the slight rise in the values of the dielectric strength in Table V. was probably due to the potentials of the electrodes not being V and zero at the instant of discharge.

A paper by Dr. H. A. Wilson and Mr. E. Gold, "*On the Electrical Conductivity of Flames for Rapidly Alternating Currents*," was read by Dr. Wilson. This paper contains an account of a series of experiments on the electrical conductivity of a Bunsen flame containing various alkali-salt vapours for alternating currents with frequencies from 7×10^4 to 11×10^5 alternations per second. The conductivity was measured between two platinum electrodes immersed in the flame, and the variation of the conductivity with the amount of salt present and with the nature of the salt was investigated. The variation of the conductivity with the frequency of alternation, the maximum E.M.F., and the distance between the electrodes was also examined. The results obtained enable a comparison to be made between the conductivities of various alkali-salt vapours for alternating currents and their conductivities for steady currents as previously determined. The conductivity was measured by means of a Wheatstone's bridge, three arms of which consisted of small air condensers and the fourth of the electrodes in the flame. One of the condensers could be adjusted until a balance was obtained. The following is a summary of the results: (1) For rapidly alternating currents a flame containing an alkali-salt vapour behaves like an insulating medium of high specific inductive capacity. (2) The conductivity of different alkali-salt vapours in a flame for rapidly alternating currents, as measured by the apparent capacity of platinum electrodes immersed in the flame, varies as the square root of the conductivity of the same salt vapours for steady currents. This result confirms the view that the negative ions from all salts have the same velocity. (3) The apparent capacity varies nearly inversely as the square root of the maximum applied potential difference. (4) The apparent capacity is nearly independent of the number of alternations per second. (5) The apparent capacity is nearly independent of the distance between the electrodes. (6) The results (1) to (5) are in agreement with the ionic theory of the conductivity of the flame for rapidly alternating currents when the velocity of the positive ions and the inertia and viscous resistance to the motion of the negative ions are neglected in comparison with the effects due to the number of ions per cubic centimetre. (7) The apparent capacity per square centimetre area of the electrodes is equal to $\sqrt{n\epsilon/8\pi V_0}$, where n is the number of positive ions per cubic centimetre, ϵ the charge on one ion, and V_0 the maximum applied potential difference. (8) Not more than one molecule in ten of salt molecules is ionised at any instant, but each molecule is probably ionised and recombines several million times per second. (9) The steady currents observed through salt vapours in flames are very far from the maximum possible currents corresponding to the number of ions produced per second.

Mr. W. Duddell expressed his interest in the method of measurement, and referred to the fact that, although the paper was entitled "The Electrical Conductivity of Flames," the authors had not measured conductivities but a complex quantity which was equivalent to a resistance shunted with a condenser. He drew attention to one of the tables given in the paper in which numbers referred to as constant varied by over 50 per cent.

Dr. Wilson said the quantity which they had measured was the apparent capacity of the electrodes.

LEGAL INTELLIGENCE.

ENGLISH ELECTRO-METALLURGICAL CO.

The Court of Appeal, consisting of Lords Justices Vaughan Williams, Stirling, and Ozens-Hardy, delivered a considered judgment last week in the case of the English Electro-Metallurgical Co. *v.* the Glasdir Copper Mines, Limited, on the plaintiffs' appeal from the judgment of Mr. Justice Joyce.

In this case the plaintiffs, the debenture holders of the defendant company, sought to put in force a charge created by the debentures. The debentures were a charge upon the whole undertaking of the company, and were issued subject to the condition that the charge created should be a floating security, but so that the company was not to create any charge in priority to them. In February, 1901, a receiver and manager was appointed, and subsequently in that year an order was made that he should be at liberty to borrow £500 for the purpose of preserving the property of the company, the money so borrowed to be a first charge upon the property. Liberty was given afterwards to borrow further sums. All the moneys which the receiver was authorised to borrow were advanced by the plaintiff company, and the charges which were executed were expressed to be first charges, comprised in or charged by the securities created by the debentures; but there was a provision that the receiver should not be personally liable to repay the advances out of his own pocket. Subsequently the company's lease was forfeited, and the only assets realised were certain fixtures and plant, which were sold. As there was not enough money in the hands of the receiver, after paying management and receivership expenses, to satisfy the plaintiffs' charges, they issued a summons asking the Court to direct that the receiver should be ordered personally to pay the sums advanced. Mr. Justice Joyce, however, held that the expenses of receivership and management had priority over the charges held by the plaintiffs for the sums advanced by them. Hence the present appeal.

Their Lordships held that Mr. Justice Joyce's decision was right, and dismissed the appeal, with costs.

A TRAMCAR COLLISION.

At the Kingston County Court last Tuesday, before his Honour Judge Russell (and a jury), Thomas Stamp Brewis, of Norbiton, sued the London United Tramways Co. for injury to a horse and damages to a van and load of hay, sustained in a collision in the Hampton Court-road, Hampton Wick, on Aug. 5 last.

The plaintiff's case was that the van was proceeding along Hampton Court-road at a walking pace on its proper side, but it overlapped on the tramlines. Without any warning a tramcar coming in the same direction as the van from Hampton Court ran into the tail-end of the van at such a pace that it pushed the van on some 6ft. The horse then bolted, and the unfortunate driver was thrown off and killed. The horse bolted along the road some distance, and the van was then overturned.

For the defence it was urged in mitigation that the night was so dark and the street illumination so bad that the driver could not see ahead of him.

After careful summing up by his Honour, the jury retired for five minutes, and on their return into court found a verdict for plaintiff, and assessed the damages at £30.

ACTION AGAINST THE HECKMONDWIKE DISTRICT COUNCIL.

The action of D. Stewart and Co., of Glasgow, *v* the Heckmondwike Urban District Council came on for trial last week before Mr. Pollock, K.C., official referee. The plaintiffs are boiler manufacturers, and the action was brought to recover the price of certain water-tube boilers supplied to and work done for the defendant Council in connection with a scheme for lighting the town by electricity. The real point in the case was whether the boilers which were supplied were capable of evaporating 4,000lb. of dry steam per hour under normal conditions and with average coal as specified in the contracts. Defendants said the boilers would not come up to that test, and counter-claimed for damages or set-off. A further point in issue would be as to what was meant in the contract by "normal condition and average coal." The Council's engineer claimed the right to say what were normal conditions, but plaintiffs said the amount of draught in the Council's works was abnormally low and was insufficient to burn the coal properly

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Eventually the Council pulled down the boilers and erected other boilers, and the action was commenced.

After the case had been adjourned it was announced that the action had been settled out of court, each party paying their own costs.

BELFAST ELECTRIC TRAMWAYS.

In the King's Bench Division on Friday last, before the Lord Chief Justice, Mr. Justice Madden, Mr. Justice Gibson, and Mr. Justice Boyd, in the case of Eccles *v.* White and Co., Mr. M'Grath, K.C., applied on behalf of the defendants, Messrs. J. G. White and Co., contractors for the Belfast electric tramways, for an order to remit the action for trial to the Recorder at Belfast. The plaintiff, Mr. John Eccles, a commission agent residing in Jameson-street, Belfast, sought to recover damages from the defendants for personal injuries alleged to have been sustained on the night of Aug. 4 in Victoria-street through the negligence of the defendants. It appeared that the plaintiff was driving a trap when he collided with a pole erected by the defendants, which was not lighted, contrary to the terms of their contract and the by-laws of the Belfast Corporation, with the result that he was thrown out of the trap and sustained the injuries mentioned.

On behalf of the defendants it was contended that the action was one which should be properly retained in the Superior Courts.

The Court remitted the action.

COMPANIES' MEETINGS AND REPORTS

CAPE ELECTRIC TRAMWAYS.

The ninth ordinary general meeting of shareholders in the Cape Electric Tramways Co. was held on Wednesday, the 6th inst., Colonel Sir Charles Euan-Smith, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report (copy of which appeared in our issue of the 24th ult.), said that, irrespective of the loss which had been incurred in the working of the Camps Bay system, the gross receipts from the working of the two systems of Cape Town and Port Elizabeth had fallen off during the year to the extent of some £17,000, a loss due, in the opinion of the Board, directly to the profound commercial depression which had reigned over the entire Cape Colony during the year under review, and which had affected all commercial enterprise in that country, and had naturally injured this Company's tramways, which were singularly sensitive to the state of the commercial atmosphere. In spite, however, of these adverse conditions, the directors had paid to the shareholders 5 per cent. on their capital, making the customary provision of £8,000 for the reserve fund. The hope expressed last year as to the early revival of prosperity had not, so far, been realised, and whilst there was no sign at present of immediate recovery, nevertheless there were symptoms that business depression had reached the worst. It was, however, his duty to inform the shareholders that since the date of the balance sheet the position had not improved, and the receipts continued to show a falling off combined with increased expenditure as compared with the same period of last year. This loss in both directions was largely due to the interruptions caused by the renewal work which was happily now nearing completion, so that they might hope in the next few months for slow and sure recovery, and, by improved service, to do better business. As to the question of dividends, it appeared to the Board opportune, in consequence of some remarks that were made at the last extraordinary general meeting called to increase the borrowing powers of the Company, to bring to the recollection of shareholders that the former large dividends and bonuses were never issued unless accompanied by a warning that it would be wrong to encourage a belief on the part of the shareholders that the Company could continue to earn and distribute so high a standard of profit and interest. It had been specially pointed out that the distributions sanctioned by the Board must necessarily be regarded as due to quite exceptional causes that might at any time cease to be operative. This was exactly what had taken place, and a period of active and promising prosperity had been succeeded by a period of profound commercial depression, which had made it impossible to earn and distribute the same dividends as formerly. The other important subject which had called forth so much criticism was the leasing of the Camps Bays tramways, which lease expires on the 31st of the present month, and this Company's connection with that line would then cease. During the past year the general renewal work of the systems was commenced, and was now nearly completed, as was also the construction of the important extension through Buitengracht-street. As practically the whole of their reserve fund had been from time to time invested in the enterprise, the money required for these renewals and extensions was obtained on loan, and the financial arrangements were completed at the extraordinary general meeting held on Oct. 25 last, whereby an issue of debentures of £200,000 was authorised. It was intended, as then announced, that £100,000 of this issue should be utilised for the repayment of the loan, and the Board would await the first favourable opportunity to negotiate the same in the market. In June last the Company was subjected to a substantial loss by a most serious gas explosion, which destroyed much of the newly completed line in Adderley-street, and, what was equally detrimental, interrupted their operations for some time in that most frequented and best section of the tramways, but the Board were, under advice, seeking remedy for this damage by legal process. Then, again, they had been subjected, both in Cape Town and Port Elizabeth, to unprecedently severe floods and violent storms, which were a great hindrance to traffic, and thus added to their many troubles. The important question of the compensation to be paid by Government for the expropriation of the Company's valuable property, the Sea Point Railway, was now *sub judice*, and therefore it would not be advisable to dwell upon it at that meeting. Whilst the Board had felt it their duty to lay before the shareholders an exposition of the various causes which had operated disadvantageously to the interests of the Company, they still bore in mind the brighter circumstances that might be found in the future. The recuperative power of Cape Colony was well known, and must be aided by the increasing gold production of the Transvaal. The abundant rains which had fallen throughout the greater part of Cape Colony also gave promise of good crops and improved agricultural conditions, and these must have, in due course, a favourable influence on commerce generally. Their new manager, Mr. Alfred S. Giles, had proved himself capable and energetic, and Mr. James A. Barkley, the manager at Port Elizabeth, had succeeded in lowering the operation expenses during the past 12 months without in any way sacrificing the efficiency of the service. He concluded by moving the adoption of the report and accounts.

Mr. SYDNEY MENDELSSOHN said that he had only recently returned from the Cape, and while he was there he took the opportunity of investigating the position of the tramways, and he found that the causes of the diminution in revenue were three in number—firstly, the enormous depression of business at Cape Town; secondly, the loss upon the lease of the Camps Bay line; and, thirdly, the tramlines had, in course of time, depreciated, and had to be relaid.

After some further discussion the report and accounts were unanimously adopted, the directors re-elected, and £500 voted to them as remuneration, and the proceedings terminated.

CARGO FLEET IRON.

The annual meeting was held last week at Newcastle on-Tyne.

Sir CHRISTOPHER FURNESS, M.P., presided, and in moving the adoption of the report, alluded to the purchase of the concern by the Weardale Steel, Coal, and Coke Co. The works had been reconstructed with subsidiary plant for dealing with by-products, and the comparatively small property which the Weardale occupied had become a vast undertaking. He also referred to the investments in the South Durham Iron and Steel Co., and to the policy which induced the directors to acquire a controlling interest in its affairs to avoid a situation of hostility involving fierce competition between the two concerns. The union of interests between the Cargo Fleet Co. and the South Durham Co. gave both the benefit of a union with the Weardale Steel, Coal, and Coke Co. They were not to regard the profits of the past nine months as being any criterion of future profits; he asked them to guard against expecting that, one year with another, the works would yield more than a fair remuneration for the capital they had adventured in it. The steel and iron trades were notoriously subject to fluctuations. In bad times like those through which they had been recently passing, they were apt to think they should never win through; in good times they were apt to spend as though they would never come to an end. The policy he invariably recommended for every concern in which he was interested was to build up a sound reserve as a bulwark against bad times.

The report was adopted.

SOUTH DURHAM STEEL AND IRON.

The annual meeting was held last week at Newcastle-on-Tyne, Sir Christopher Furness, M.P., presiding.

The CHAIRMAN, in moving the adoption of the report, said the expectations held out at the last annual meeting had been amply fulfilled, the profits of the nine months having been £109,123, against £80,095 for the previous 12 months. They had continued to enlarge their production and reduce their costs by judicious capital expenditure, but they could not have reached such a high total if they had not been able to take full advantage of the steel produced by the associated company, the Cargo Fleet Co., all of which they had rolled in their mills to the mutual advantage of both concerns. The steel trade was notoriously one of many fluctuations, and it had been remarked that in the industry "one must be either a prince or a pauper." He thought they had gone through the pauper period, and, judging by the order-book, it looked as though they were about to experience a fair measure of prosperity.

The report was adopted.

TUBES LIMITED.

Mr. ARTHUR CHAMBERLAIN presided at the annual meeting of Tubes Limited, at Birmingham, last Friday, and, in moving the adoption of the report, he said the balance-sheet showed a loss of £12,000 in the place of a profit of £5,000 for each of the two previous years, or a difference to the bad of £17,000. For the past three years, he said, prices had steadily fallen. In 1902 their total prices fell 20 per cent. below 1901, in 1903 they fell 10 per cent. over 1902, and in 1904 they fell again 20 per cent. more than in 1903. Last year, on the top of all that, they fell 25 per cent., making a total fall of 55 per cent. in four years, and without any corresponding fall in material. There were not many businesses which could support such a fall as that and still be alive.

GENEVA TRAMWAYS.

The report of this Company for the year ended Sept. 30, 1905, to be submitted at the meeting on the 15th instant, states that the profit and loss account of the Swiss company shows a gross profit on working of £18,791, and including the credit balance of £2,855. 12s. brought

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forward from the previous period, makes a total of £21,046. 12s., and after making provision for the necessary contributions to amortisation, renewal, and reserve funds, and for sundry expenses, there remained a balance of £14,504. 15s., out of which a dividend of 1 per cent., amounting to £8,000, has since been paid, leaving a balance of £6,504. 15s. to be carried forward. Additional rolling-stock having become necessary, this balance, together with a further amount from the current year's earnings, has been set aside for this purpose, which will absorb a sum not exceeding £10,000. Of the authorised issue of £20,000 prior debentures £4,000 have been subscribed and issued and subsequently redeemed in accordance with the terms of the supplementary trust deed of Aug. 26, 1903. Consequent upon the continued inability of the Compagnie Genevoise des Tramways Electriques to pay adequate dividends on its capital with which to meet this company's indebtedness, the revenue account of this company shows a loss for the period of £34,270, increasing the amount standing to debit of revenue account to £151,559, mainly the result of the accumulation of unpaid interest on the debenture issues. The directors have every reason to be thoroughly satisfied with the assistance received at the hands of the directors of the Swiss company and also with the services rendered by the general manager and staff.

ARON ELECTRICITY METER CO.

The profit and loss account for the year to Sept. 30 last, after providing for general charges, depreciation, and share of expenses and discount on the issue of debentures, shows a net profit of £11,724, making, with the balance of £412 carried forward last year, a total available profit of £12,136. Of this amount there will be set aside for the debenture sinking fund, in accordance with the trust deed, £2,500. Out of the balance of £9,636 the directors propose to pay 4½ per cent. on account of the preference dividend in arrear, absorbing £5,620, and to carry forward £4,016. The directors consider this result most encouraging. Trade in Germany and Austria has been very healthy throughout the year. The factories in Schweidnitz and Charlottenburg are also giving every satisfaction. The business in France and England is still in a somewhat unsettled condition. The outlook is, however, distinctly hopeful, and the directors will continue their policy of economy and care.

WELDLESS STEEL TUBE.

The report of this Company for the year ended Sept. 30, 1905, states that the result of the year's trading, after writing off £3 767 for depreciation, and charging all repairs and maintenance of property, plant, etc., and deducting managing directors' salaries and directors' and trustees' remuneration, is a loss of £3,845, which, deducted from the balance from the last account of £8 888, leaves a surplus of £5,042. From this there has to be deducted debenture interest for the year £1,282, preference dividend at the rate of 5½ per cent., leaving a balance of £1,670, which the directors recommend shou'd be carried forward.

BULLERS LIMITED.

The report of this Company for the year ended July 31, 1905, states that the trading accounts, after paying directors' fees and managing directors' salaries, show a profit of £35,588, which, with £781 brought forward, makes a total of £36,369. The directors propose to pay a further 2½ per cent. on the ordinary shares, making 10 per cent., to place £5,000 to reserve, which will then amount to £50,000, and to pay a bonus of 5 per cent. on the ordinary shares, carrying forward the balance, £1,369.

NEW COMPANIES REGISTERED.

Crawford Electric Lamp Syndicate, Limited. — Capital, £30,000. Object: to carry on the business of manufacturers, sellers, and suppliers of electric lamps, suppliers of electricity, etc.

H. E. Steel Limited.—Capital, £10,000. Object: to carry on the business of electrical, automobile, and general engineers, manufacturers of automobiles, omnibuses, and public carriages, etc. Registered office: 27, Regent-street, Cheltenham.

Automatic Electric Block Signalling Co, Limited.—Capital, £1,000. Object: to adopt an agreement with the Electric Railway Signalling Syndicate, Limited, to acquire any patents and inventions, and to carry on the business of electricians, suppliers of electricity and electrical installations and machinery for light, signalling, heat, motive power, and other purposes. Registered office: 302, Finsbury-pavement, E.C.

Chilian and Bolivian Railway Construction Co., Limited.—Capital, £202,500. Object: to purchase or otherwise obtain concessions, contracts, rights, and privileges for the construction, equipment, improvement, administration, or control of railways in the Republic of Chili and Bolivia, or elsewhere in South America, or any other part of the world; to construct, equip, and work railways, tramways, etc.

Liens Registered.

Marconi International Marine Communication Company, Limited, London, E.C.—Lien registered Nov. 21, for £8,000 7 per cent. debentures part of £25,000 authorised. No trustees. Charged on the undertaking and all the property and assets, present and future including the uncalled capital for the time being.

Standard Rubber Company, Limited, Manchester.—£250 debentures, created and dated Nov. 9, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holder: F. H. Barker, Ashenhurst House, Todmorden. No trustees.

Bolckow, Vaughan, and Co., Limited, Middlesbrough-on-Tees.—Lien registered Nov. 25 for £32,000 4 per cent. debentures, part of £1,000,000. Amount previously issued, £261,600. No trustees. Charged on all the property, present and future, the undertaking, and business.

APPOINTMENTS VACANT.

Electrical Engineer, Radcliffe Urban District Council. Salary, £150 to £172 per annum.

Improver. Wages. 10s. per week. Applications to Box 702, *Electrical Engineer* Office.

Wireman for electric light and power plant. Applications to Box 29, *Electrical Engineer* Office.

Representatives for an electrical contracting firm. Applications to Box G 33, *Electrical Engineer* Office.

Laboratory and Workshop Assistant, Battersea Polytechnic, S.W. Commencing salary, 20s. a week.

Switchboard Attendant. Wages, 25s. per week. Applications to Box R P 5 *Electrical Engineer* Office.

Assistant Lecturer and Demonstrator in Electrical Engineering, Leeds University. Salary, £175 a year.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Electrical Engineer, colliery in the North of England. Applications to Box Q 11, *Electrical Engineer* Office.

Junior Charge Engineer. Salary, 30s. per week, rising to 35s. Applications to the Borough Electrical Engineer, 335, High-street, Cheltenham.

Telegraph Inspector, Malay States. Salary, £225 per annum. Applications to the Crown Agents for the Colonies, Whitehall, S.W., by Dec. 12.

Electrical Mechanician, Malay States. Salary, £225 per annum. Applications to the Crown Agents for the Colonies, Whitehall, S.W., by Dec. 12.

NEW COMMITTEES.

LOUGHBOROUGH.—*Gas and Electricity*—Alderman Bumpus chairman, and Councillor Wootton vice-chairman.

MAIDENHEAD —*Electric Lighting* —Councillor Good, chairman.

MIDDLESBROUGH.—*Electric Lighting*—Councillor Charles Dorman, chairman.

STEPNEY.—*Electric Lighting* — Aldermen Barker, Brady, and Kearsey; Councillors Algar, Berringer, Gordon, Gould, Kay, Masters, O'Brien, Stettauer, and Vinall.

WARRINGTON.—*Electricity and Tramways*—Alderman Smethurst chairman, Councillor Wilkinson deputy-chairman.

WIGAN.—*Electric Light and Tramways*—Alderman Robert Layland (chairman), Alderman R. Johnson (vice-chairman), the Mayor, T. Ashton, R. Bannister, J. Cheetham, J. Gaskell, J. T. Gee, A. S. Hilton, W. Johnson, J. McQuaid, J. O'Donahue, J. Partington, R. Richards, and M. Segrave.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Swindon.—The Electricity and Tramways Department require tenders for three double-deck cars. Tenders by Dec. 19.

Heckmondwike.—Tenders are required for an installation for water purification at the electricity works. Tenders by Dec. 14.

London, W.—Messrs. Grice and Co., Addison Wharf, Warwick-road, Kensington, require a 10-ton electric derrick crane with 60ft. to 70ft. jib, continuous current.

Yarmouth.—Tenders are to be invited by the Port and Haven Commission for an electrically-driven crane. Including foundations, etc., the cost is estimated at £2,000.

Grimsby.—The Corporation require tenders for contracts contained in Specifications No. 35 39 and 43-45, for electrical plant, cables, and buildings. Tenders by Jan. 5, 1906.

Omnibus Lighting.—A London motor omnibus company is open to receive proposals for the lighting of its vehicles by acetylene or electricity. Apply to Box 306, Willing's, 125, Strand, W.C.

Sao Luiz.—The Municipality require tenders for electric lighting of the town. Tenders by Dec. 16. Particulars may be obtained from the Municipal Secretary of Sao Luiz in the State of Maranhao, Brazil.

Manchester.—Tenders are required for transformers and switchboards. Specifications may be obtained on payment of £1. 1s. (returnable) from the electricity department of the Corporation. Tenders by Dec. 19.

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Launceston (Tasmania).—Tenders are invited for the supply of 500 or more electric meters and for maximum demand indicators. Tenders to Mr. C. W. Rocher, town clerk, Town Hall, Launceston, Tasmania, by 12 noon on Jan. 15.

Sofia (Bulgaria).—Tenders are invited for the electric lighting of the Government Cadet School. Tenders by Jan. 19. Offers must be addressed in the Bulgarian language and be accompanied by a deposit of 5 per cent. of the amount of the tender.

Derby.—The Tramways Committee invite tenders for the supply and delivery of materials and construction of works in connection with the conversion of existing single line into double line from Deadman's-lane to Navigation Bridge. Tenders to the Town Clerk by 9 a.m. on Dec. 19.

Spain.—The *Gaceta de Madrid* contains a notice inviting tenders, which will be opened at noon on Jan. 30 at the Directorate-General of Public Works, Madrid, for the concession of an electric tramway between Santander and Astillero. A deposit of about £208 is required to qualify any tender.

Castlerea.—The Rural District Council invite tenders for the construction of works for lighting the town of Ballaghaderreen: (1) builders' work; (2) hydraulic turbine plant; (3) electrical work. Specifications and particulars may be had from Mr. C. Mulvany, M.I.C.E., Engineer's Office, Athlone, on payment of £1 as a deposit, returnable after receipt of bona fide tender. Tenders by Dec. 23.

Poplar.—The Guardians invite tenders for the supply and erection of the following plant at the children's homes and schools now in course of erection at Hutton, Essex: (Section X) steam-engines, dynamos, pipework, etc.; (Y, part 1) main switchboard, wiring, motors, etc.; (Y, part 2) fire alarms, telephones, and electric bells. Tenders to Mr. G. Herbert Lough, clerk, Guardians' Offices, 45, Upper North-street, Poplar, E., by 6 p.m. on Dec. 13.

Spain.—The *Gaceta de Madrid* of Oct. 10 contains details of a concession for the construction of an electric tramway as an extension to that of the east of Madrid. Tenders must be sent in by Dec. 13 to the Director of Public Works, Madrid, in whose office particulars may be seen. A deposit of 1,899·95 pesetas, or about £60, is required to qualify any tender. Local representation is necessary. The same journal of Oct. 12 contains a notice of a concession granted to the Sociedad Los Tranvias de Zaragoza for the construction of an electric motor tramway in that city. The *Gacetas* may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, E.C.

Madrid.—The Directorate-General of Public Works, Madrid, require tenders for the concession of an electric tramway between Zumárraga and Azcoitia, in the province of Guipúzcoa. An application for this concession has already been made by Don Dionisio Sorseta, who, at the same rates, will enjoy certain preferential rights over other tenderers. The competition will turn, in the first place, on a reduction of the tariffs proposed, and if two or more identical propositions are made, a further competition will take place verbally as to any reduction tenderers may be prepared to accept of the period (60 years) of the concession. A deposit of 6,897 pesetas (about £208) is required to qualify any tender.

Australian Commonwealth.—Tenders are invited by the Deputy Postmaster-General, Brisbane, for the supply and delivery at the Departmental Stores, Brisbane, of insulators, phosphor-bronze wire, copper sleeves, binders, and tapes. Tender forms, specifications, and conditions may be obtained from, and samples seen at, the Stores Branches, Postmaster-General's Department, Sydney, Melbourne, Adelaide, and Brisbane. Tenders by noon on Dec. 18.—Separate tenders are required by the Deputy Postmaster-General, Melbourne, for the supply and delivery at Melbourne of (1) 10 miles of 26-pair lead-covered paper-insulated telephone cable; (2) 1 mile of 156-pair lead-covered paper-insulated telephone cable (12½lb. conductors); (3) 5,000 barrel insulators delivery within three months of date of acceptance of tender. Tender forms, specifications, etc., and sample of insulator, may be seen at the General Post Offices, Melbourne, Sydney, Brisbane, Adelaide, Perth, and Hobart. Tenders must be endorsed "Tender for ——," as the case may be, and addressed to the Deputy Postmaster-General, Melbourne. They may be deposited in the tender-box at the General Post Office, Melbourne, or, if sent by post, must be prepaid and registered. Tenders by Dec. 17.

RESULTS OF TENDERS.

Warrington.—The tender of W. Rouse and Son, of Heckmondwike, at £279. 18s. 6d., for four car top covers, has been accepted.

North-Eastern Railway Co.—The above company have placed an order with the Brush Electrical Co., Loughborough, for 200 patent truck frames.

Bridlington.—The Council have authorised the acceptance of a tender, amounting to £1,475, for the carrying out of the electricity extension works.

Salford.—The amount of the fibre conduit order obtained by the Key Engineering Co. noted in our last issue should read 13,000 yards, and not 6,000 yards.

Torquay.—The Town Council have accepted the following tenders: Siemens Bros. and Co., engine and generator, reversible booster, motor-generator, switchgear, and connections, £5,168. 15s.; Tudor Accumulator Co., battery of accumulators, £1,966.

Whitchurch (near Cardiff).—The Asylums Committee of the Corporation have accepted the following tenders: Electrical Power Storage Co., batteries £958; Siemens Bros. and Co., engines and generators, £11,998; General Electric Co., switchboard, £627.

Beckenham.—The Urban District Council have accepted the following tenders: General Electric Co., engines and dynamos, £1,256; Mirrlees and Watson, condensers, £1,402; Elliott Bros., switchboard, £545; Brush Electrical Engineering Co.'s amended tender for machinery; and Babcock and Wilcox, boilers £3,375, pipework £1,750.

Fulham.—It is recommended that 100 meters be obtained from the General Electric Co. as follows: 70 5-ampere, at £1. 17s. 6d. each; 30 10-ampere, at £1. 19s. 6d. each. It is also recommended that the tender of Messrs. Spittle, at £299, be accepted for the electric light fittings for the town hall extension in accordance with the designs prepared by the borough surveyor.

London, S.E.—The London County Council have received the following tenders for the proposed construction of tramway lines over Vauxhall Bridge and the reconstruction of lines in Vauxhall Bridge-road:

J. Mowlem and Co.*	£4,995	0	0
J. G. White and Co.	5,200	12	7
Dick, Kerr, and Co.	5,543	16	7
C. Wall	6,520	0	0

* Recommended for acceptance.

Switchgear, etc.—Messrs. Cowans Limited, Springfield-lane, Salford, have recently received the following orders: Admiralty—main switchgear for dynamos and circuits for H.M. ships "Britannia," "Hibernia," "Warrior," "Africa," and "Cressy," and main switchgear for new battleship "Dreadnought" (the reverse-current devices for this contract are to be Andrews' patent Manchester type direct-acting circuit breakers); Greenock—feeder switchboard; Great Western Railway (per Electric Construction Co.)—13 sets alternating-current Andrews' discriminating apparatus; Bournemouth—equipment of three additional alternating-current generators with Andrews' patent discriminating cut-outs of the inductive balance type previously supplied.

St. Marylebone.—The Electric Supply Committee recommend the acceptance of the tender of the British Thomson-Houston Co., at £135 10s., for two spare armatures for the motors driving the induced-draught fans at the generating station; and the tender of Babcock and Wilcox, at £850, to put in the foundations for two boilers, superheaters, and economiser at the generating station to form a future extension of the boiler plant. The same committee have received the following tenders for a milking booster and switchboard at the generating station:

Phœnix Dynamo Manufacturing Co., Bradford*	£82
Electromotors, Limited, Manchester	98
Siemens Bros. and Co., London	103

* Recommended for acceptance.

India.—Messrs. Walter Locke and Co., of Calcutta, have been entrusted with the work of installing electric lights and fans in the Calcutta Medical College. The same firm is also busy with the electric installation in the new offices of the South British Insurance Co., the Russo-Chinese Bank, and Department of Commerce and Industry, also Messrs. Martin and Co.'s new offices in Clive-street, and St. Stephen's Church and parsonage, Kidderpore. The tenders for the Mussoorie electricity undertaking numbered 20 in all. The Brush Co.'s tender was the lowest, and the Municipal Board recommended to Government that it be accepted. Messrs. James Simpson were the lowest for pipes, and their tender was accepted. The electric tenders are, however, still under consideration. The Government Sanitary Engineer, U.P., has taken them all to Calcutta to consult with the electrical expert to the Government of India before a final decision is arrived at. The issue is exciting much interest among electrical firms.—*Indian Engineering.*

Shoreditch.—The Borough Council have received the following tenders for the extension of plant at their Whiston-street generating station:

Contract No. 34.—Three water-tube boilers, superheater, etc.			
Stirling Boiler Co. (accepted)	£6,605	0	0
Babcock and Wilcox	7,150	0	0
J. Fraser and Son (not according to specification)	7,478	0	0
Ditto	9,873	0	0
Contract No. 35.—Steam and water pipes, valves, etc.			
Stirling Boiler Co. (accepted)	1,175	0	0
E. Le Bas and Co.	1,176	0	0
Aiton and Co.	1,375	0	0
Babcock and Wilcox	1,395	0	0
J. Spencer	1,407	10	0
J. Wilson and Co.	1,472	0	0
Bennett, Sons, and Shears	2,050	0	0
Contract No. 36.—Wrought-steel flue.			
J. Fraser and Son (not according to specification)	326	0	0
Ditto (accepted)	531	0	0
Babcock and Wilcox	750	0	0
Fraser and Fraser	786	0	0
Meehan and Co.	796	0	0
Pierson and Co.	810	0	0
Stirling Boiler Co.	872	0	0
Westwood and Wrights	875	0	0

North Metropolitan Electric Tramways, Limited.—The official opening of the electric tramway service through Alexandra Park on Wednesday marks the conjunction with the London County Council tramways to within a few feet of the Crystal Palace. Sir Francis Cory-Wright started the new service at Turnpike-lane, and within a few minutes the first car, containing the directors of the Metropolitan Electric Tramways, Limited, drew up at the terminus. The cars are of somewhat novel design. In addition to there being no seating accommodation on the outside, a patent trolley arm makes it possible to negotiate very low bridges that with the older type of trolley would be impossible.

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BUSINESS NOTES.

TRACTION.

Hythe.—It is stated that motor 'buses will run between Hythe and Folkestone at an early date.

Colombo.—The relaying of the tramways on the Thermit system will be taken in hand shortly.

Birkenhead.—The Town Council have agreed to grant licenses to the Mersey Railway Co. to run four motor 'buses in the town.

Brighton.—A service of motor 'buses has been established between Worthing and Hove, and it is hoped to extend the service to Brighton.

Ilkeston.—At the last meeting of the Town Council objections were made against the running of trams on Sundays, but the mayor ruled discussion out of order.

Saint-Pierre (France).—An inquiry has been held into the proposal of the Finistère Tramway Co. to extend their line of electric tramways from Conquet to Brest.

New Issue.—The British Columbia Electric Railway Co. are offering for public subscription an issue of 185,000 5 per cent. cumulative perpetual preference shares of £1 each at £1. 0s. 10d. per share.

Beckenham.—The Urban District Council have approved a committee's recommendation that the draft agreement with the British Electric Traction Co. for the supply of current for the Penge tramways be adopted.

Aston.—The Public Works Committee reported to the Council that progress was being made with the reconstruction of the tramways, and that, with favourable weather, the trams would be running on Monday week.

Wigan.—The Electric Light and Tramways Committee have refused the application of the Ashton-in-Makerfield Urban District Council for a reduction of fares between Aston and Wigan and Bryn Station or Rose Hill to Wigan.

Portsmouth.—Arrangements are now in progress for the acquisition by the Corporation of the light railway that runs over Portsdown Hill. An extension of the tramway system to more of the suburbs of Southsea is also in contemplation.

Leyton.—The town clerk has forwarded to each member of the Council a print of the Tramway Order 5 Edward VII., Tramways Orders Confirmation (No. 2) Act, 1905, which received the Royal assent on Aug. 11, 1905. The report was received.

Eastbourne.—With a view of rendering the motor 'bus service more available for holiday traffic, the cars are to be run on special occasions to the summit of Beachy Head, *via* the Duke's Drive, as well as to Hampden Park. The service is now proceeding very smoothly, and is much appreciated both by visitors and residents.

Keynsham.—At a meeting of the District Council a letter was read from the Bath Electric Tramways Co. informing the Council that they intended to make an application to the Light Railway Commissioners for an order to authorise the construction of light railways in Somerset. It was decided by the Council to formally oppose the extension.

Lewisham.—The Works and Highways Committee of the Borough Council recommend that, subject to the Finance Committee submitting the necessary estimate of expenditure, the borough surveyor be authorised to place No. 4 burners in all the lamps along the route of tramways from Rushey-green to Loampit-hill at a cost of £60. 16s. per annum.

Leeds.—The Council had before them at their meeting on the 6th inst. a motion that the Tramways Committee be instructed to issue transfer tickets to workpeople travelling by workmen's cars when they require to transfer from one section to another, so as to enable the ticketholder to travel at least two miles for 1d. The matter was referred to the Tramways Committee.

North-Eastern Railway Co.—The company have decided to introduce a service of autocars on the railway between Newbiggin, Morpeth, and Blyth. The service will commence with the New Year, and the following additional trains will be tried experimentally: Morpeth to Newbiggin, 9; Newbiggin to Morpeth, 8; Morpeth to Blyth, 4 (Saturdays, 5); Blyth to Morpeth, 5; Newbiggin to Blyth, 5; and Blyth to Newbiggin, 5.

St. Marylebone.—It was moved at yesterday's meeting of the Borough Council that the London County Council be informed that the Borough Council of St. Marylebone are prepared to sanction the construction of a tramway along Edgware-road on the condition that one-third of the cost of widening be paid by the boroughs of Paddington and Hampstead, one-third be charged to the improvement and one-third to the tramway account.

Edinburgh.—For some time past the tramway company have been experimenting with an improved system of lighting for their cars. After exhaustive trials the directors have decided in favour of the acetylene lamps, which have been in use on the Abbeyhill and Morningside route. The lamps, which are pendant from the roof, give a bright light, well diffused over the car. The directors have entered into a contract for fitting up 100 cars in the meantime.

Greenock.—Decision has been given by Sheriff Neish in an action by Michael M'Gowan against the Greenock and Port Glasgow Tramway Co. for £100 damages in consequence of injuries received. The sheriff finds that pursuer was pushed off the car by the guard, but that the latter was not acting within the scope of his employment in pushing the man, therefore his lordship finds that the defenders are not liable to the pursuer in damages, and awards the defenders expenses.

Luton.—The trial trip of the motor omnibuses in connection with the suggested Herts and Beds service took place last week. The promoters of the scheme for connecting Luton with Dunstable and St. Albans by motor 'bus explained details before the Luton Chamber of Commerce. It was pointed out that the promoters did not wish to run counter to the Corporation of Luton. The meeting was of the opinion that the Council should be left alone to consider the tramway scheme.

Cowdenbeath.—The plans of the proposed tramways have been submitted to the Town Council, and now lie in the burgh office for public inspection. The Council find the plans do not show a double line through the burgh, and therefore they mean to appeal to the company in connection with the laying of two lines of rails. Sidings are marked to be laid down at the Bleachfield, Broad-street level crossing, High-street crossing, Toulford Arms, and Parker's-buildings, North-road.

West Yorkshire Tramways Scheme.—Parliament will be asked in the forthcoming session to sanction a scheme under which a company will be incorporated and granted power to construct and use various tramways and tramroads in the parish of Huddersfield, in the county borough of Huddersfield, the parish of Rastrick, in the borough of Brighouse, and the parishes and urban districts of Elland, Greetland, and Hipperholme, and in the parishes of Fixby and Clifton, in the rural district of Halifax.

Newcastle-on-Tyne.—At the Council meeting on Wednesday, the Mayor, in reply to an enquiry, stated that there were 102 cars on the streets and that overcrowding had been reduced. The idea of reducing fares on some routes could not be entertained. The Council agreed to authorise the construction of a double line of tramway along the new extension of Market-street from Pilgrim-street to New Bridge-street. This was to commence by a junction with the existing tramways in Market-street, and to terminate by a junction with the existing tramways in New Bridge-street.

Stepney.—The Town Council are in sympathy with the resolution passed at the Lewisham town's meeting, hoping the London County Council will speedily introduce a Bill authorising the passage of tramways over the bridges. The town clerk has been instructed to serve a notice upon the North Metropolitan Tramways Co. informing the company that unless the repairs necessary to the tramway margins, breasts, and rails in several streets in the borough are proceeded with at once, the Council will forthwith carry out the work and charge the company with the expenses incurred in so doing.

Camberwell.—The Finance Committee of the Borough Council recommend that the London County Council be asked to agree to charge the Council the rate of interest at present charged on loans for the Denmark-hill to Lordship-lane improvements until the period when the actual cost may be obtained, and when the total amount required from the Council may be taken up by deed. The recommendation arises out of the London County Council's request for payment of £2,533 and £23 by way of contribution towards the cost and expenses incurred by it in carrying out the Denmark-hill to Lordship-lane improvement, these amounts being one-third of the cost which the Council agreed to contribute.

Dewsbury-Batley.—The new tramway service on Bradford-road has now been in existence a week, and has been greatly appreciated. Experiments have been made with a view to preparing a time-table, and this will be done when the results have been tabulated and analysed this week. New one-decker regenerative cars have been tried on the Hick-lane and Thorncliffe-road lines, but it has not yet been decided where they will be permanently established. There are 14 cars on the Bradford-road lines, and the average speed has so far been 8¾ miles per hour. The speed could be accelerated if there were fixed stopping places, but there is no disposition at present to change the old system of "stop when required."

Wallsend.—The Town Council have adopted a motion calling upon the Newcastle Corporation to carry out its promise of a through service. The Council was induced to support Newcastle's plea for a tramline through Walker by the riverside on the understanding that they would run a through service to Wallsend. Newcastle now pleaded that the engineering difficulties at Fisher-hill could not be overcome. It was pointed out, however, that Newcastle had land to the south of Fisher-hill which would provide an alternative route. Meanwhile the people of Wallsend were suffering great inconvenience. It was further agreed to call on the Tyneside Co. to proceed with a promised extension to run a regular service on Neptune-road, and to provide more workmen's cars.

Wallasey.—The opening of a splendidly-equipped club to be used for social and athletic purposes by the Council's employés in the tramways and electricity department was celebrated last Monday evening by the holding of a most successful smoking concert, at which about 100 were present. The function took place at the commodious club premises, which are tastefully furnished. There is also fitted a fine billiard table, a piano, gymnasium apparatus, etc., whilst papers and periodicals are to be provided for the edification of the members. The tramway employés are to be congratulated on the acquisition of such well furnished premises, and it is to be trusted that the club will be well supported. The opening ceremony was performed by Dr. Napier, chairman of the Tramways Committee, who was supported by a number of councillors.

Elland.—Particulars of the proposed tramway scheme of the National Electric Construction Co. to link Halifax with Huddersfield, *via* Elland, were laid before the Council on the 6th inst. The intended route from West Vale to Elland would be *via* Long-wall, Jepson-lane, Victoria-road, South-gate, Dewsbury-road into Rastrick. Assurances had been given that any necessary widenings of streets or roads for trams would be done at the cost of the undertakers, also that the line from West Vale to Elland would be completed in six months from the date of the Act and the whole scheme within three years. The promoters of the scheme promise to take electric energy for the tramways from the Elland Council if it could be supplied by them at

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cheaply as by other people. The company intend to ask for 42 years' possession, instead of 21 years as provided by the Act of 1870.

London.—The Special Committee of the Court of Common Council submitted a report at the last meeting on a letter from the London County Council relative to a proposal, in view of [the approaching completion of the Tower Bridge northern approach, to construct a tramway along the new thoroughfare, from the existing lines in Aldgate, *via* Mansell-street and the new thoroughfare, to near Little Tower-hill; and asking whether the Corporation would be prepared to assent to the proposal, which had been included in a draft Bill seeking parliamentary authority for new lines. The committee stated that, while fully appreciating the spirit in which the London County Council had approached the Corporation on the subject, they were of opinion that, as the consideration of the proposal in question would be affected by any discussion which might take place in Parliament on the Bill as a whole, the present was not an opportune time for the Corporation to express an opinion on such a proposal. The report was adopted.

Christiania.—The *Elektroteknisk Tidsskrift* announces that an electric railway will shortly be constructed between Christiania (Norway) and Sandviken. It is to be a double track-railway of 1·435m. gauge, the central lines of the tracks being 4m. distant and the rails 29·76 kg in weight. The maximum gradient is 1 : 50, and the minimum radius of curves is 200m. The railway is to be constructed as a standard railway. Motorcars having a speed of 60 km. and more per hour are to be used. The journey from Christiania to Sandviken is to be completed in 21½ minutes, corresponding to an average speed of 37½ km. per hour, inclusive of stoppages. One hundred and twelve trains, 56 in either direction, are to be run each day. Electrical energy is to be supplied to the railway either from a special power station near Hovik or Lysaker or else from the municipal electricity works. The cost of construction of the railway is estimated at 1,770,065 kr., inclusive of the cost of purchasing the ground, as well as the rolling material, line, and electric plant.

Guildford.—It is reported that the directors of the West Surrey Light Railway Co., who are the promoters of schemes for the provision of electric tramways between Guildford and Stoughton, and for similar tramways at Woking, in addition to a projected light railway between Woking and Bagshot, will make an early start with the project. Arrangements have been made with the firm of Messrs. Johnson and Phillips for the execution of the work. Under the order the period within which the tramways must be completed is three years, and the agreement with Messrs. Johnson and Phillips, we understand, provides for a start to be made with the work within a month from the signing of the contract. It is also stated that it is the intention of the company, as soon as the Guildford to Stoughton line is completed, to apply for powers to construct tramways from the town to Merrow, and to Shalford, in accordance with the proposals originally made. Each of these lines will be independent of the other, and, as at present proposed, neither will cross High-street, although they will be brought as close together at the Guildford termini as possible.

West Bromwich.—The Highway Committee of the Corporation report that for some time past they have, together with the Electric Lighting and Power Committee, been in connection with the South Staffordshire Tramways (Lessee) Co. with reference to matters in dispute between the Corporation and the company. A settlement of these matters has now been arrived at. The company has paid certain arrears due for electrical energy supplied, and is to be allowed to run smaller cars, which must be of a type approved by the committee. A time-table giving the tram service in the borough has been submitted and agreed upon, and is to be in force for a year. This provides a less frequent service than five minutes between Handsworth and Carter's Green, and 10 minutes between Carter's Green and Great Bridge and Wednesbury respectively—namely, 7½ minutes and 15 minutes. In consideration of the above alterations, the company agrees to take a minimum supply of electrical energy of 900,000 units per annum, instead of the minimum of 300,000 per annum provided in the lease, but at the prices fixed by the lease, this minimum price to be continued during the term of the lease.

Liverpool.—An inquest was held last Friday on Catherine McNair, who was killed by an electric train on the Lancashire and Yorkshire Railway at Formby, near Liverpool. The evidence showed that the deceased waited for a steam train to pass, and was going over a level crossing when an electric train knocked her down. The horn of the electric train was not sounded when approaching, but it was promised that a recommendation of the jury that the horns should be sounded when approaching all level crossings should be placed before the proper authorities. The coroner said that, although he had no power to compel the railway to do it, the public ought to have better protection on certain portions of this line. At the last meeting of the Council it was moved that the Tramways Committee be instructed to institute a service of motor omnibuses on the Edge-lane route to meet the convenience of the inhabitants of this residential district, and that they be instructed to issue, before 7 a.m. (as an experiment for six months) return tickets on payment of a single fare, such tickets being available for the return journey at any time on the day of issue. These matters were referred to the committee for consideration.

Tramway Accident.—Lord Salvesen closed the record and ordered issues for the trial of an action at the instance of Hector Mackenzie Lamont, stationer and newsagent, Main-street, Wishaw, against the Lanarkshire Tramways Co., Edinburgh-road, Motherwell, for £760 for personal injuries. On Wednesday, June 7, 1905, the pursuer was a passenger by one of the defenders' electric cars from Wishaw to Motherwell. At a bridge near to the boundary line of the burgh of Wishaw, and to the east of the Lanarkshire Steel Co.'s works, the trolley pole, which under the bridges is almost level with the heads of the passengers, left the wires. When the car came from under the bridge the trolley pole swung round and struck the pursuer violently on the head, throwing him to the other side of the car. The pursuer says his injuries confined him to the house for eight weeks and to bed for five, while he still suffers from the effects. He avers that the car was being driven recklessly and at an excessive rate of speed, and says that for the safety of the outside passengers the conductor should have guided the trolley pole when passing under the bridge. The defenders admit that the pursuer was struck by the trolley, and that the pursuer was bruised, but they aver that the pursuer's injuries are greatly exaggerated. The accident, they say, was the result of a pure misadventure which no care on their part could have averted.

London County Council.—On the recommendation of the Finance Committee to invest £66,787 of the tramways renewals reserve fund, Sir M. Beachcroft at the usual weekly meeting on Tuesday said it was stated that the reserve fund now stood at £83,000, but he would like to know what 1d. per car mile placed to the renewals fund would represent. It was a big question whether 1½d. per car mile was not the right sum to put away, and they were told that 1d. ought to be the minimum. The Chairman of the Finance Committee promised to give information on the point. The Highways Committee recommend that the estimate of expenditure on capital account of £32,000, submitted by the Finance Committee, be approved in respect of the road work and platelaying (including rails) for the reconstruction of the existing tramways in Vauxhall Bridge-road, and the construction of tramways over the new Vauxhall Bridge, for the underground conduit system of electrical traction; that expenditure on capital account not exceeding £5 300 be sanctioned for the provision of track and slot rails, etc., for the reconstruction of the tramways in Vauxhall Bridge-road, and the construction of tramways over the new Vauxhall Bridge, for the underground conduit system of electrical traction; and that the offer of Messrs. J. Mowlem and Co. to execute for the sum of £4,995 the road work and platelaying in connection with the construction of tramways over the new Vauxhall Bridge for the underground conduit system of electrical traction be accepted.

Lancaster.—In future, all children under the age of 12 years are to be allowed to travel on the tramcars at half fare, the minimum fare to be ½d., and workmen will be allowed to use the return half of their tickets at any time during the day on which such tickets are issued. At the last meeting of the Council it was reported that Messrs. Kershaw and Co. had submitted a summary of their proposals with reference to the Lancaster and District Tramways for discussion, as follows: (1) The Corporation to agree to defer its power to purchase the company's undertaking for a period of 42 years from August, 1910, the date at which such powers may be exercised. (2) In the event of the Corporation purchasing the reconstructed undertaking, Section 43 of the Tramways Act not to apply, the price to be paid by the Corporation to be at fair market value as a going concern, but without allowance for compulsory purchase. (3) The Corporation to consent to the doubling and use as a double line of the present lines of the company within the borough, except in North-street, Cable-street, and the portion of Stonewell between those streets. (4) The Corporation to consent to the company employing the overhead system of electric traction; the designs and positions of the posts and the description of cars to be to the reasonable approval of the Corporation. (5) The company to apply for the necessary powers to construct a tramway to Skerton—this line would form a junction with the company's lines at the intersection of Owen-road and Heysham-road, and to be of single line with passing places. (5) The company to take a supply of electrical energy to operate the tramways within the borough from the Corporation at a price to be agreed upon. After full discussion it was arranged that Mr. Kershaw should reconsider the whole matter, and then submit other alternative proposals for consideration by the committee.

Dundee.—The Dundee-Broughty Ferry tramway is approaching completion, and our announcement made two weeks ago that traffic would be running over the line by the New Year seems likely to be fulfilled. The tramway is five miles long, representing about nine miles of single track. From end to end the rails are laid, the poles and brackets for carrying the conductors are erected, and the permanent way is all but completed. Operations are being pushed forward with dispatch, particularly at that part where the line departs from the highway and enters upon the lands of Craigie. Here the curve has been opened out, and stretching ahead is a straight of some 500 yards, upon which a high rate of speed can and will be attained. Over this portion of the line there is a noteworthy change in the construction of the permanent way. The rails are laid between whinstone setts, but the intervening space is filled in with tar macadam superimposed on a bottoming of rubble and concrete. The overhead equipment, as stated, is well forward, and underground cables are laid as far east as Craigie-terrace. At Dundee boundary, where the company's lines merge into those of the Corporation, the necessary junction and electrical bonding have been made. A good deal of work remains to be done at the power station and administration departments at Milton of Monifieth. A large staff of men are engaged. About one-third of the extensive car-sheds has been roofed, and this work has been completed so far as the engine-house and power-house are concerned. The engines and boilers have been placed on their seats. Inside the flooring is being laid down, and the completion of the stalk will be hastened so as to admit of steam being got up on as early a date as possible. A sub-committee of the Tramway Committee recently made a visitation with a view of determining a site for the proposed shelter at the junction of Constitution-street and Hilltown. The committee, in view of the alteration of service which will follow the opening of the Broughty line, deferred making a recommendation, the understanding being that the whole question of shelters would be discussed at an early date.

Wandsworth.—With reference to the resolutions passed at the last meeting of the Council relative to the suggested widening of York-road, Wandsworth, in connection with the proposal to reconstruct for an underground conduit system of electrical traction the northern

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route of the tramways acquired from the South London Tramways Co., and the proposed construction of a tramway from Clapham, *via* north side Clapham Common and Cedars-road, to Lavender-hill, the Highways Committee have forwarded the following estimates to the Finance Committee for submission to the Council—viz.: (*a*) For acquisition of property required to widen York-road, Wandsworth, to 54ft., where such width can be obtained without interfering with buildings, £12,000 (total estimated cost £12,000, Borough Council to carry out widening. London County Council to contribute two-thirds of cost). (*b*) For one-third of cost of (1) wood paving, etc., carriageway of Long-road and north side Clapham Common from south side to Cedars-road (total estimated cost of work, £4,600); (2) constructing surface-water sewer along Long-road (total estimated cost of work, £561), £1,720. Regarding the plan received from the London United Tramways Co. showing the proposed positions of manholes on the line of the company's electrical cables from Lots-road, Chelsea, through Wandsworth to Wimbledon, as follows—viz.: (1) in Merton-road, near Lavenham-road; (2) in Buckho'd-road, underneath sewer aqueduct; (3) in North-street, near South-Western Railway bridge—the Highways Committee recommend the Council not to object thereto, subject to the exact positions of the manholes being approved by the Council's surveyor, to the whole of the works being carried out to his satisfaction, and to the Council's usual charges for reinstating the surface of the public way being paid by the company. The town clerk reports that the following parliamentary plans have been deposited: (1) London County Council (tramways and improvements)—(*a*) tramway from Queen's-road, crossing Wandsworth-road and passing along Cedars-road, Clapham Common north side, and the roadway crossing Clapham Common, to join the existing tramway at Clapham Common south side; (*b*) tramway from the existing tramway at the Broadway, Tooting, along Mitcham-road to the county boundary; (*c*) tramway from the existing tramway terminus opposite the Tate Public Library, passing along Streatham High-road to the county boundary, providing for a single up line in the part of Streatham High-road between Stanhope-road and Gleneldon-road, and a single down line leaving Streatham High-road opposite St. Leonard's Church and passing along Gleneldon-road, Bournevale-road, and Stanthorpe-road to rejoin the line in Streatham High-road.

Hastings.—The Town Council had under consideration at their last meeting a report presented by the borough engineer with reference to the Old Town tramways. The engineer thought that, instead of forming an additional roadway, it would be desirable to widen one or other of the existing ones. He submitted an estimate of the cost of carrying out the High-street widening scheme which was as follows: purchase of properties, including compensation to tenants, etc., £61,038; laying-out the new road, £4,900—total, £65,938. Amount to be realised for sale of the land, £11,482; contribution from tramways company, £5,000; portion of roadway to be paved at the expense of the Corporation, £340—total, £16,822, making a net cost of £49,116. With regard to the laying of a tramway down through the widened road, the engineer proposed that a single line only should be laid, with a passing place between Swan-lane and Courthouse-street, another between Salter's-lane and the south corner of the garden of Old Hastings House, and a double line from the bottom of Harold-road brought down as far as the north end of Torfield House. With regard to the All Saints scheme, the widening would be entirely on the west side of the road, which comprised 105 separate properties. In this scheme it was proposed to entirely sweep away the buildings at Mercer's Bank. The street would be of a uniform width of 40ft., and it was proposed to pave it with wood blocks. The estimated cost of scheme would be as follows: purchase of properties, £39,381; laying-out and paving new road, £8,248—total, £47,629; estimated amount for resales, £6,970; contribution from tramways company, £5,000; portion of roadway to be paved by the company, £1,786—total, £13,756—leaving a net cost of £33,873. The tramway would be laid as a single line from the commencement of the "Wilderness" property, with two passing places in the street, and then widening out to a double line at the south end. The company would prefer the High-street scheme, but he could not see that it would make the slightest difference to them as regards either passenger traffic or the construction of the tramway. It was doubtful whether the Board of Trade would sanction a single line of tramways up High-street without widening the roadway so that there would be sufficient room for a vehicle to pass the car on the east side, although powers have been obtained to lay tramways in streets equally as narrow as High-street, and the cars could be controlled by electric signalling in an exactly similar manner to the method adopted at Dover. He thought, however, that to lay down a tramway through High-street without it being widened would be found a great hindrance to business. It was agreed that the report be printed and circulated among the members of the Council.

LIGHTING AND GENERAL.

Monmouth.—The Town Council have decided to lay a new electric cable at a cost of £107.

Long-Distance Telephone.—The new telephone between Rome and Paris will be opened early next year.

Birmingham.—A reduced scale of charges for electric current will come into effect in the quarter commencing Jan. 1, 1906.

Hastings.—In future the electricity accounts will be made up to March 31 in each year, instead of up to Dec. 31, as hitherto.

Clacton.—The agenda for Wednesday's meeting contained a motion referring to an important modification of the electric lighting scheme.

Dublin.—An inquiry has been held into the Corporation's application for sanction to borrow £100,000 for electric lighting works extensions.

Maidenhead.—Extensions are to be made to Taplow at a cost of £430 and £25.

Chelmsford.—The Town Council have asked the Chelmsford Electric Lighting Co. to instal flame arc lamps and incandescent lamps with clear glass globes.

Eastbourne.—During the half-year ending Sept. 30, 1905, 1,036 consumers with 76,204 lamps were connected, as against 937 and 67,946 respectively in 1904.

Sunderland.—An extension to the Hylton-road power station and the installation of four new boilers and certain other plant at an estimated cost of £16,000 is being recommended.

Stock Exchange.—The Stock Exchange Committee have ordered the Oriental Telephone and Electric Co.'s £100,000 4 per cent. redeemable debenture stock to be quoted in the official list.

Western Telegraph Co.—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, for the quarter ended Sept. 30, 1905.

Islington.—It has been decided to heat the Council's strong rooms by means of four electric radiators at a cost not exceeding £42. Mains are to be laid in the City-road at a cost of £575.

Poplar.—A resolution approving of the steps taken by the London County Council with respect to the question of cheap bulk electricity for the Metropolis has been passed by the Borough Council.

Stafford.—A report submitted at the last Town Council meeting showed that during the quarter ended September the output of gas had increased by 12·94 per cent., and that of electricity by 25 per cent.

Barsi Light Railway Co.—The directors of the Barsi Light Railway Co. recommend a final dividend at the rate of 3½ per cent., making 6 per cent. for the year to June 30, carrying forward £3,213.

Pentypridd.—The National Telephone Co. and the Post Office have completed the additional wiring and connections preparatory to intercommunication between the subscribers of both systems within the local area.

Brighton.—A committee of the Council have refused to recommend the application of the National Telephone Company for permission to place their lines underground. The total expenditure was estimated at between £40 000 and £50,000.

Falmouth.—The Chamber of Commerce has been considering the telephone service of the railway company, and consider it objectionable to have the call office at an hotel. It is suggested that another office be established near the post office.

New Address.—Mr. George A. Goodwin, M.I.C.E., Whit.Sch., and past-president of the Society of Engineers, has removed his offices from 28, Victoria-street to 25 Victoria-street, Westminster, where he practices as a consulting engineer and mechanical expert.

Rand Central Electric Co.—The following figures are given for November: kilowatt-hours generated, 866,000, yielding a gross revenue of £8,100. For the corresponding period of last year the result was: kilowatt-hours generated 795,000, yielding a gross revenue of £7,450.

Oerlikon Steam-Turbines.—The Maschinenfabrik Oerlikon has appointed Mr. G. Wüthrich, 19, Barclay-road, Fulham, S.W., manager of their British, Irish, and Colonial department and London resident engineer, with offices at Oswaldestre House, Norfolk-street, Strand, W.C.

Dover.—It has been decided to purchase a 50-kw. transformer at a cost of £65 to replace two smaller ones to be used in outlying districts. Some old plant was recently sold for £52. 10s. The Electricity Committee is considering the proposed increase of the power plant.

London County Council.—On Tuesday it was agreed to lend the Woolwich Borough Council £820 for electric lighting purposes and £7,500 for electric light installation. Improvements are to be effected to the electric lighting at the Fulham Palace-road school at an expenditure of £55.

Warrington.—The following scale of charges for electric energy supplied for power purposes has been adopted: load factor, 40 per cent., 1·0d. per unit; 50 per cent., ·94d.; 60 per cent., ·88d.; 70 per cent., ·82d.; 80 per cent., ·76d.; 90 per cent., ·70d. Intermediate values of load factor will be worked out proportionately.

Colchester.—The borough electrical engineer's last report contains the following figures: Output of electricity (lighting) in units during October, 1905, 75,248, (1904, 56,018); ditto (traction) ditto, 32,759 (35,540); ditto (used in generating station), 4,314 (—); number of consumers at end of October, 803 (576); total number of 8 c.p. lamps connected, 34,950 (27,381).

Change of Address.—We are informed that, owing to greatly increased business, Messrs. Bruce Peebles and Co. have transferred their London office from Westminster to 1, London-wall-buildings, E.C., which will be the headquarters of Mr. Roland S. Portheim, managing director, with Mr. Morton Beales as manager and Mr. W. J. W. Bullock as chief engineer of the contract department.

Bedford.—The last report of the Electricity and Street-Lighting Committee recommends that the electrical engineer be empowered to purchase the following materials—viz.: four-light radiator, £2. 4s. 6d.; frequency indicator, £5. 10s.; 220 yards $^{7}/_{16}$ twin service cable, £26; drawing-paper cupboard, 10s.—total, £34. 4s. 6d.—and that extensions of private mains be carried out at a cost of £73.

Stepney.—Applications by the Postmaster-General for the Council's permission to the placing of an overground telegraph pole at the south-west corner of the north side of Trafalgar-square, and to the placing of an underground telegraphic pipe along north side of Cable-street and east side of Christian-street, from 85, Cable-street to 10, Christian-street, also to building boxes, have been granted.

New Firm.—Messrs. L. E. Wilson and Co. have commenced business as telephone experts and engineers at 20, Cross-street, Man-

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chester. Mr. L. E. Wilson was formerly chief electrician of the National Telephone Co. in the Manchester district, and with the aid of his wide and varied experience this firm should meet a decided want, in view of the rapid strides in telephone work now being made in this country.

Wednesbury.—The auditor (Mr. T. H. Gorle) in his report on the accounts of the electricity department for the year ended March 31 last points out that, taking into consideration the fact that two-thirds of the loss on the first year's working arose from capital charges (paying off a portion of the principal and interest on loans), it did not show up so badly, being about equal to 1d. in the £ on the rates for the actual trading.

Edinburgh.—The lighting of side streets was further discussed on Wednesday. It will be remembered that the Electric Lighting Committee have been experimenting in certain streets with the Nernst lamp, supplying to the Cleansing and Lighting Committee current at the ordinary gas rates. A proposal by the electrical engineer to provide Nernst lamps at 47s. each was referred to the Cleansing and Lighting Committee.

Middlesbrough.—An application from the Cleveland and South Durham Electric Power Co. asking for the necessary consent of the Corporation to supply power to Messrs. Sir Raylton Dixon and Co., the Grand Opera House, and Messrs. Richardsons, Westgarth, and Co., the probable total demand being a million units per annum, has been declined, on the ground that the Corporation was already supplying on reasonable terms.

Wisbech.—The Town Council have confirmed their previous resolution to apply to the Board of Trade for a further provisional order under the Electric Lighting Acts, 1882 9, amending the provisional order of 1901 and enabling the Council to transfer their order, with its powers, duties, and liabilities, to a company, and to pass such further resolution as may be necessary in accordance with Sub-Section 6 of Section 3 of the Electric Lighting Act, 1882.

London Gazette.—The partnership between L. L. Hermes and W. A. Wallis, electrical engineers and contractors, 29, Uxbridge-road, Ealing, Middlesex, has been dissolved by mutual consent. A receiving order has been made out on debtor's petition in the estate of J. W. Smith, electrical engineer and contractor, 55, Bolton-road, Darwen. The first meeting in the estate of W. G Leather, electrical engineer, 25 Howard-street, Sheffield, will be held at the official receiver's offices, Figtree-lane, Sheffield, at 1.30 p.m. on Dec. 13.

Westminster.—Applications have been received from the General Post Office for consent to the placing of underground telegraphic lines in Hazlewell-road and in Gwendolen-avenue, Putney; from the County of London Electric Supply Co. to lay conduits in Hotham-road, Putney; and from the General Post Office to fix a stay to the existing telegraphic post on the eastern side of The Platt, Putney, near North-place, and to erect an overground telegraphic line from existing overground line in Priory-lane to Templeton House, Roehampton.

Hackney.—The Borough Council have confirmed the application for a Bill in the next session of Parliament conferring further powers on the borough, including provisions to enter into agreements with other local authorities for giving or taking a supply of electrical energy in bulk or otherwise. It was explained that the Bill would not in any way be antagonistic to that of the London County Council, and its object was to protect the rights of the Borough Council. This year the undertaking had yielded £1 400 towards the relief of the rates.

South Shields.—The quarterly statement of the electricity undertaking shows that the number of units consumed during the last three months was 138 086, as compared with 137,250 in the corresponding period of last year. The value of the current sold was £2,431, which, with meter rents and the proceeds of public lighting, brought the total amount from sales to £3,428, as against £3 664 in the corresponding three months of 1904. The reduced revenue is accounted for by the fact that the average price per unit last quarter was 4·23d., as compared with 4·71d. in the same period of last year.

Underground Telegraphic Cables.—At the meeting of the council of the Newcastle and Gateshead Chamber of Commerce on Wednesday, the Secretary said that the underground cable was being pressed forward as much as possible. The Postmaster-General had written stating that he hoped that the cable would be complete from London to Glasgow by the end of the current financial year. A spur line from Warrington, on the main underground line to the North, had been constructed through Manchester and Bradford to Leeds, with the intention of bringing it forward to Newcastle.

West Cumberland.—The West Cumberland Power and Tramway Co. will shortly erect a large central generating station from which iron mines, collieries, and works will be supplied with cheap electrical energy. The same generating station will supply current to tramways which the company will construct between Maryport and Whitehaven, and also for lighting purposes in certain districts. Sir Douglas Fox and Partners and Messrs. Harper Bros. estimate that the demand for industrial power alone will be equal to 15,000,000 units per annum, and that the total annual net return will be £27,150.

Wrexham.—The borough electrical engineer's last report shows that there have been used for tramways in October, 1905, 11,852 units and for lighting, etc., 36,317 units: the total consumption was 48,169 units as against 39,440 units in October, 1904. Six new consumers were connected, the total number of consumers now being 197. The Mayor and Councillor Hughes have been appointed a committee to consider the question of fixing a scale or basis of charges for materials supplied to and work done for consumers, and matters relating to the users of the department and to advise and report thereon.

Liverpool.—It is proposed that the resolution of the Electric Power and Lighting Committee of Dec. 1, 1905, as to the supply of motors on hire—"That the consulting and resident electrical engineers be instructed to prepare a detailed report showing the proposed working, and how the proposal will be carried out, also a statement of the financial result, increased cost, etc., and that the consideration of the report be deferred until the detailed report is received"—be not approved, and that in lieu thereof the report of the consulting and resident electrical engineers upon the subject be approved.

St. Annes.—In his last report Mr. J. H. Clothier, the electrical engineer, gives the following particulars: units sold during October, 47,966; units sold to Oct. 31, 356,095; equivalent to 8-c.p. lamps connected, 20,099; units sold per 8-c.p. lamp connected, 5 78; maximum load, lighting 199 kw., traction 105 kw.; total number of consumers, 383. Applications received, 11 for 353 8-c.p. lamps. The arrangements for connecting the feeder and balancer at the tramway sub-station are complete. The offer of Messrs. Pearson and Son to affix their smoke-preventing apparatus to one of the boilers at the electricity works has been accepted. The question of the revision of the prices charged for electrical current has been referred to the Electric Lighting Sub-Committee for report.

Crewe.—New offices have been completed in Gresty-road, on the southerly side of the station, for the accommodation of the electrical and telegraphing engineering staff of the London and North-Western Railway Co. Mr. A. M. Thompson, chief of the signalling department, has charge now of the telegraph department, and the members of the staff are being moved from the locomotive offices to the new buildings, and about 100 men, comprising the electrical and telegraph staff at Stockport, are being drafted to Crewe so as to concentrate there the chief officers under Mr. Thompson. Important developments in connection with the electrification of further large signal boxes are contemplated at the north end of Crewe Station, and when these are completed they will contain, it is said, the largest electric signalling apparatus of any railway station in the country.

Coventry.—The City Council had before them on Tuesday a report from a special committee recommending that no alteration be made in the present scale of charges either for gas or electricity. Regret was expressed by the chairman of the Electricity Committee at the result of the investigations, and he mentioned that in consequence of this the electricity department had lost one valuable customer and the gas department another. It was mentioned that in the neighbouring town of Birmingham it was decided to alter the prices of both gas and electricity, but Alderman Andrews, for 15 years chairman of the Coventry Gas Committee, cast doubts on the wisdom of such a course, and urged that it was unwise to expend about £24,000 simply to accommodate one firm. Councillor Gardner advocated the appointment of a board of reference for such matters as affected both departments, and Councillor Errington favoured the two departments being managed by a joint committee. The report was adopted.

African Rubber.—The report for 1904 on the Gold Coast by the Acting Colonial Secretary (Mr. C. H. Hunter) states that attempts have been made to encourage native planters to form plantations of the indigenous rubber trees, but, owing to the apathy of the chiefs, these have not hitherto meet with much success. Samples of Para rubber grown in the gardens at Aburi have been very favourably reported on, and the prices quoted for samples shown in the English market compare well with the Ceylon and South American product. Sir W. T. Thistleton-Dyer, writing on the subject, has expressed the opinion that "the production of Para rubber on our West African Colonies is an enterprise which has now emerged from the experimental stage, and may be safely encouraged by the Colonial Governments." The Para rubber tree, says Mr. Hunter, appears to be the most satisfactory rubber-producing plant to cultivate in the Gold Coast, and steps are being taken to procure further supplies of seeds from Ceylon and the Straits Settlements for intending planters, with a view to foster the interest aroused in the cultivation of this very valuable product.

Cardiff.—At the last meeting of the Asylums Committee Mr. Arthur Ellis, electrical engineer, submitted a report in connection with the electric lighting of the Whitchurch Asylum, the contract for which was placed in the hands of Messrs. D. Furth and Son, of Manchester. Mr. Ellis said there were altogether 3,604 lights to be wired, and the contractors had asked him for a certificate for £1,012, and his refusal had led to the present trouble. The next lowest two tenders were those of Messrs. Lee and Warren, Kettering (£6,491), and Messrs. Clay Bros. and Co., Cardiff (£6,964). The committee resolved that notice be given to the contractors that the work be proceeded with in a reasonable manner and with reasonable dispatch, and, failing this, that further notice to determine the contract be given; further, that notice be given to the sureties of the steps taken and contemplated by the Corporation, and that, in the event of the contract being determined, the same be relet to Messrs. Lee and Warren, or, failing them, to Messrs. Clay Bros. and Co., upon the terms of their tenders respectively, subject to their sureties being deemed satisfactory. An application of the National Telephone Co. for permission to place their wires underground has been referred to the Public Works Committee.

Gloucester.—At the last Council meeting the Electricity Supply Committee submitted Mr. White's further figures and information with reference to the charges for the supply of current for power purposes, and it was resolved that it be recommended that the following reduced scale of charges for the supply of electrical energy for power purposes only be adopted as from the end of the current quarter: for the first 200 units per quarter, 2d. per unit; for the next 1,000, 1½d.; for the next 10,000, 1¼d.; and for all beyond 11,200, 1¼d. It was reported that the representatives appointed by the Electricity Supply Committee and the Light Railways Committee to confer as to the price to be charged for current required for the light railways undertaking had conferred as to the question, and ultimately left it to the then mayor to suggest what would be a fair charge as between the two committees, and that the mayor had come to the conclusion that a charge of 1d. per unit was a reasonable and proper rate to be

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charged for the supply of electrical energy for the light railways, and that such charge should commence as from the end of the last municipal financial year—namely, March 31 last. The committee's recommendation that such charge be adopted for the current municipal financial year was agreed to.

St Pancras.—A special meeting of the Council is to be held at the Town Hall, Pancras-road, N.W., to-day, to consider as to passing resolutions in regard to the Council's application to Parliament in the ensuing session for an Act for all or any of the following purposes—that is to say: (1) to empower the Council to continue, maintain, and extend their stations for generating, transforming, converting, and otherwise dealing with electricity upon lands in their possession; (2) to empower the Council to continue, maintain, and from time to time extend, enlarge, improve, rebuild, and use their dust and refuse destructor upon lands in their possession; (3) to exempt the Council in respect of all lands used in connection with their electricity and dust destructor works from all indictments, actions, and other proceedings for nuisances; (4) to provide for the payment of the expenses of carrying the intended Act into execution, and for the borrowing of money; (5) to alter or repeal all or some of the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883, and any Acts or orders relating to the Council; 6) to vary and extinguish all existing rights and privileges which would or might interfere with or delay the accomplishment of any of the objects of the intended Act, and to confer other rights and privileges; (7) to provide for meeting the expenses in connection with the promotion of the said Act.

Fulham.—In their last report the Finance Committee made the following recommendations: "That the Council concur in the suggestions of the auditor that the electricity revenue shall be charged with an appropriate share of the central establishment expenditure, and that such amount be fixed at £200 instead of £100 per annum; that the electricity revenue shall also be charged with the actual cost incurred by its overdraft on cash account; and that the borough treasurer be instructed in future when the electricity account or the general account is overdrawn, and the money is not provided by the bank, but transferred from one account to another, to credit the interest of such overdraft to the general rate, or *vice versa*, at the same rate as would have been paid to the bank had the money been drawn from them. That no alteration be made in the present system of the collection of the electric lighting accounts, and that the period of 14 days from the date of demand for the allowance of discount be adhered to; also that the demands be delivered in batches as at present. That in view of the auditor's stand in cutting out from the accounts the loans of £3,600 from the electricity reserve, and £5,000 from the cemetery reserve to the works department for wood paving, the borough treasurer be instructed, in order to comply with the requirements of the auditor, to adopt a different method in transactions of this nature in future, and that he keep an internal account of these loans with a view to paying same back by way of contributions from the rates.

Lewisham.—Applications from the South Metropolitan Electric Light and Power Co. giving notice of their intention to (1) lay two $^{19}/_{16}$ high-tension concentric lead-covered cables from the existing mains on the west side of High-street, Lewisham, across that thoroughfare to the south-west corner of Court Hill-road, along the south side of the latter thoroughfare in an easterly direction for a distance of about 410 yards, and crossing to the London County Council sewer works, also two similar cables from Court Hill-road, along the north side of Hither Green-lane in a westerly direction for a distance of 66 yards, and crossing to the north-east corner of Ladywell Park-terrace and thence along the east side of that thoroughfare in a southerly direction for a distance of about 87 yards to the London County Council sewer works; (2) the laying of $^{19}/_{09}$ low-tension concentric lead-covered cables from a proposed junction box on the east side of Clarendon-road, at the south-west corner of St. Mark's-road, along the south side of the latter thoroughfare in an easterly direction for a distance of about 76 yards; (3) the laying of a similar cable from the north-east corner of Wisteria-road, on the west side of Gilmore-road, along the west side of the latter thoroughfare in a northerly direction for a distance of 107 yards, the cable to be placed in earthenware troughs filled with bitumen and laid under the footway where possible; and (4) from the General Post Office for permission to place an underground telegraphic line along the north side of West-hill, east side of Taylor's lane, south and west sides of Coombe-road, Sydenham, from the existing line on the north side of West-hill, at the west corner of Ormanton-road, to the north-west corner of Coombe-road, and to erect a fire alarm post at the latter point, have been agreed to.

St. Marylebone.—The Electric Supply Committee have reported as follows on the question of additional plant which will shortly be required in connection with the undertaking: "Under the Council's Act of 1904 the sanction of the London County Council is required before money can be borrowed for expenditure in this connection. The approximate amounts which will be required are as follows: a ninth turbine (to be supplied by Messrs. Parsons and Co., the contractors for the electrical plant) at the generating station, £10,000; a storage battery at North-street sub-station, £10,000; a storage battery at Rathbone-place sub-station, £5,000; two boilers at the generating station, £9,000. With regard to the turbine, it probably will not be actually required for a year, but we consider it would be a wise precaution to put the order in hand at once in order to ensure a sufficient reserve plant being in hand in the event of the failure of one of the present large turbines. The expenditure in respect of the storage batteries at North-street and Rathbone-place has always been contemplated, but the cost of these will be covered by the £15,000 which (under the provisions of the order of the Court of Aug. 7, 1903) the Metropolitan Electric Supply Co. have to repay to the Council in respect of the nine motor-generators at North-street, which they (the company) are now arranging to take back. The additional battery power at North-street is necessary to ensure a continuity of service to Hertford House, and in the recent negotiations with the Office of Works we undertook to instal this additional power by March next. In order to ensure the Council being in a position to take over the supply of the whole of the consumers in the borough by the end of March next, it is, in the opinion of the consulting engineer, necessary to immediately order the storage battery at Rathbone-place. We are inviting tenders for the batteries required, and will submit recommendations to the Council in due course. The two new boilers will be required for the ninth turbine above mentioned, and the contract for the same should be put in hand during the forthcoming year. We have referred the matter to the Finance Committee to consider as to the application to be made to the London County Council for sanction to the borrowing of money necessary for the foregoing additional plant." It has been decided to lay a second set of service lines to Hertford House, and to instal a change-over switch so that a supply may be given either from the special feeder or from the street distributing main. Messrs. Wheatley Kirk and Price have been instructed to sell old meters and other apparatus.

Bermondsey.—The Electricity, etc., Committee on Tuesday reported the receipt of the following letter from the London Electric Supply Corporation to the town clerk: "Dear Sir,—I have submitted your letter of 15th inst. to our managing director. He is sorry to be at issue with you, but he is quite confident that his recollection of what passed between you and him on the occasion referred to is correct, and he is entirely at a loss to understand how it is that your recollection of what actually transpired on that occasion is diametrically at variance with his. He quite recognises that an opinion expressed by you in the ordinary course of conversation cannot, in any sense, be interpreted as that of your committee or be regarded as committing them, however remotely, to the adoption of that or a similar opinion. If you or your committee have been under the impression that our managing director entertained any such idea, I trust that what I have stated will suffice to dispel it. In regard to your committee's repudiation of the suggestion that the Council's electric lighting undertaking is a burden upon the rates I would refer you to a circular letter issued in December, 1904, by the Municipal Association for Bermondsey and the neighbouring district, wherein it is stated that the constant recourse to loans inflicts serious burden upon the ratepayers, and that the ratepayers are year by year experiencing a large loss by the electrical lighting undertaking. That letter bears printed upon it the names of gentlemen who, it is presumed, are of sufficient intelligence to gauge the effect upon ordinary minds of statements purporting to emanate from them. It is fitting, perhaps, that I should state that the corporation is not a member of the association in question. In regard to your remark that your committee is not prepared to accept the statement in my letter that this corporation could supply your Council with electrical energy in bulk at a price below that at which they themselves can generate it, it is to be observed that your committee's opinion upon this point has been arrived at in the absence of any quotation from this corporation, and cannot, therefore, be regarded as well founded. I would remark that this corporation, in endeavouring to enter into business arrangements with your Council, had not the remotest intention of seeking to induce the Council to abandon their electric lighting undertaking; the object, as has been previously stated, was to reduce the Council's generating expenses. Referring to the last paragraph of your letter, it only remains for me to add that any such arrangement as that proposed, if entered into, would certainly not have the effect of compelling the users of electricity to pay a higher charge for lighting and power; on the contrary, its tendency would inevitably result in a lowering of prices to the consumer, and would undoubtedly reduce the cost of the supply to the public lamps.—Yours faithfully (signed) H. C. CARTER, secretary." To this letter the town clerk had replied as follows: "Nov. 27, 1905. Dear Sir,—I have submitted your letter of the 14th inst. to my Electric Lighting Committee. I regret you should still insist upon your entirely erroneous version of what passed between your managing director and myself, and am compelled again to repudiate the statement that I expressed any approval of your managing director's proposals. With regard to your suggestion that the Council's electric lighting undertaking is a burden upon the rates, my committee is of opinion that you should have taken some means to make yourself acquainted with the facts of the case rather than rely upon a statement circulated by the irresponsible body described by you as the 'Municipal Association for Bermondsey and the neighbouring district.' The accounts of the electricity department of the borough of Bermondsey (examined and passed by the district auditor appointed by the Local Government Board) are published, so that any ratepayer may have access to them. It will be found they prove the reverse of the view you express and which you say is based upon the authority of the Municipal Association. As to the sufficiency of the intelligence of the gentlemen to whom you refer, my committee express no opinion, nor do they think it needful they should do so. May I point out that your suggestion that you could supply this Council with electricity in bulk at a price 'below that at which the Borough Council could generate it' was made without knowledge either of the present or anticipated future works cost of the Council's electricity department. My committee, moreover, is of opinion that there are more satisfactory means of reducing generating expenses than by falling in with your corporation's proposals. My committee remains of opinion that the reference in your letter of Oct. 26 to a suggestion to obviate any further capital outlay on the part of the Council in connection with its electric installation and thus 'put an end to the cutting rates' between this Council and your corporation, could only bear the interpretation that the business of supplying electricity would by becoming a monopoly do away with the wholesome competition which now ensures to the users of current fair and reasonable charges for power and light. My committee instruct me to say that it still thinks no good purpose would be served by the officials of this Council meeting your corporation, and is, further, of opinion that there can be no useful purpose served by a continuance of this correspondence.—Yours, etc. (signed) FREDK. RYALL, town clerk. The Secretary, London Electric Supply Corporation, 25A, Cockspur-street, S.W."

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PROVISIONAL PATENTS, 1905.

Nov. 27.

24452. Improvements in incandescent electric lamps. Francis Harrison, 14, Ossian-road, Stroud Green, London.

24461. Improvements in or in connection with drain and sewer, water, and other pipes and electric conduits. Harold Easton Routledge, 3, Brown street, Market-street, Manchester.

24475. Improvements in appliances for carrying and suspending globes for inverted incandescent electric and other lamps. William Anderson and Henry Anderson, 41, Reform-street, Dundee. (Complete specification.)

24482. Improvement in electric incandescent lamp. Joseph Stwirsky, 36, Newman-street, London.

24494. Improvements in electrically-driven clockwork mechanism for registering and indicating purposes. William Robert Sykes, jun., Frederick Thomas Hollins, and Frederick William Leake, Walton House, Fillebrook-road, Leytonstone.

24502. Improvements in or relating to electric arc lamps. André Blondel, 111, Hatton-garden, London. (Complete specification.)

24507. Process for electrolytically producing peroxide of hydrogen. Gustav Teichner, 55, Chancery-lane, London. (Complete specification.)

24518. Self-generating steam or hot-air power electric machine. Carl Peter August Dahl, 77, Wells-street, Oxford-street, London.

24538. Improvements in electrodes for electrolytic apparatus. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (Marie Kellner, Eglantine Kellner, Eleonore Kellner, Eduard Kellner, Marie Kellner, heirs of Carl Kellner, Germany.)

24539. Improvements in electric demand indicators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

Nov. 28.

24605. Improvements in printing telegraphs. Leo Kamm, 37, Powell-street, Goswell-road, London.

24621. Improvements in or connected with electromagnetic generators. Louis Alexandre Gianoli, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 2, 1904, being date of application in France.) (Complete specification.)

Nov. 29.

24718. Improvements in or relating to wireless telegraphy. Ferdinando Lori, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Nov. 30, 1904, being date of application in Italy.) (Complete specification.)

24721. Improvements in insulators. Francis Heron Rogers, 16, Devonshire-square, London.

24724. Process for the electrolytic manufacture of metal tubes and other bodies. William Clark, 53, Chancery-lane, London. (Friedrich Darmstadter, Germany.)

24729. Improvements in and relating to electric controllers Claude William Atkinson, 1, Queen Victoria-street, London.

24747. Improvements in electric automobiles. Alfred Dinin and Maurice Espagnent, 40, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 9, 1904, being date of application in France.) (Complete specification.)

Nov. 30.

24761. Improvements in or relating to electric switches of the enclosed type. The Electric and Ordnance Accessories Company, Limited, Robert Frederick Hall, and Joseph Booker, 24, Temple-row, Birmingham.

24777. A mechanism for setting back the motion work and hands of electric clocks. Sharman Dermot Neill, 22 Donegall-place, Belfast.

24785. An improvement in the production of the electric arc for scientific and industrial purposes. Vladimir Mitkevitch, 10, St. George's crescent, Liverpool. (Complete specification.)

24794. Improvements in brush-holders for electrical machines. Herbert William Wilson, care of the East Anglian Engineering Company, Limited, Stowmarket, Suffolk.

24809. An improved system of syntonic radio-telegraphy Armande Parravano, 55, Chancery-lane, London. (Complete specification.)

24810. Improvements in the electrical control and propulsion of vehicles or trains of vehicles. John Smith Raworth and Arthur Basil Raworth, Queen Anne's-chambers, Westminster, London.

24811. Improved means of fixing an electric bell to an alarm clock and the like. Henry Richmond Rushton, 84, Ramsden-road, Balham, London.

24835. Improvements in or relating to electric bell pushes and in the manufacture of the same. George Thomas Piggott, 77, Colmore-row, Birmingham.

24850. Improvements in or relating to switches or controllers for electric motors for ships' steering gear, hoists, and the like. Joseph George Cockburn, 70, Chancery-lane, London.

24853. Improvements in and relating to electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24855. Improvements in and relating to electric resistances. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24856. Improvements in and relating to vapour electric apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24858. Improvements in electric fire-alarm systems and apparatus. Harold Hawthorn, 40, Chancery-lane, London.

24877. Improvements in dynamo-electric machines. Arnold Frank Hills, David Urquhart, and Alfred Edward Honey, 4, South-street, Finsbury, London.

24882. Improvements in and relating to electric arc lamps burning mineralised carbons. Hippolyte Hegner, 65, Chancery-lane, London.

Dec. 1.

24902. Insulating supports for conductor rails of electric railways. Henry Lewis Doulton and Charles Edward Morris, Lambeth Pottery, London.

24931. Improvements in or relating to electrical time switches. Robert Francis Sidebottom Venner and Robert Constantine Griesbach, 37, Essex-street, Strand, London.

24943. Improvements in telephonic and other electrical apparatus. Maurice Ravel de Malval, 53, Chancery-lane, London.

24962. Improvements in or relating to electric traction systems. Edward Albert Mitchell and the Dolter Electric Traction, Limited, 46, Lincoln's-inn-fields, London.

Dec. 2.

24995. Method and means for the control of any bank of electric lamps displaying characters and the like. George Edward Carr, 46, Goldspink-lane, Jesmond, Newcastle-on-Tyne.

24996. Improvements in and relating to electric arc lamps. Llewellyn Burbank Codd, Standard Works, Dame Agnes-street, Nottingham.

24998. Improvements in trolley boom controlling apparatus for electric tramcar and the like vehicles. Samuel Hindley, 58, Bute-street, Sheffield.

25007. Improvements in trolley poles. Thomas Walls, 37, West Nile-street, Glasgow.

25023. Improvements in or applicable to electric lifts and equivalent apparatus. Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

25032. Improvements in electric stoves. Obed Charles Hawkes, 35, Temple-row, Birmingham.

25047. Improvements in and relating to vapour electric apparatus or devices. Sir Oliver Joseph Lodge, Knight, Alexander Muirhead, and Edward Ernest Robinson, 323, High Holborn, London. (Complete specification.)

25053. Improvements in and connected with the insulation of electric cables. The Land-und Seekabelwerke Akt.-Ges., 6, Lord-street, Liverpool. (Date applied for under Patents Act, 1901, Dec. 2, 1904, being date of application in Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 21.

1904.

25647. Space telegraphy. Stone. (Date applied for under International Convention, Nov. 25, 1903.)

26174 Electric transformers. British Thomson-Houston Company, Limited. (General Electric Company.)

27401. Electric motor control systems. British Thomson-Houston Company, Limited. (General Electric Company.)

28175. Electric tramways and railways. Baynes.

28827. Bolometers and space telegraphy. Stone. (Date applied for under International Convention, Feb. 15, 1904.)

1905.

617. Construction of splicing ear for electric trolley wires or the like. Phillips.

1391. Controllers for apparatus adapted to be operated by alternating currents. Jackson. (Date applied for under International Convention, June 6, 1904.)

2194. Inspection boxes for electric light leads and the like. Wenham.

2766. Locks and switches for gates of electrically-controlled lifts. Major, Stevens, and Stevens.

3009. Electrical tramway conduit systems. Fell and Rider.

3125. Electric motor starters. Jones.

3372. Casings for electric switches and fuses. Headley.

5197. Electric switches. Byng and Coates.

5295. Electromagnetic pump. Ibbetson.

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6872. Ozonisers and like apparatus for treating gases electrically. Wood-Smith.

8267. Means for electrically recording weights lifted by a crane or the like Russo and Feinstein.

8739. Method for safeguarding electric unipolar cells. Grisson.

8921. Contact boxes for surface-contact electric railways. Campbell and Stephens.

10581. Devices for electrically operating the points on electric railways. Jokech, Petrik, and Butta.

11301. Couples for sulphide of copper thermo-electric generators. Cie. Thermo-Electrique (Systeme Hermite) Soc. Anon. (Date applied for under International Convention May 3, 1905.)

13662. Insulators of electric railways, tramways, and the like. Tweedy.

13707. Fluid-pressure brake systems for railway and tramway vehicles and the like. British Thomson-Houston Company, Limited. (General Electric Company.)

14465. Controlling and recording apparatus for use with electrical indicating instruments. Harrison. (Electric Railway Improvement Company.)

16518 Dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

17079. Receivers for electric waves Schneider.

17823. Receiver system for wireless telegraphy. Harrison. (Date applied for under International Convention, Aug. 26, 1904.)

18214. Apparatus for broaching tanks or the like. Chloride Electrical Storage Company, Limited, and Benest.

18432. Electric lighting apparatus for use in connection with cycles and the like. Lewy.

22460. Electrodes. Yasuda. (Date applied for under International Convention, Jan. 21, 1905.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅜-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	9/16- 1/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼ 7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	6⅞-6¼
—— 4½ per cent. Mortgage Debentures	00	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2¼ 2⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅜-½
—— Non. Cum., 6 per cent. Pref.	2	..	1 -2
—— 4½ per cent. 1st Debenture Stock	100	..	91-98
—— 4½ per cent. 2nd Debenture Stock	100	..	80-85
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5⅛-5¼
Crompton and Co.	3	..	1½-2¼
—— 5 per cent. Debentures	100	..	94-99 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅜-1⅝
—— "A" Shares, 01-017,139	5	..	2-2¼
—— 5 per cent. Debentures	100	..	92 97
—— 4 per cent. Deb. Stock, Red.	100	..	85 90
Electric Construction, Nos. 1 to 112,100	9	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1⅝ 1⅞
—— 4 per cent. Perp. 1st Mort Deb.	100	..	96-98
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-100
W. T. Henley's Telegraph Works, Ordinary	5	..	12½ 13,
—— 4½ per cent. Preference	5	..	5½-5⅝
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	16 17
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	32-34
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	12½ 12⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10½ 10⅝
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11½-12,
—— 4½ per cent. Debenture Stock, Red	100	..	107-109
Bromley (Kent) Electric Light and Power Co.	5	..	5½-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	102 105
Brompton and Kensington, Ordinary	5	..	9 10
—— 7 per cent. Preference	5	..	9 9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9-9½
—— Nos. 60,001-80,000	5	..	9 9½
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	104-107
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	5⅜ 6⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5½-5⅝
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum Pref., 1-40,000	5	..	4⅜-5
—— ditto (1903) 40,001-80,000	5	..	4⅜-5
Chelsea Electricity Supply	5	..	5 6
—— 4½ per cent. Debentures	100	..	110-112
City of London, Ordinary	10	..	11½-12½
—— 6 per cent. Cumulative Pref.	10	..	13½-14½
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	104 106
County of London Electric Supply, Ordinary	10	..	8½-9⅛
—— 6 per cent. Cum. Pref.	10	..	12⅜-12⅝
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	112-115
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	102-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5½-5⅝
—— 6 per cent. Cum. Pref.	5	..	5⅝-6⅛
—— 4½ per cent. First Mort. Deb.	100	..	108-110
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	85-90

Name.	Amount paid.		Last price
	£		£
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5½-5⅝
—— 4½ per cent. First Deb. Stock, Red.	100	..	101-104
Havana Electricity, 1-15,000	10	..	9-10
Hove Electric Lighting, Ord., 1-13,000	5	..	8½-8⅞
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1 150,000	1	..	⅝-1
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	10⅞-11⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅞-10¼
London Electric, Ordinary	3	..	1¾-2¼
—— 6 per cent. Pref.	5	..	4⅜-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	9¼-10¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Mortgage Debenture, Red.	100	..	97-99
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,0.9	5	..	8-8¼
—— do., 57,0 0-75,000	5	..	8-8⅛
—— 5 per cent. Pref., 1-57,00	5	..	6¼ 6⅜
—— do., 57,0 0-75,0.0	5	..	6¼-6⅜
Notting Hill Electric Lighting	10	..	14⅛-15⅛
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6⅜ 6⅝
—— 4 per cent. Debenture Stock	100	..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3¼ 3⅜
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13 14
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4¼-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5-5½
Westminster, Ordinary	5	..	11½-12½
—— 5 per cent. Cum. Pref., 110,1 1-138.251	5	..	5¾-6¼
Electric Tramways.—			
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5	..	5⅞-6⅛
—— Ord.	5	..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	142-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	105-107
Barcelona Tramways, Ord., 1-20,000	10	..	13⅜-14½
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9½-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-58,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov Certs. all pd.	100	..	96-98
British Columbia Electric Railway Co., Ord. Def.	100	..	124-127
—— Ord. Pref.	100	..	111-114 xd
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	106-109
—— 4, per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each	40	..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	9⅜-10¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	11-11½
—— 5 per cent. Perpetual Debenture Stock	100	..	121-123
—— 4½ per cent. 2nd Deb. Stock	100	..	98-100
Buenos Ayres and Belgrano Trams.	5	..	3⅛-3⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	..	107-109
—— Prov. Cert., all paid	100	..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,268	5	..	9½-9⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-109
Cape Electric Tramways, Nos. 1-480,000	1	..	⅝-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4¾ 5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	101-103
Cork Electric Tramway and Lighting Co., Ordinary	10	..	14⅛-15⅛
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13⅛-14⅛
—— 6 per cent. Pref., Nos. within 1-60,0.0	10	..	14⅛-15⅛
—— 3 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14⅛
—— 4 per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	21-22⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	10-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	⅛-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9⅜-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	104-107
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8⅜-9⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9⅜-9⅛
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	..	93-96
—— 4 per cent. Pref.	100	..	101-103
—— " " deferred	100	..	85-88
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	110-112

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	47-49
—— 4 per cent. Debenture Stock	100	105-108
—— 5 per cent. Pref. Stock '91	100	119-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	114-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	97-98 xd
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	99½-100½
Waterloo and City, Ordinary	100	94-97

Name.	Amount paid.	Last price.
Telephones.—	£	£
National Telephone, Preferred	100	110½-111
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅝-5¾
—— 3½ per cent. Deb. Stock, Red.	100	97½-98½
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 2	1,185	1,131	+ 51	− 1,412h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 2	172	174	− 2	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 3	900	874	+ 26	− 758	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 2	389	337	+ 52	—	2	2	,, 31	17,133	4,709,738	266,525	·85	14·5	8,866	—
Blackburn Corporation	Nov. 29	837	721	+ 112	—	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	,, 2	340	350	− 10	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Dec. 2	153	182	− 24	− 1,039	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 3	1,841	1 719	+ 122	—	40	38	March 31	95.766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	Nov 29	1,217	706	+ 511	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1·32	11 83	3,226	7·19
Bradford Corporation	Dec. 2	4,056	3,607	+ 448	+ 5,880	96	77	,, 31	230,085	47,108,000	5,033,392	1·172	10·927	2,396	—
Brighton Corporation	,, 3	744	720	+ 24	—	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 1	4,363	4,175	+ 188	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 2	1,058	933	+ 125	—	10 60	10·60	March 31	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 3	258	273	− 15	− 1,355	8¼	8¼	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 1	1,777	1 816	− 39	+ 70	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 2	150	164	− 14	− 637	8·5	8·5	Dec. 31	10,713	2,935,003	359,756	—	7·14	—	5·18
Central London Railway	,, 2	6,939	6,937	+ 2	− 961	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65 10	57,931	35·80
City and South London Railway	,, 3	2,994	2 897	+ 97	+ 300	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T. and L. Company	,, 1	386	334	+ 2	+ 633	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 2	173	154	+ 19	—	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 1	87	87	—	− 25 h	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars Dublin S. District, Electric	,, 1	4,554	4,375	+ 199	− 618	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dundee City Tramways	Nov. 29	885	707	+ 179	+ 1,477	23	23	May 15	44,695	11,641,525	933,006	·90	11·49	1,943	7 13
East Ham Corporation	Dec. 2	753	572	+ 181	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 2	14,985	13,641	+ 1,344	+ 21,061h	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 2	1,337	1,155	+ 182	+ 1,894	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 2	2,160	2,066	+ 94	+ 722	27	26	,, 31	112,651	27,102,921	2,910,693	1	9·29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	Nov. 29	105	84	+ 21	− 794	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	Dec. 2	5,505	5 180	+ 326	—	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 2	1,950	1,602	+ 348	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	Nov. 25	9 789	9,573	+ 525	—	103	103	,, 31	547,625	116,642,663	12.166,419	—	—	—	—
Liverpool Overhead Railway	Dec 3	1,351	1,423	− 58	− 1,545h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	Nov. 25	13,140	11,177	+1,963	+70,777	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	Dec 2	132	127	+ 5	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	Nov. 30	80	79	+ 1	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	Dec. 2	12.227	11,094	+1,133	+19,709	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Metropolitan District Railway	,, 3	7,862	7,577	+ 505	+ 2.915	24*	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 3	17,130	16,812	+ 318	+ 1,978	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 2	124	102	+ 22	+ 454	—	2¾	,, 31	6,159	1,972,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 2	3,666	3,542	+ 124	+ 2,874	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 3	1 691	1 310	+ 241	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 2	1,369	1,272	+ 97	+ 1,116	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	Nov. 30	532	511	+ 21	− 498	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	Dec 2	742	360	+ 382	—	6½	4¼	,, 31	14,881	2 837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	Nov. 9	514	497	+ 37	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	Dec. 4	4,092	3,773	+ 319	—	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 3	4,790	4,387	+ 403	+ 8,187	65¾	52½	,, 25	240,565	63,952 283	6,049 899	·903	9·543	3,653	6·477
Southampton Corporation	Nov. 29	837	723	+ 113	− 393	—	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	Dec. 1	717	372	+ 345	+ 6,360	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 3	1,225	1,081	+ 145	+ 1,560	20	20	,, 31	64,858	15,364,463	1,495,685	1·004	10·36	—	6·37
Swindon Corporation	Nov. 29	161	125	+ 36	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	.
Wallasey U.D.C.	Dec. 2	689	614	+ 75	+ 851	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	Nov. 30	1,811	930	+ 881	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 25	725	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. h Half-year's figures.

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NOTES.

Birmingham Electric Club.—At the annual meeting of the above on Saturday last, Mr. J. A. Jeckell, manager of the city of Coventry electric power station, was elected president for the ensuing year, and Mr. Riddle, of the firm of Inniss and Riddle, City-chambers, New-street, Birmingham, was elected secretary.

Change of Title.—Our Austrian contemporary, the *Zeitschrift für Elektrotechnik*, is extending its scope so as to include the construction of machinery. With the commencement of the year 1906 it will assume the title of *Elektrotechnik und Maschinenbau*, organ of the electrical industry in Vienna. We wish it success in its enlarged sphere.

Wireless Telegraphy.—The *Echo de Paris* states that the French Administration of Posts and Telegraphs have established three new wireless telegraph stations at Bizerta, Port Vendres, and Cherbourg. It is only intended to continue the experiments, which have hitherto not been sufficiently conclusive. The Administration hopes that the new experiments will give more decisive results than those made at Ile de Porquerolles and Ushant.

Books Received.—"La Théorie Moderne des Phénomènes Physiques," by Prof. Augusto Righi. Prof. Righi's work has been rendered into French by M. Eugène Néculcéa, and is issued from the office of *L'Eclairage Electrique*, Paris, with a preface by M. G. Lippman.—"The Practical Telephone Hand-Book," by Mr. Joseph Poole, A.I.E.E. (London: Whittaker and Co. 6s. net.) This is described as a guide to the telephonic exchange, and in it the author has succeeded in revealing its inner workings. It is intended to be of use to telephone employés and the general public.—"Practical Dynamo and Motor Construction," by Mr. Alfred W. Marshall (London: P. Marshall and Co. 1s. net), is a hand-book of constructive details and workshop methods used in building small machines.—"La Séparation Électromagnétique et Électrostatique des Minerals," by M. Désiré Korda (Paris: *L'Eclairage Electrique*).

Faraday Society.—Three papers were read before the Faraday Society at its meeting on Tuesday evening. The first, on the "Physics of Ore Flotation," was a joint contribution by Mr. James Swinburne and Mr. G. Rudorf, B.Sc., Ph.D., who argued that the theory that balls of sulphuretted hydrogen carry up particles of sulphide is invalid. The sulphides generally treated are not attacked by acid solution, so that there is no hydrogen evolved. The sulphides of zinc, iron, and manganese alone are attacked at all by dilute acids, therefore it cannot be the hydrogen sulphide that carries up the particles of sulphide. Prof. A. K. Huntington's paper dealt with the concentration of metalliferous sulphides by flotation, and had reference to the processes of Potter and Delprat. It was illustrated with a number of experiments. The last paper of the series was contributed by Prof. James Walker, F.R.S., and was upon the ions of pure water.

Tramways and Light Railways Association.—In the *Official Circular* for December is given a list of lectures and visits for which arrangements have been made. Last night (Thursday, Dec. 14), Mr. Elmer E. Cook (member) lectured "On Improvements in Trucks" (which we deal with separately), Mr. J. B. Hamilton (member of council) in the chair. On the afternoon of the same day the members visited the power station of the District Railway at Lots-road, Chelsea. A large attendance is expected in the theatre of the institution on Wednesday, Jan. 10, 1906, when Mr. A. L. C. Fell (member of council) will read his paper on "Brakes" before the association, and Mr C. R. Bellamy (vice-president) will take the chair. The *Circular* also contains a full report of Mr. Walter L. Green's practical paper on "The Paving of Roadways," and of the discussion, in which Messrs. Jas. Devonshire, Frank Trier, Percy Morris, and A. H. Pott took part. A notice is also given of the members' visit to the motor exhibition at Olympia, and of various other matters interesting to tramway and light railway men.

Wireless Telegraphy.—It is reported from Halifax that the Marconi Company contemplate another change in the site of their Cape Breton station. Representatives of the company have visited Lorne Head, near Louisberg, 25 miles from the present station, inspecting properties suitable for a site for the proposed new station. This would be the third change, as the second station, which is located at Glace Bay, four miles from Table Head, is about completed. A chief trouble with the Glace Bay station is that while messages can be transmitted from there, it is not possible with anything like equal facilities to receive. This is the point where failure comes in. It is thought that if a new station at Lorne Head is built it will be used for the reception of messages, while that at Glace Bay will be reserved for transmission. The cost of the first Table Head station was practically defrayed by the money given to Mr. Marconi by the Dominion Government of Canada when he first determined to erect Transatlantic stations in Nova Scotia. The present Glace Bay station has cost over £30,000. Nothing definite will be done until Mr. Marconi arrives.

Engineering Standards Committee.—We have received a copy of the committee's report on work in progress, which briefly describes the work of the committee from its inception in January, 1901, to July 31, 1905. The number of sub-committees has increased with the gradual development of the original single committee formed by the Institution of Civil Engineers, and there are now 35 sectional and sub committees. The whole work is supported by the five leading technical societies of this country and from H.M. Government, and there are serving on the different committees representatives from most of the technical societies and trade associations of this country. The Electrical Plant Committee is divided into three sub-committees—viz, generators, motors, and transformers; cables; telegraphs and telephones — presided over respectively by Colonel R. E B Crompton, Mr. R. Kaye Gray, and Mr. John Gavey, C.B. A great many matters have been under the consideration of these sub-committees, and at frequent intervals the Electrical Plant Committee have been called together to receive and consider their reports prior to their transmission to the main committee for final approval. Appended to the report is a list of members serving on the committees, together with a list of publications and templates issued.

Sand-Box for Tramcars.—An apparatus for the sanding of electric tramlines has been invented by Mr. Henry Liddle, of Newcastle. It is claimed for the invention that it will not only minimise the expense, but also the danger connected with the running of electric cars. The apparatus consists of a cast-iron box, made in two sections and bolted together. In the centre is a flat, perforated slide valve, working on parallel steel rollers. This valve is worked by means of a rod and crank, and brought to rest by the expansion or recoil of a spiral spring, the spring being encased in the sand-box casting, and kept in its place by a gunmetal bush, through which the valve spindle moves. In the upper section of the box is fixed an oblong bush with hardened knife-edge, the valve being so adjusted by adjustable roller bearings as to

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be slightly clear of the bush. This bush communicates with the sand hopper on the car, and consequently when at rest the sand is always on the flat valve. As soon as the valve is set in motion, the perforation or porthole in the valve is open to admit sand to the lower section of the box, and through the sand-pipe to the lines. A sheet-iron plate is fixed by means of screws on either side of the box, which can be quickly removed, and the valve examined. These plates also serve to keep the rollers in position. Another feature of the arrangement is that on the deck of the car, communicating with the motorman's foot, is a fixed hinged step or crank, which can be thrown back inside a circular case when not in use, the idea for this being quick manipulation at both ends of the car in case of emergency.

Storage Batteries.—Within recent years the use of storage batteries for the operation of signal devices has increased rapidly. They were at one time employed xclusively for electric interlocking, but, as Mr. E. L. Adams points out in his paper read before the American Railway Signal Association, their use for automatic signals is being extended. At interlocking signals it is difficult to determine when the battery requires charging, but Mr. Adams's experience leads him to the conclusion that to have an adjustable resistance so connected that the main tainer can discharge the battery at its normal rate for a period of five minutes and to note when the voltage drops to a predetermined point, is the most reliable means of ascertaining. On automatic installations there are two methods in use—one where the storage battery is used to operate signals only, the primary battery being used on the track; the other where the storage battery is used on signals and track. When a signal system is so laid out that there are both single and double locations, it is a moot question whether the batteries at the single location will stand without injury twice as much charge as they are discharged. Mr. Adams considers that the use of the storage battery on a track circuit is its most natural application. On track circuits a constant current through the relay coils is desired, and the storage battery can provide this current, unless track conditions are exceptionally bad. Charging plants for both electric interlockers and automatic signal systems are, in most cases, operated by a gasoline engine belted to a generator of about 500 volts. There are cases where electric motors are used to drive the generators, but these cases are few, for most interlockers and charging stations are located at isolated points where a gas-engine is the only source of power.

Water-Turbines.—At a meeting of the members of the Northampton Institute Engineering Society on the 1st inst., Mr. W. Chappell read a paper on "Water Turbines as applied to the Generation of Electricity," in which he described the development of turbine building in Europe and America, and compared the cost of the turbine with that of an ordinary steam-engine. He estimated that the amount of water power available in the world is about 54 million horse-power, out of which only about two million horse-power is at present in use. He then dealt in detail with the various types of turbines suitable for the generation of electricity. In order to gain large power units at moderate falls, a number of turbines of the same design can be put on to the same shaft, whilst another type used for large power units where there is a great change in the fall, and where a large quantity of water is to be utilised, is the combined high and low pressure turbine which is in use at Chevres, in Switzerland. The efficiency of a water-turbine ranges from about 75 to 85 per cent. In a factory near Zurich measurements were taken, and the following efficiencies worked out at three-quarter load = 86 per cent., half load = 82 per cent., quarter load = 78 per cent. In order to get good efficiency, the revolving wheel must be small. Mr. Chappell then described the apparatus at work at the hydro-electric power station at Paderno, Italy, the electrical station at Chevres, and along the Niagara frontier. With regard to the comparative cost of water power and steam power, he claimed that the advantage of the former was really more than generally supposed. He estimated the expenditure of a dam and water carrier, which is generally made in the form of an open concrete channel or wooden trough, also a line of piping and the turbines to work out at from £2 to £3 per horse-power. The figures in the case of a steam plant and the land and buildings necessary for housing same work out to about £30 per horse-power. Running expenses, again, show in favour of water-power plant, which is about £2 per horse-power per annum more economical than steam plant, the cost of which works out at £4 per horse-power per annum.

Improvements in Trucks.—Mr. Elmer E. Cook read a paper before the members of the Tramways and Light Railways Association last night on "Improvements in Trucks," in which he dealt especially with those types designed to meet the wants of tramways and light railways. He pointed out that more attention must be paid by those engaged in the operation of building or equipping of tramways to the truck or bogie, which causes great discomfort to tramway passengers, and especially those who travel inside, when the type adopted is cheap or coarsely made. Discussing the standard types of electric traction trucks, he said that the only fault which could be found with them to-day is the lack of machining and fitting, and the same care in bolting together as in many of the other less important parts of the car. He attributed the cause of this state of affairs to the inexperience and conservatism prevailing throughout the tramway world, including the committees as well as the engineers and managers. The average life of this type of truck is about five years, but Mr. Cook remarked that a few extra pounds spent in assembling the various members would lead to a much longer life. He then presented a number of lantern slids showing some of the imperfections to which he referred in the paper. He said that the greatest improve ment made in the last six years in electric traction trucks was in the adoption of the radial type. In the opinion of Mr. Cook, it combines the best qualities of the ordinary single-truck car and the bogie or double-truck car, while excluding all the disadvantages found in either type. It can be adapted to any size of car, ranging from 14ft. to 32ft. In the case of the shorter cars, its first cost is about 75 per cent. greater than the ordinary rigid wheel-base truck, but where it displaces bogie cars the cost is not only less, but it gives a full track efficiency by the application of only two motors. In addition, it has not the destructive effect on permanent way. In the case of steel-tyred wheels, the flanges on the radial wheel may be thicker than upon the rigid wheel-base trucks. Another advantage of radial trucks is the saving of current, as its working principle has almost entirely obviated the friction at curves and turnouts. The truck has only been on the market for a very short time, but some 34 different undertakings have applied it, so that there are commercial possibilities before it.

Telephones for Locomotives.—In a United States consular report just issued, details are given of a wireless telegraphic device whereby the means of communication with engine drivers while trains are in motion are greatly improved. The device is known as the Pfirmann-Wendorf apparatus, and experiments covering a period of several months, carried on by the Prussian State Railway, are said to have proved uniformly satisfactory, even under the

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most unfavourable conditions, due to rain, snow, fog, and darkness. These experiments were made on a specially-prepared track, several miles in length, extending from Goldstein to Sachsenhausen. Each locomotive used was supplied with a small Pfirmann-Wendorf apparatus, which, with its storage battery, occupies a very small space. Communication between this apparatus and the two track rails was supplied by the metal parts of the locomotive through the axles and wheels, while an insulated contact device connected the apparatus with a carefully-insulated auxiliary rail running midway between the track rails, the contact device being so arranged that it could easily be moved back and forth or sideways. Positive and negative charges can thus be sent in different directions, frequent changes being made from one rail to another. If there is an obstruction of any kind within a certain distance, an alarm is thus given, both visibly and audibly, by means of a red light and by the ringing of a bell. Engineers, signalmen, and stationmasters can thereupon communicate together by telephone, the central auxiliary rail serving as the channel of communication. In each locomotive there is a telephone, which is protected against the vibrations caused by the motion of the locomotive through being fastened on springs. In like manner, in cases of sudden danger, track guards can transmit a warning to the engineers of approaching locomotives. If for any reason a storage battery becomes exhausted it can be replenished with electricity produced by the locomotive, and even if this supply fails the current from a semaphore or signal station can still transmit to the engineer explanations and instructions. If by mistake a semaphore falsely registers a clear track, the endangered trains nevertheless supply each other with signals of warning. An alarm is also given automatically when a switch is falsely set or insecurely closed. The auxiliary line may be of ordinary T iron or of old rails, as desired.

Wireless Telegraphy and Submarine Cable.—The submarine cable situation in Alaska, which is complicated by the failure of wireless telegraphy, has brought forth an expression of opinion on wireless telegraph problems from Major W. A. Glassford, chief signal officer of the department of Columbia. He said that one of the claims made in behalf of the wireless service was its adaptability to that section, because it would span over the physical difficulties encountered by the present land wires. In combating this view, Major Glassford said that the Signal Corps were to-day operating the longest successful wireless system in the world between St. Michael and Safety Harbour, a distance of 107 miles. This plant was evolved and installed by the Signal Corps, and would naturally meet with any improvements or extensions, if such were possible. The mere fact that the chief signal officer of the army, after a personal visit to Alaska last year, did not recommend the installation of the wireless plant demanded by the Alaskan papers shows that he found such extensions or improvements were not possible. On the contrary, an extension of the cable and land lines will doubtless be recommended. It has been shown, said Major Glassford, that a single stretch in wireless communication is quite possible, but a chain of them has not so far been accomplished. Even though the wireless installation of the Signal Corps might be extended 107 miles or more overland there would be objections, and possible insurmountable difficulties in establishing a chain over so long a distance from St. Michael to Valdez, which in a straight line is between 500 and 600 miles, but with a chain of stations would be in the neighbourhood of 1,000 miles. There has not been discovered so far any means by which a message can be sent and one received at the same station at the same time, and the consequent delay would be considerable. It is, therefore, clear that, even though great improvements have been made in the wireless telegraph, it could not handle the volume of business that would be given to it as is now transmitted by the telegraph, so that under the circumstances it is not surprising to find that in his annual report to the department, Major Glassford strongly recommends that the earnings of the telegraph service should be applied entirely to extensions and improvements of the system and to the laying of additional cables. The fact that this recommendation receives endorsement from General Constant Williams, in command of the department, points to the likelihood of its adoption. In fixing the above limit of distance to wireless telegraphy, Major Glassford was evidently influenced by his own experience with certain apparatus. These conclusions do not apply generally.

Association of Technical Institutions.—The council of the association have just completed an inquiry into the co-operation of employers with technical institutions for the technical education of their apprentices, and the results of the inquiry have been published in the form of a report. The idea of holding such an inquiry originated at the annual general meeting of the association, when two papers on the subject were read and discussed. In the first place, a form of inquiry was sent to the 65 institutions affiliated to the association and to technical institutions not affiliated to the association. As a final step in the inquiry, information was sought from some of the large employers of labour whose educational work with their employés was not likely to be connected with the various technical institutions already approached, and several of the replies received from all sources have added valuable information on the subject. It is evident that a large number of employers of labour are co-operating with technical institutions in encouraging the attendance of their workers at evening classes. At the Barrow works of Messrs. Vickers, Sons, and Maxim, Limited, it is one of the rules of admission that all apprentice lads are advised to become students at the local technical classes, and, providing satisfactory evidence of their attendance is given, the apprentices may, as vacancies arise, compete for entry into the drawing office. Students are also granted a reduction in the number of working hours, while rewards in the shape of increased pay, bonuses, and preference are also held out to them. Two large engineering firms in the neighbourhood of Birmingham are considering their terms of apprenticeship, so as to make the progress of their apprentices dependent (in conjunction with other things) on progress at afternoon and evening classes at the municipal technical school. A number of engineering firms in Bolton offer scholarships to their apprentices, tenable at evening classes, in science and technology. In Bradford arrangements have been made between the Engineering Employers' Federation and the Technical College Committee for an efficient course of instruction to apprentices. One firm in Edinburgh, which charges no premium to its apprentices, requires them to attend evening classes, and at the end of three years, if sufficiently qualified, they are allowed to attend the day college for two winter sessions, the summer months being spent in the works, while in Glasgow the scheme whereby apprentices are allowed to spend part of their time at college and the other part at the works has been for many years in operation. Though the report does not profess to be a complete one, it is sufficient to indicate the useful purpose which such an association serves in bringing about more co-operation between employers of labour and technical colleges.

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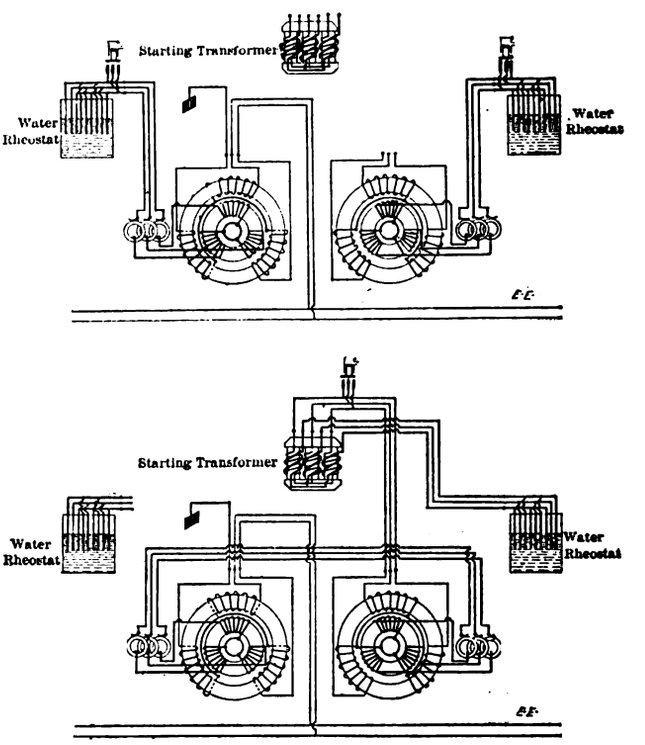
Rubber.—A great deal of activity is manifest in financial quarters for the acquisition and cultivation of rubber fields, and two new rubber companies are being promoted to work rubber estates in Ceylon and Liberia. There is no doubt about the profitableness of an investment in a rubber concern, provided, of course, that the undertaking is perfectly *bonâ fide*, as in this case we have no reason to suppose otherwise. The trees are known to yield a profitable return within five years of planting, while they seed abundantly in much less time. As Mr. H. A. Wickham pointed out in our columns in 1902 (vol. xxix., p. 42), the Hœvea is a large tree, which under favourable conditions attains a girth of 12ft. in the bole. It is most favourably planted and cultivated at a distance of 33ft. by 33ft., 40 to the acre, and giving, say, 5lb. of rubber per tree at 3s. per pound, it would yield at the rate of some £30 per acre for the sale of rubber alone, quite apart from the value of the seed crop, to be converted into oil worth £25 to £30 per ton. The Rubber Estates of Ceylon, Limited, whose prospectus has just been issued, will have some 1,200 acres under rubber at Dec. 31, 1905, and before the end of another 12 months a further 1,100 acres should be planted, which, together with the opening out of the remainder of the forest, should give a total of 3,200 acres under cultivation in parts of Ceylon which are considered by experts to be very favourable for the purpose. The directors estimate that a rubber yield of 1lb per tree, or 200lb. per acre, selling at, say, 3s. 6d. per pound net (whereas the present selling price is over 6s.), and costing 1s. per pound to produce, would give a profit of £25 per acre. This fully bears out the contention of Mr. Wickham that it is more advantageous to plant only 40 trees to the acre, each yielding 5lb. of rubber, for, apart from other considerations, there would be a saving in labour which the planting of 200 trees to the acre would necessitate. The Liberian Rubber Corporation, Limited, is being floated with a capital of £270,000 to take over from the Monrovian Rubber Company, Limited, a concession of about 2,800 acres in the Republic of Liberia. Sir Harry H. Johnson, late consul-general in Uganda, who is chairman of the company, in his report to the directors, states that the collecting stations, which now number four, can be immediately increased to 30, and the output of rubber can be increased to about 500 tons a year, which would give a net profit of £65,000 per annum, taking the present price of rubber as a basis. He estimates that within six years there will be 2,300,000 cultivated rubber trees yielding African rubber of excellent quality at a price of at least 4s, which should leave a profit of 1s. per tree per annum. It will be seen that the methods of working and calculations of the two companies are by no means identical, but is evidently impossible to make adequate comparison between the two, as the Liberian territory consists of vast primeval rubber forests. Both companies are launched under most favourable auspices, so that the outlook seems bright.

Heavy Electric Railroading—Mr. Bela Valatin contributes an article to the *Electrical World and Engineer* in which he deals with the problems of electric traction by the use of other than direct-current methods, which has been found disadvantageous. There are now three competitive systems—the direct-current, the single-phase, and the three-phase—and it is possible that each will find adoption in particular cases. The author makes a comparison of the three systems, with results favourable to three-phase current. The principal points which enter into electric traction for main-line railway service, and which determine the choice of any particular system, comprise the amount of capital outlay, the economy of operation, security of service, and flexibility of the system to meet the special requirements of traffic on a main-line railway. We have already referred to the Valtellina three-phase railway (particulars of the equipment and results of tests were given recently). With the newest type of locomotive used on this system, by means of a connecting rod the axle is driven at the same number of revolutions as the motor. By this new method an advantage is gained over the direct coupling of the motor to the axle, in that the motor is made independent of the locomotive axles and wheels. The mechanical efficiency of this new method is very high. Tests have shown that the use of connecting rods does not increase the friction losses over those due to direct connection. Mr. Valatin has prepared a comprehensive table giving a comparison of the weights of electric railway motors, from which it is observed that the weight factors of the polyphase motors indicate that these machines give the best output for the amount of material used. He points out that for the construction of large motors with a low number of revolutions, the three-phase motors are specially well suited owing to their ability of better utilising the space, inasmuch as the collector rings can be placed outside



the frame, whilst the weight of the three-phase motor is less than that of the direct-current. The reduced efficiency, the corresponding increased losses, the larger commutator, the pulsating magnetic field, all cause the weight of the single-phase motor to be greater than that of the direct-current motor. To the assertion that the reduced weight of the three-phase motor has been obtained at the cost of security, Mr. Valatin replies that the results of actual experience on the Valtellina system, where the bearings of the motorcars have been in service over 125,000 miles without requiring replacing, is proof of their security. There is no difficulty in using all motors in parallel under high tension by the application of the cascade regulation, which is used principally to allow the ascending grades at a decreased speed, and to ensure a higher economy at starting. The diagram shows an arrangement by which both motors can be used under high tension and work in parallel at high speed. In cascade connection, a transformer is put in circuit between the starting rheostat and the high-tension side of the secondary motor. This transformer is used only when starting, and it does not influence

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the economy, inasmuch as the transformer losses simply replace a part of the rheostat losses. With reference to the operating cost, the energy consumptions of each of the three systems have to be considered, as has also the number of stops on the line. Another consideration is whether the energy transmitted to the moving trains on down grades must be mechanically braked, or can be returned to the line to be used by other trains. The recuperation is of special importance when the returned energy can be used immediately; this would be the case where there is a dense traffic, or where the central station is also called upon to supply energy for other purposes than the moving of trains. The experience on the Valtellina line shows that the recuperation on light down grades is used to advantage, even though no other train is simultaneously on the line to absorb the same. The existing installation of three-phase roads have fully proved, says Mr. Valatin, that the two-wire high-tension equipment fully conforms to the most severe exigencies for safety of service demanded by the important traffic of a main-line railway, and the experiences on the Valtellina have shown that the safety of service and durability of construction of the overhead equipment depend on the suitability of the current collector. Mr. Valatin concludes by saying that for heavy electric traction the three-phase system is far superior to all others. If the single-phase system had not the advantage of requiring only one wire, instead of the two used by the three-phase, it would not be considered at all. Against the advantage of the single wire there must be placed the lower installation cost, smaller weights of motor-cars or locomotives, greater security of service, and less cost of maintenance on the side of the three-phase. In time these advantages, he says, will cause the present prejudice to be overcome.

Institution of Electrical Engineers.—The seventeenth annual dinner, which was held at the Hôtel Cecil last Friday night, brought together a fine constellation of *savants* and distinguished representatives of the engineering professions. Mr. John Gavey, the president, was in the chair, and among the guests were Lord Strathcona, Major-General Sir A. E. Turner, Sir Joseph W. Swan, Colonel R E. Crompton, C.B., Sir George Murray, Sir Alexander Binnie (president of the Institution of Civil Engineers), Prof. Dr. E Budde (president of the Verband Deutscher Elektrotechniker, Berlin), Sir Norman Lockyer, Mr. C. E. Spagnoletti, Mr. R. Kaye Gray, Mr. James Swinburne, Sir J. C. Lamb, C.B, Sir Charles Owens, Colonel Sir H Jekyll, Dr. R. T. Glazebrook, Sir A. B. W. Kennedy, Mr. H. Babington Smith, C.S I. (secretary of the General Post Office), and the Hon. J. G. Maydon (Minister of Railways in Natal). After the loyal toasts had been duly honoured, Mr. Babington Smith (in the absence through indisposition of Mr. R. W. Perks, M.P) proposed "The Institution of Electrical Engineers." He said that the only reason he could think of for being called upon was that he was the representative of their oldest and one of their best clients. One of the originators of the Institution was the late Captain (afterwards Major-General) Webber, who for many years was connected with the telegraph service of the Post Office. The past-presidents of the Institution included some eminent men connected with the Post Office and they had now their present engineer in-chief, whose election was received with great satisfaction by his colleagues. The President, in reply, said he could scarcely conceive that such enormous progress had been made in electrical science and industry in the last 50 years. He remembered the time when the only representatives of electrical engineering were the telegraph engineers. When the units had been laid down by English manufacturers, they were legitimised by Europe and became international units. He said the electrical engineer had invaded every industry, and where he had intervened he had increased the output and reduced costs. He thought that in the immediate future the engineer, whatever his speciality might be, would have to include in his curriculum a thorough knowledge of electrical engineering. Sir Alexander Kennedy, in proposing "The Electrical Industries," said no great industry had ever built so satisfactory a superstructure on so sound a foundation financially as the electrical industries had done in the course of the very few years which they had taken to attain their present growth. There could hardly be any industry which had to keep itself, and had kept itself, so intimately in contact with the latest experiments, theories, and discoveries of physical science, and he even went so far as to say there was no industry which had ever done so much, although it was a manufacturing industry, towards the advancement of the very science upon which it was based. The industry, he said, was healthy from the commercial point of view, and success from the commercial view meant success all round—even in Westminster. In coupling with this toast the names of Mr. E. Cunliffe Owen and Dr. E. Budde, he said he hoped the latter had not come to reproach them for stealing from Berlin Prof. Kapp, but now they had him they were going to stick to him. At the same time Dr. Budde could take back with him the knowledge that English electricians looked upon his countrymen as their very good friends. Mr. E. Cunliffe Owen, C.M.G., in responding, said that the recent exhibition at Olympia was a success, and resulted in a surplus. They intended to set apart a certain amount for the newly-instituted benevolent fund of the Manufacturers' Association, and they also intended to make a grant to the benevolent fund of the Institution of Electrical Engineers to the amount of £250. Dr. Budde also responded, and at the outset delivered to the Institution the greetings of the German electricians, whom he represented. The Institution had been the first to go abroad and inspect foreign works and doings, and he assured them that their invitation to foreigners to visit them in return would be highly appreciated. He asserted, with warmly-expressed sympathy of his audience, that the contact between scientific and technical men could not be too close. Research and intellectual labour form a tie which draws together the best in the world. German electricians looked with joyful admiration on the great men who stood out from the ranks of their English friends and the imposing results they had achieved. The scientists of the Fatherland were ever ready to join in advancing the international solidarity of science and technics, and in so doing to do something to sink race differences. Mr. Alexander Siemens proposed "The Colonies," which, he said, were connected to the Mother Country by submarine cables, so that electrical engineers had done a great deal towards consolidating the Empire. This toast was ably responded to by the Hon. John G. Maydon. The last toast of the evening, "Our Guests," was proposed by Mr. W. M. Mordey, who particularly welcomed the railway men, from whom they expected a great deal. They had encroached upon their preserves, but they hoped to do so still more in the future. He seriously advised them to place themselves in the hands of the electricians. He acknowledged the debt of gratitude which the Institution owed to the Civil Engineers for lending them their hall, and he coupled the toast with the name of Sir Alexander Binnie, president of the Institution of Civil Engineers. In reply, Sir Alexander declared that electricians had conferred inestimable benefits on mankind by bringing into more intimate relationship the different peoples of the earth, and by so doing wearing off the rough edges of nationalities.

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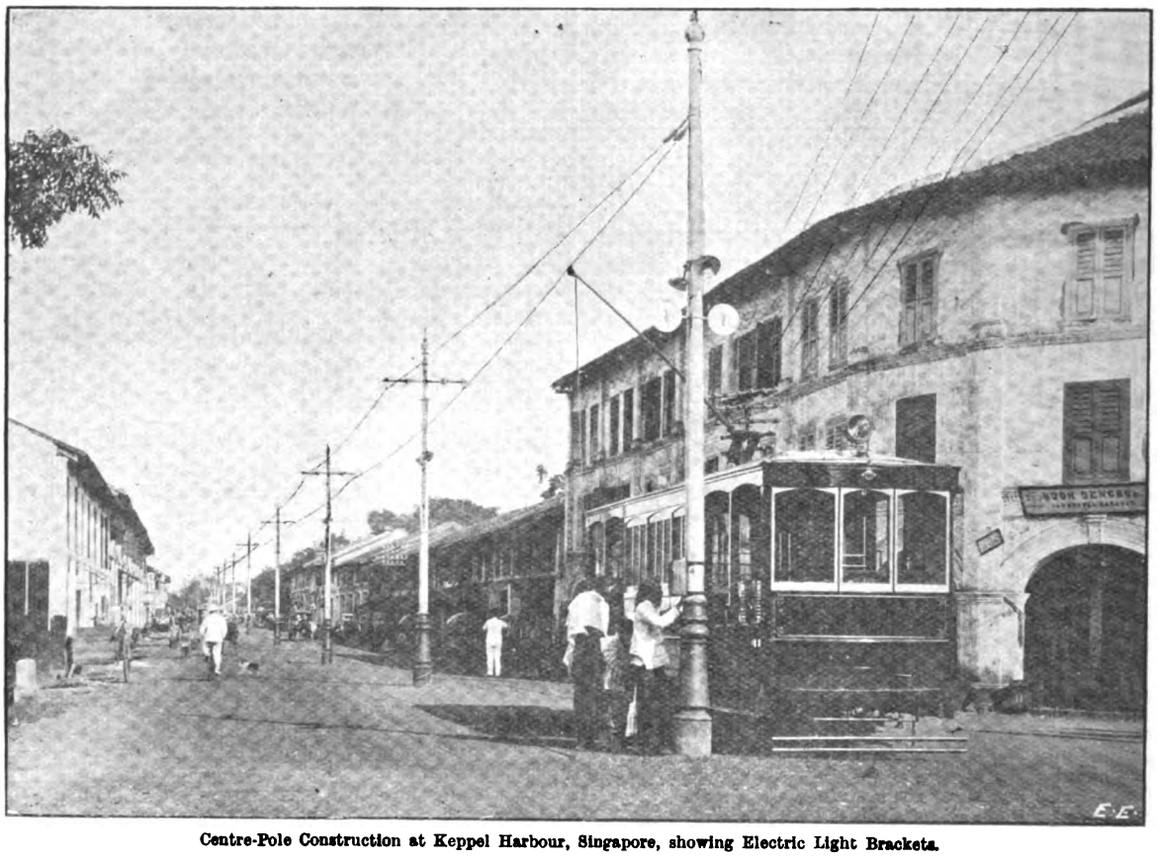
ELECTRIC TRAMWAYS IN SINGAPORE.

The newly-equipped tramways in Singapore may, with the exception, perhaps, of that thriving enterprise in Calcutta, safely claim to be the largest and most up-to-date system east of Suez. The buildings in Singapore, like those of other places in the Far East, range from substantial brick and stone structures to rudely-made huts of the native Malays. From the illustrations given herewith it will be seen that the streets are for the most part broad, straight, and level, thus being admirably adapted for electric tramways. The total population is approximately 250,000, which, besides Europeans, includes Eurasians, Chinese, Malays, Indians, Japanese, and many others. The climate of Singapore is tropical. The town being almost on the equator, there is very little variation in temperature all the year round. The effect of this on the vegetation is most marked. Palms, cacti, fruits, and flowers flourish in abundance, and, except where clearings have been made for buildings or agricultural purposes, dense jungles are still in existence, affording as safe a home for their denizens as do the jungles of adjacent Burma.



Centre-Pole Construction at Keppel Harbour, Singapore, showing Electric Light Brackets.

The city of Singapore (or Sincapore) was founded in 1819 by Sir Stamford Raffles, and it is owing to his sagacity that the happy choice of Singapore was made as the site of the present flourishing commercial emporium for British trade in the East Indies. In 1824 the British Government by treaty purchased from the then resident officer or chief, called the "tumangong," for 60,000 Spanish dollars (£13,500) and a life annuity to the Sultan of Jahore, and his resident officer of 24,000dol. (£5,400), the sovereignty and fee simple of the island, as well as all the seas, straits, and islands to the extent of 10 geographical miles around. In 1830 it was made the capital of the Straits Settlement, superseding Penang, and to-day it is undoubtedly the most important trading centre in the South-East of Asia. Its geographical position, combined with its splendid harbour, adds to it further importance as a port of call for steamship lines trading between Europe and the Far East.

The construction of the tramways was authorised by an ordinance passed by the Legislative Council of the Straits Settlements in 1902 The promoters of the scheme were the Association General, Limited, London, and the East India Construction Syndicate, Limited, London, was formed for the purpose of carrying out the construction of the tramways. The consulting engineers to the company are Messrs. Alfred Dickinson and Co., of Birmingham and London, who prepared all the detailed plans and specifications, and superintended the carrying out of the work. The contractors for the whole of the work, which included the construction of a bridge over the Kalang River, were Messrs. Dick, Kerr, and Co., Limited, of London and Preston. The work was commenced in July, 1903. and the first section of the line was opened for traffic in July, 1905.

The total length of the tramways is 16 miles of route, the length of the single track being about 26 miles 4 furlongs. The track is laid to a gauge of 1m., with rails of the girder type weighing 95lb. per yard. The rail joints are welded by the "Thermit" process, so that the track forms one continuous length. During the initiation of the scheme considerable discussion took place as to the advisability of having welded joints, the question at issue being, of course, the variation in the temperature. It was finally decided, however, that this difficulty was of too slight a nature to affect the joints after having been securely welded together by this special process. In addition to the Thermit joint a single 6/0 S.W.G. copper bond is supplied at every joint, thus ensuring perfect electrical conductivity.

The lines in the centre of the city, and those running to the docks, are for the most part double-track centre-pole construction, while the two routes leading north and north-east along the Serangoon and Gelang roads respectively are single lines with passing places, and are equipped with side-pole construction. Commencing near the entrance to the Keppel Docks, the route of the tramway follows Telok Blanga-road, past the entrance of the P. and O. Company's Wharf, passing the extensive wharves of the Tanjong Pagar Dock Company, to the junction of Anson-road and Tanjong Pagar-road, where it divides, one route following Anson-road, Cecil-street, and terminating on Collyer Quay, opposite Johnston's Pier, the other following along Tanjong Pagar-road, South Bridge and North Bridge roads, a portion of Victoria-street, and thence along Gelang-road to within a short distance of the bridge over the Gelang River. The route leading north commences near the Raffles Hotel, then follows Bras Bosah-road, Selegie-road, and Serangoon-road as far as the municipal boundary, where it terminates. A loop line is laid along Lavender-street, thus joining the

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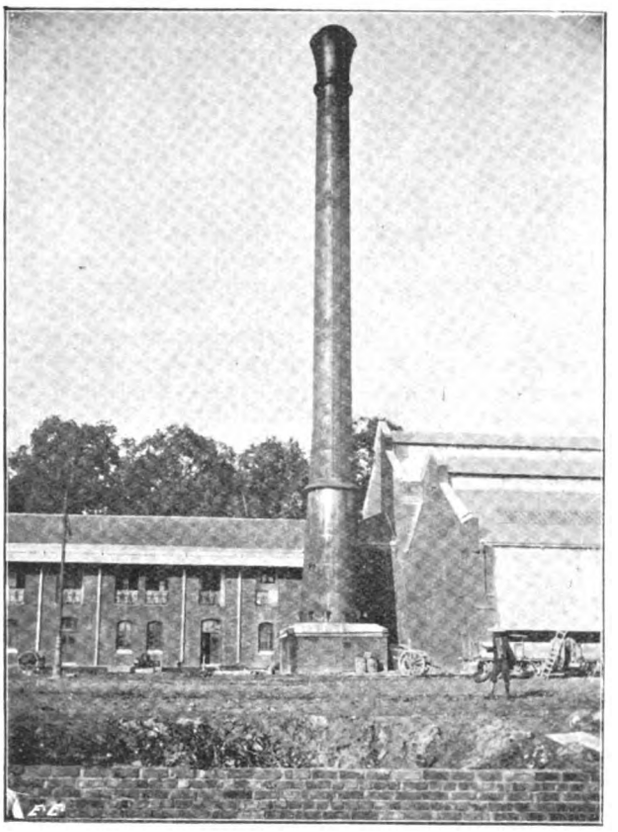
routes along the Gelang and Serangoon roads. There is also a short route which commences at the junction of North Bridge-road and South Bridge-road, and follows High-street, New Bridge, River Valley-road, and Tank-



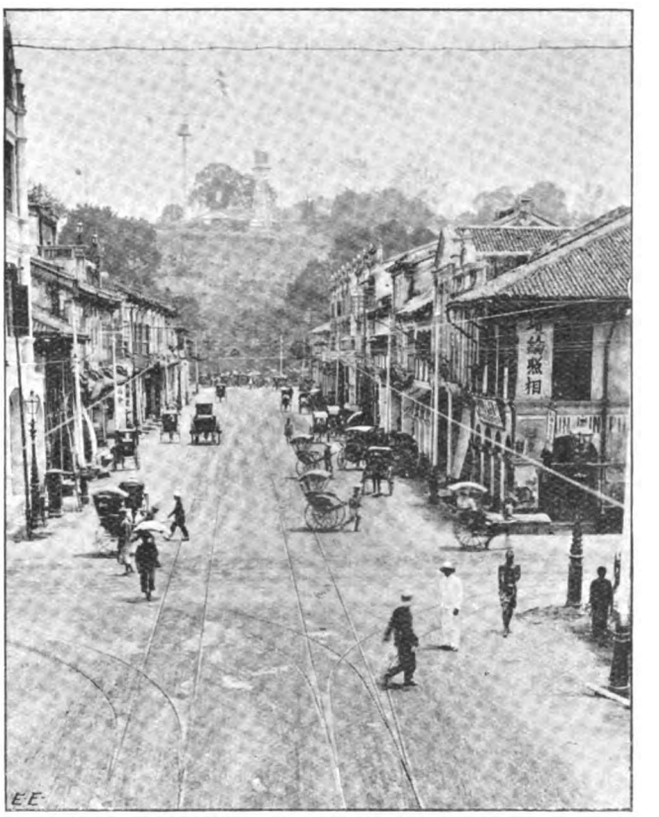
View of Chimney at the Singapore Power Station.

road, terminating near the station of the Singapore-Kranji Railway in the latter road.

The permanent way throughout is of a very substantial construction. The rails are laid on a longitudinal concrete sleeper, 8in. deep by 18in. in width. The flange of the rails is embedded in the concrete to a depth of 2in., and consequently there is a solid bed of concrete 6in. deep under the flange of the rails. The gauge of the track is maintained in the usual manner—*i.e.*, tiebars are spaced 8ft. apart throughout. After the rails and concrete foundation were laid, the road surface up to the rail-level has been

High Street, Singapore, looking up North Bridge Road.

made up with macadam, rolled and consolidated in the usual way. The overhead construction consists principally of side and centre pole construction, and also some two miles of span-wire construction. The poles are of mild steel, 28ft. 3in. in length, 7in. in diameter at the base, tapering to 4in. in diameter at the top. They are set 6ft. in the ground, and are embedded in a solid block of concrete, each pole being provided with an ornamental cast-iron base. On the centre poles the lengths of arms are 2ft.,



An Important Crossing on the Singapore Tramways.

while those on the side poles vary in length, according to the distance from the pole to the track. The trolley wires, which are not necessarily over the centre of the track, the possible variation being about 10ft., are divided into half-mile sections by means of section insulators. At each of

A Street in Singapore, showing Tower Wagon for erecting Overhead Work.

these points the main feeder cables are tapped and current is conveyed to the trolley wires by means of $^{37}/_{16}$ rubber-covered cables, which are carried up the inside of the poles and along the side of the bracket arms. The pressure on

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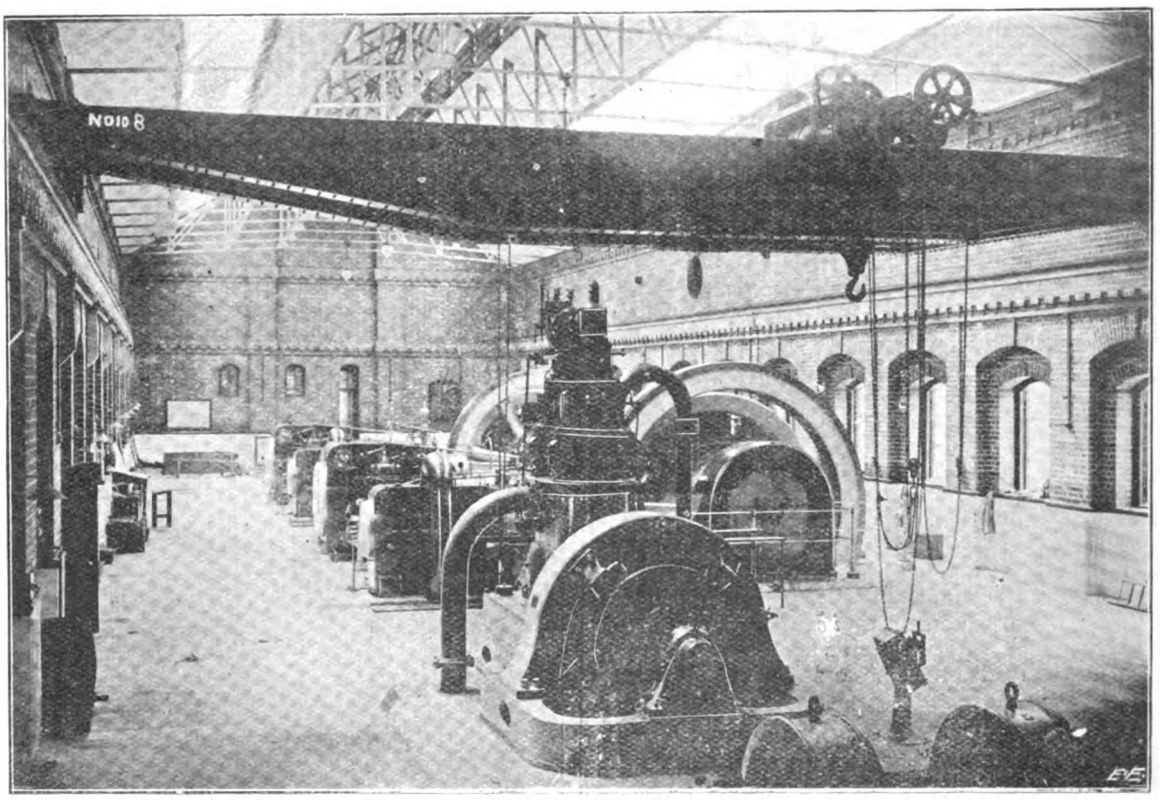
the trolley wires is 500 volts. A lightning arrester is provided in each section pillar, as is also a telephone giving direct communication with the power-house; and to guard against the tropical storms, which are so prevalent in Singapore, the overhead system is additionally protected by heavy lightning arresters at every half-mile of wire—these are fixed on the poles in cast-iron boxes, and are connected directly to the trolley wire. The whole of the feeder cables were supplied by Messrs. Callender's Cable and Construction Company, and laid by them on their solid bitumen system. The system of feeders has been arranged with due regard to future requirements, as it is generally anticipated that within the near future the traffic will rapidly increase, both as regards passengers and the conveyance of goods.

The generating station and car-shed occupy a most desirable position near the Rochore Canal, from which water is obtained for condensing purposes. The depôt buildings comprise the engine-room and basement, boiler-house, car-shed, machine shop, carpenters' shop, paint shop, smithy, offices of the general manager and his staff, and the usual outbuildings. The engine-room is 190ft. long by 48ft. 9in. in width, and contains two main traction 500-kw. sets, one steam lighting set, one motor-generator lighting set, and the necessary switchgear. The boiler-house contains eight Lancashire boilers, arranged in two batteries of four boilers each; each boiler is capable of evaporating 6,000lb. of water per hour, with a working pressure of 175lb. per square inch. Feed water is supplied to the boilers by four feed pumps, two to each battery; these are of the duplex compound non-condensing type, taking water either from the hot-well or storage tank. There are two Green's economisers, each containing 228 tubes, one being situated at either end of the boiler-house. The main traction engines, of which there are two, were built by Messrs. Yates and Thom, Blackburn, and are of their well-known horizontal cross-compound condensing type, running at 100 r.p.m., and are each capable of giving a maximum output of 927 b.h.p. per minute with a steam pressure of 165lb. per square inch at the cylinders. Each engine is provided with a Worthington surface condenser, but may be worked either condensing or non-condensing. In order to leave the engine-room as free and open as possible, it has been arranged so that the condensers are fixed to the basement constructed below, as are also all the steam-pipes and other usual accessories.

The generators were built by Dick, Kerr, and Co., and are of their continuous-current multipolar type, compound-wound. Each machine is designed to give an output of 500 kw. with a pressure of 550 volts when running at a speed of 100 r.p.m. Each generator is direct-connected to the shaft of the engine, and is designed to run separately or in parallel. They are in every respect in accordance with the firm's standard practice. The magnet frame is of cast iron, the pole-pieces being built of laminated steel and cast into the magnet frame. The commutation is sparkless at all loads, and the windings are so arranged as to give a 10 per cent. rise in the EMF. from no load to full load. The lighting sets are for lighting the city and depôt by means of incandescent and arc lamps, and consists of one 150-kw. Dick Kerr generator running at a speed of 350 r.p.m. to 400 r.p.m. The dynamo is designed for use either as a compound or shunt machine, and is coupled to a Willans triple-expansion condensing engine with extension base. Also a 50 kw. Dick-Kerr motor-generator set, shunt wound, designed to give a normal output of 100 amperes at 500 volts and a maximum of 115 amperes at 550 volts, and two balancers of the same firm's make, for use in conjunction with the above lighting dynamos, for 500 volts pressure.



View of Engine Room, Singapore.

The switchboard was built by the contractors, and is composed of 15 panels, each supported independently on an iron frame. The board consists of a main station panel, two generator panels, five feeder panels, one Board of Trade panel, and six other panels for lighting, etc. The chimney stack, which is of steel, is 135ft. in height and 7ft. internal diameter, and is a notable landmark for many miles around. The base of the stack is built in a substantial manner, and is finished square on the outside, massive stone blocks being provided at top of base to form the foundation for the circular part of the chimney.

The car-shed is 212ft. in length by 138ft. in width, and is built to accommodate 84 cars. Inspection pits run the entire length of each track, with the exception of the curves at the entrance to the shed.

The rolling-stock consists of 50 passenger cars, three bogie motor goods vans, 15 four-wheel goods vans, and 15 four-wheel goods wagons. The passenger cars are divided into two distinct types, 30 being of the single-deck, single-truck, open type, to seat 32 passengers; and 20 single-deck, single-truck combination type, to seat 40 passengers. The whole of the rolling-stock was built for Messrs. Dick, Kerr, and Co. by the United Electric Car Company, of Preston, and is in every way up to this firm's

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usual standard. The car bodies are mounted on Brill 21-E trucks, and each are equipped with two of the well-known D K. 25B traction motors. The motors are of the four-pole, series-wound, single-reduction type, and are suspended on bearings 4in. in diameter. They are designed to work at a pressure of 500 volts, and are capable of giving for one hour 25 b.h p. when running at a speed of 570 r.p.m, the temperature not rising above 110deg. F. in excess of the surrounding atmosphere. The controllers are of the same firm's standard D.B. 1 form "C" patent metallic shield blow-out pattern. They are of the series-parallel type, and are so designed as to give an easy acceleration to the car and an equal division between the two motors driving the various combinations. The cars are fitted with Hudson and Bowring lifeguards. The three bogie motor goods vans are each mounted on Brill 27-G trucks, the equipments being of the D K 25B quadruple type, with the D.B 1 form "C" controllers. They are intended for use of a double purpose, that of conveying goods and hauling goods trucks, the general arrangement of the body being such as to provide a self-contained van with divided sliding doors on each side, which may be securely locked up, and a vestibule canopy at each end as the platform for the drivers. The 15 goods wagons are equipped in a similar manner to the passenger cars; they are 12ft. in length and 6ft. 6in. in width. These wagons are for general use for the conveyance of various classes of goods up to six tons in weight; the frame is made of mild-steel channels, stayed by longitudinal and cross stays, knees and gusset plates; the side of each wagon is provided with strong hinges. In order to protect the goods from the weather, each wagon is supplied with a detachable light angle-iron frame, upon which a tarpaulin is spread the full length of the car at a height of 7ft. from the flooring of the wagon. They are in construction similar to that of the goods wagon as described above. Each van is fitted with double sliding doors, and is the same size as the goods wagon.

ELECTRICITY AS A HOME COMFORT*

BY J. D MACKENZIE.

When your secretary wrote asking me to address you on electric lighting, and in so doing to take the place of a gentleman whose name is so well known in electrical circles, I felt a great deal of diffidence in accepting, and that for several reasons. But principally because, as you are all aware, everyone nowadays knows everything about electric lighting. In these days of general illumination—mental, not material—what with free libraries, halfpenny-a-day encyclopædias, sixpenny books on electric light and how to make it, and last, but by no means least, the super-technical magazine article writer, there is really nothing left for the like of me to speak about; or, at least, gentlemen, there ought not to be. Why? I'll tell you in all confidence, even little Tommy-six-year-old-last-July and the gasfitter round the corner know all there is in it. And so no doubt you can understand with what reluctance I had to face the task of giving you "cauld kail re-het." Borne up, however, by the thought that some of you, perhaps, may be still—shall I say—unsophisticated enough not to place all your confidence in the aforementioned sources of information, and that a humble disciple of Volta and Faraday, Hopkinson, Kelvin, Edison, and Swan—men whose names are blazoned on the page of history—may be able to give you at least a plausible excuse for a discussion—borne up by that thought, gentlemen, I am here to-night.

The subject of the following few remarks is "Electricity as a Home Comfort." A strange title, perhaps, and yet it is stranger, when you come to think of it, how comprehensive that title really is. For, if you wish electricity to be a home comfort, it must (1) be well planned and (2) well carried out. And what more can you—can anyone—possibly want and so my remarks this evening shall be comprehended under these two main topics: (1) the design of electrical arrangements; (2) executing design. And, just in passing, may I add that many a time when executing some of the designs submitted to us, we would feel quite happy if we were assisting at the execution of the designer. Now, in designing any electrical arrangement several things must be considered: (*a*) the purpose in view; (*b*) the ease or difficulty of carrying into effect; (*c*) accessibility for repair; (*d*) the effect of each part of the arrangement on its immediate surroundings; (*e*) the general effect of the whole arrangement. The most of the following remarks deal with electric lighting, but, as the title is quite general, a few words on other applications may be said at this stage.

Bells.—Here the purpose in view is to give an audible signal that attention is required at a certain point, and such signal may or may not be accompanied by a subsidiary visual sign. Now, in a private house, when you have accomplished this object—when you have given the signal—with as little noise as possible, your purpose is achieved; there is no necessity for installing a bell which will sound and resound through every nook and cranny of your dwelling on the slightest provocation. In doing so, you have overstepped the limit, and "Electra" is a home comfort no longer. But, you say, a bell in the kitchen is no good when the servants are upstairs. Granted! But place another gentle reminder upstairs; better far that you should hear in more than one place the soft "tintinabulation of the bells—silver bells," than be doomed by a cruel fate and your architect to listen to the

> "brazen bells, ...
> How they clang and crash and roar!
> What a horror they outpour!
> On the bosom of the palpitating air."

Pushes are used for actuating the "bells," and it is quite as easy to get a push ½in. diameter to be as effective as the "3in. best cocus push with best German-silver springs and platinum contacts" of the average specification; and the former has this advantage over the latter, that it can be concealed in some neat little corner, and not, like the other, be continually glaring at one with its cyclopean countenance.

Telephones of the miniature variety are now so often installed in the homes that I must not pass them by without comment. They will just achieve their purpose quite as effectively when hid in a corner cupboard or below a shelf on your mantel-piece as they do when spoiling the symmetry of your panelled walls. And if you, personally, do not object to their appearance, have mercy on your friends to whom the sight brings vivid memories, if not of a "disembowelled hurdy-gurdy," at least of business worries and work, from which they wish for an evening to rid themselves.

Electric Heating.—Here there are several cases requiring very different treatment. If one intends to use electric heating on any large scale, it is important to design special circuits for such, so as to take advantage of the special cheap rates given by corporations and supply companies. The various purposes to which the heating property of the electric current can be applied are so numerous that I can only glance at the subject. But just to quench the ardour of my gas friends while yet there is time, may I say that I believe gas to be the proper medium for general heating purposes in the like of larger cities where gas is very cheap. But for country houses having no gas plant, but with their own electric supply, there is no reason why electricity should not be used throughout, and be quite economical at that. In the laundry it might be used with advantage to iron one's linen, and is really not so very expensive in upkeep, while the fact that cleanliness is increased to a maximum and risk of fire reduced to a minimum, and that your laundress is not half asphyxiated with the noxious vapours from coal gas, ought to go far to outweigh any disadvantages on the score of cost. In the public rooms, not only does one wish the heating effect, but also some of the warm glow which, from custom, we associate with fire, and hence one wants, in such rooms, radiators of the incandescent lamp pattern; and here I must confess, notwithstanding electricity, I have a most decided sentimental partiality for the old-fashioned log fire, or even for a good peat or the more prosaic coal one, and relish nothing better than to sit in the gloaming watching the fitful glow of the

* Paper read before a Glasgow Engineering Society.

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flame playing among the logs and casting long and weird shadows through the room.

Such, however, is not the most efficient way to get the greatest heat value out of the fuel. But to return to electric radiators. The purpose is to give heat, and although it may be much more effective as far as appearance goes to place the radiators on the earth or into the interior of the fireplace, unless provision is made for closing the flue effectively, the heat, instead of being radiated through the room, is sent uselessly up the chimney. There seems no reason why niches should not be left in some of the walls suitable for the reception of such radiators, where they would be out of harm's way when not required. In bedrooms, however, many people are unable to sleep if there is any light in the room, and in such cases the resistance type of radiator should be used, where the heating effect is given without any lighting effect, and thus such persons can retire to rest in perfect comfort. For bedrooms there is no more ideal way of heating than the electric radiator, and each year sees more and more use being made of such; but that does not exhaust the applications of electricity for heating purposes. What nicer than an electrical pot for heating shaving-water with no more trouble than inserting a plug attached to a yard or so of wire into a wall socket; and in "My lady's" dressing-room we must have an electrical heater for "My lady's" curling tongs—a heater which is so absolutely under control that there is no danger of having the tongs too hot or too cold, or of injuring the most delicate tresses. And does that exhaust the home comforts of electricity? By no means; for you can dispense with the hot-water bottle and have an electrical substitute, and when laid down with an attack of influenza you can have—if you wish it—an electrical poultice on your chest. At breakfast you may have your coffee steaming hot from an electrical coffee-pot, and can watch your eggs boiling before you, so doing away with the temptation to use language at the cook, and adding its little quota to the home comforts. And not only so, but it is not the Utopian conception of a day dreamer that electricity could do all the cooking, for it is a quite practical thing, and not so very expensive either. At the Electrical Exhibition so recently held at Olympia the model electrical kitchen attracted much attention, and not only so, but a dinner for 65 persons was cooked entirely by electricity and set down for a total current cost of 4s. 8d. at 1d. per unit. This is scarcely an exorbitant sum. I have also here on the table another adaptation of electricity in the shape of an ozoniser to purify the air and disinfect it by the generation of ozone. This is, perhaps, the latest field which is being commercially exploited by electricity, and the effect of such a manufactory of ozone in one's dwelling can be readily imagined. Foul air is purified, and an atmosphere of healthfulness produced which the finest coast resort or mountain sanatorium cannot give. Indeed, gentlemen, the applications of electricity in the home are now so numerous that were I to expatiate on them all, the time would be too short to enable me to deal more particularly with electric lighting, the branch which, no doubt, interests the most of us here to-night more closely than any other. Now, in dealing with electric lighting, we have all the points raised at the outset of this paper to consider, and so we will deal *seriatim* with them.

The purpose in view, I take it, is to give light, to give light effectively, economically, and, shall I add, unobtrusively. This, you will no doubt grant, is an axiom, and yet I venture to say it is more honoured in the breach than in the observance. When primitive man rubbed two pieces of dry stick together and so got fire, he placed them on the ground, heaped on some more, and, having made a cheerful blaze, sat down and calmly looked into it, content no doubt with his inventive genius. Discovering, however, the want of portability of this method of obtaining light, he took a pine splinter or some dried rush pith and carried it in his hand through the dark glades of the primeval forest. And so when the rush light gave place to the cruisie, and the candle and the gas jet, we, still under the influence of these primæval instincts, placed each of them at a very moderate altitude, so that, in fact, "all who are in the house may see the light," to use a scriptural phrase. And now to-night, after centuries of use and wont, we will have, as you see exemplified in this very room, a sample of that unobtrusiveness to which I refer, because I believe I am safe in saying that 90 per cent. of you on coming in turned your eyes in the direction of these lamps. Certain I am that under normal conditions such would have been the case.

Now, lighting is only effective when one can get sufficient illumination where required and nowhere else; it is most economical when all the available light rays are concentrated in the desired direction, and often it is most unobtrusive when both these conditions are fulfilled. As the quality of unobtrusiveness brings in the vexed question of electric fitting, it may be as well to deal with that part of the subject now. And in dealing with electric fitting we must also consider two others of the condition—namely, the effect of each part of the arrangement on its immediate surroundings, and the general effect or "hang" of the whole scheme. And here, by the kindness of Mr. Harold Watson, of the Helland House Manufacturing Company, you will see a series of designs illustrating various periods in the electrical fitting. Of course, the first stage was the inverted gas fitting, a by no means handsome arrangement, and from this we have progressed until we now reach what might be called modern development. There is a still later step, an ultra-modern art which in one bound has carried us back into a field of barbaric ornamentation, which is neither fish, flesh, fowl, nor good red-herring (neither Egyptian, Greek, Arabic, nor good Anglo-Saxon), and whose only saving grace lies in its oddity and the moral courage of the designer. The craftmanship in the most of these fittings is exceedingly crude; and, personally, I consider that crude craftmanship can never be called art, and that artistic design is only spoiled by such craftmanship. I will run a few slides through the lantern illustrating the trend of modern design. But now let me point out one error which mars each and all of these designs—they are all calculated to draw attention to the source of light, a relic of our primal instinct. And with electric light there is not the slightest excuse for pondering to such a depraved taste, yet designer after designer arranges the lines of his design so as to harmonise with the electric lamp bulb or shade, and to throw it into stronger relief, and then, when the eye craves—perhaps, even demands—some slight consideration, an attempt is made to meet it by shielding the light from view by such makeshift devices as obscured lamps, and glass and silk shades—devices which rob us of from 20 to 70 per cent. of the possible light given out by the lamp. Now it is decidedly bad policy to waste—to deliberately waste—electrical energy, if it is possible to use it effectively, because it simply means that the running cost is so much higher than it ought to be. If you have a room requiring 10 16-c.p. lamps obscured, and with shades on them, giving, say, a total obscuration equal to 50 per cent.—a by no means uncommon event—you could obtain the same total effect, as far as light is concerned, by 10 8-c.p. clear lamps, and this with half the consumption of energy. And hence the importance of considering carefully whether or not we are moving on right lines in our lighting schemes.

Within recent years a decided improvement has been effected by such ideas as that of the Linolite Company, for example, and more recently for shop-lighting by the introduction of silvered reflectors behind the lamps, giving a concentration of all the available light rays in one desired direction. Now, such a method of lighting is at once the most effective and economical, but it is quite apparent that this method of lighting and the orthodox electrolier have nothing whatever in common. And at this stage it may be as well to crystallise my idea of the ideal lighting into one sentence—viz, get the light but conceal the source of it. In other words, have no visible electric lamps or fittings. There are various ways and means of concealing electric lamps and still obtaining the lighting effect, and I may just indicate a few of them. The most straightforward way is, of course, as already mentioned, the use of lamps placed higher up, backed by silvered reflectors, and so spaced that an even distribution of downward illumination is attained.

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Such a method of lighting is at once the most natural, efficient, and economical, and is just the most delightful for reading or sitting under. But at once you will meet me with the objection that the ceiling is left absolutely in shadow, and what becomes then of the pride of the plaster worker and the decorator, who left their handiwork flashing proudly in its coat of mingled ivory and gold. Well, I frankly plead guilty of rank heterodoxy. I admire a ceiling which is dark under artificial lighting. And I have a reason for that also. Now for a moment consider the charm of "night." Poets have sung it, prose writers have waxed ecstatic over it, novelists and playwrights have used it as the chosen setting for their choicest scenes. And what, pray, is its most charming feature? Is it the moonlight? Well, that is nothing more than sunlight by reflection. But is its charm not rather in a dark canopy—may I not call it ceiling—studded with a myriad points of light? And so I venture to think that a ceiling without any direct lighting, but whose darkness is pierced at many points by gleams of light which brighten the rest of the room would be more restful than our present methods. In fact, in my opinion—I may be an extremist—any method would be better than our present one. Because it is really most unkind of anyone to invite me as a guest and then permit his hall lantern to inflict a sharp blow on my optic nerves as I am ushered into his house, and when shown into his otherwise hospitable "salle de manger" to allow his modern art electrolier to repeat the infliction with a five-fold force. Why, it's a positive act of war! A ceiling nicely panelled off in wood or plaster and with cupped recesses into which the cap and, say, one-third part of the lamp (a spherical one) would fit, leaving two-thirds below the level of the ceiling, would, I think, look just not half bad. I would have these recesses painted with a glossy white enamel, or lined with silvered-glass reflectors, the lamps to be of 2½ c.p. to 5 c.p. each, and placed so as to ensure an even distribution of light.

(To be continued.)

THE COMMERCIAL TESTING OF SMALL MOTORS UP TO 15 B.H.P.*

BY THOMAS CARTER, A.M.I.E.E.

An enterprising ironmonger hung in his window a card inscribed with the legend, "If you do not see what you want in the window, please step inside and ask for it." A customer entered the shop, and to the smiling assistant said, "Kindly give me a Bath bun"; to which the assistant replied, "The baker's, sir, is next door, and there you may be supplied; or, perhaps, you want a bathbrick, which we have in stock—that would be cheaper than a Bath bun." The customer, according to his temperament, would answer either, "Thanks, a bathbrick will do quite as well as a Bath bun for my purpose," or, "No, a bathbrick will not do, and as you state in your notice that I am to come to see you about what I want, kindly get me a Bath bun as quickly as possible, as I will have nothing but that, no matter what the price is." This imaginary incident, however grotesque and fanciful it be, contains some analogy to the present position of the manufacturer of electric motors, who, like the ironmonger, practically hangs out a card at his office door, saying, "We will give you whatever you want, only come and give us your orders"; and, as a result, since there are customers who insist on having their Bath bun, so to speak—that is, who will have something to which they have taken a fancy when something more nearly standard would do quite as well—there is the chaos of outputs and speeds which the Standards Committee has recently been endeavouring to reduce to something like consistent lines, without as yet much success, since each manufacturer seems to prefer to work to suit his particular class of customers. It is, however, evident that on the whole things are settling down in this direction to greater consistency than was previously the case. A much more serious trouble, especially as regards testing, arises from the enormous number of different voltages throughout the country. Those most commonly used for motors are 100, 105, 110, 115, 200, 205, 210, 215, 220, 225, 230, 240, 250, 260, 400, 410, 420, 430, 440, 450, 460, 480, 500, 520, 530, and 550; but even these are not all, for motors have been specified to run at a given speed on a circuit with a voltage of some such ridiculous value as 204·8. If the man who drew up that specification came to design a motor, especially one of 2 b.h.p. or 3 b.h.p., he would have put down 205 volts and mentally reserved at least 5 per cent. either way in the speed, and he would then have thought himself lucky if he got it. Assuming that the "standard" voltages vary round about 105, 210, 240, 420, 480, and 540, and allowing for motors running at half normal speed, two-thirds normal speed, and full speed as standards, no less than 13 different armature windings are required for each size of motor frame, and even then special intermediate windings have sometimes to be employed.

In designing a test shop at Messrs. J. H. Holmes and Co.'s works for motors up to 15 b.h.p. in quantities, this uncertainty of voltage was the first difficulty that met the writer, and it proved to be almost the only one of any magnitude. The system had to be absolutely flexible, and that in a double sense, because the available source of supply in the case referred to might be at any kind of voltage from 110 up to 500, though 110 was to be the normal voltage. An unsophisticated person might think that it would be sufficient to save up motors to test until a few of the same voltage had collected, and then to run these all together from some common source of power. He would not think so long, however, if he were in charge of a test department which received six motors of different voltages in one afternoon, all to be tested and dispatched on the day after to-morrow, with six people wanting to know the reason why if they were not. The first requisite is that there need be no "looking for volts," as it is currently called in the test shop for larger machines, where there are occasionally wonderful combinations of generators for getting the different voltages required for two or three machines at once. In such a case it is not so important to be able to get any voltage at any minute, as the cost of testing is a smaller percentage of the total cost of the machine; but in the case of small motors, where each shilling is valuable comparatively, the cost of testing is a fairly large proportion of the whole, and there is, therefore, less time to lose. This explains the necessity for perfect flexibility, that is, for having an arrangement capable of testing a motor of any voltage from a source which is at the same, or any other, voltage.

Before describing the actual apparatus used, it may be well to speak of the tests generally made on motors of the size dealt with here. The motors are built up from stock parts, of course, including as a rule armatures and field coils, and it is the writer's practice to have the two latter parts inspected by the test department before they leave the winding shop—the field coils simply having their resistance measured on a portable Wheatstone's bridge, while the armatures are tested by measuring the drop in volts from segment to segment all round the commutator with a constant current sent through the winding from the nearest lamp-holder through a portable resistance of variable value. The insulation resistance is, of course, also measured. The taking of these tests by the test department is not a universal practice, as in some places the winding shop does its own testing of these parts after winding them: but it is found that the check on the winders by the department which will next deal with the parts, and will suffer from the delay if the errors are found only on beginning to run the motor, has resulted in much less time being wasted over putting on faulty motors for test than was formerly the case. It is, in fact, a means of transferring the delay from one's own department to another's—in this case the right one, though that does not always happen—and this is really a splendid thing to accomplish, if a somewhat cruel one. On receiving the complete motor from the assembling shop, presumably ready for testing, the first thing to assume is that the brushes are wrongly set or insufficiently bedded in, and, therefore, this is always checked over. It is a curious fact that hardly one man in ten in an ordinary way can be made to realise how much difference the condition of the brushes may make to the first run of a machine, and yet it is one of the most important points to attend to. A little may be said, in passing, about carbon brushes for motors, though there is time for only a very vague reference to this matter. As a rule the writer uses, for all machines, from 1 b.h.p. right up to motors and generators of, say, 150 b.h.p. to 200 b.h.p. or kilowatts respectively, one of three sizes of brushes, 1in. by 7-16in., 1½in. by 7-16in., 1½in. by ¾in. respectively in contact area. There is a 1in. by ¾in. brush for low-voltage machines, and there are two other sizes, 1¼in. by 7-16in. and 1¼in. by ⅝in., necessitated by a peculiar design of brush gear on two sizes of machines only, but practically only the first three sizes have to be stocked in large quantities. It is not pretended that these three sizes will give perfect results in all cases that can possibly crop up, but it is wonderful how far they are found to be quite suitable when there is nothing else in stock. It is, of course, remarkably easy to supply spares when so few sizes are used, and altogether this arrangement compares very favourably with the practice of a firm known to the writer in America—where the standards come from!—which used at least 60 different sizes of brushes for machines ranging from ¼ b.h.p. up to 60 b.h.p. The grade of carbon used is quite ordinary—namely, what is known as "Crown" quality, made by Conradtz, of Nürnburg—and this has been found to give quite as good results as other more expensive grades,

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and to run very quietly and sweetly. In cases where special brushes, generally of low specific resistance, are required, the writer used to use "graphitic" brushes, made by "le Carbone," of the quality known as Z, which were good, but expensive, as all low-resistance brushes seem to be. Afterwards brushes were used in these cases made of a mixture of carbon and metal dust, which reduced the resistance, but gave poor results if the commutator tended to be hot at all, as in that case, or if there was the least sparking, the metal particles appeared to fuse on to the copper of the commutator, making it very rough in a short time. Recently, however, the Morgan Crucible Company have been making "Morganite" brushes, which are of quite special construction, and are often found to be very good in the difficult cases which crop up from time to time, as they can be built up of copper and graphite, or of graphite of varying specific resistance, or in almost any way desired to suit special cases. To enter further into this matter here is impossible, however: the subject of brushes and commutation, though a most fascinating one, lies outside the scope of this paper.

The motor, then, has had its various parts checked over while the brushes have been the subject of this little digression, and it is ready for its running tests. It is useful at the outset to find the "neutral point" on the commutator corresponding to the armature conductor in the centre of the gap between the pole-pieces. This is most easily done by finding experimentally the position of the brushes where the motor runs at the same speed in both directions of rotation. The brushes will need to remain in this position for a reversible motor, but in other cases a better result can usually be got with the lead a little backwards from this point. It is important to notice that the further the brushes are away from neutral, the less efficient is the motor. The writer recalls one case where there was too weak a field and too strong an armature, in which the light load current of the motor, which is a rough criterion of efficiency, varied from one ampere to 11 amperes when the brushes were moved from the neutral point to a place not abnormally far back from it. This was a special case, but the tendency is always the same.

The motor can now be set to its temperature run, after getting some readings of speed variation with varying loads, as well as seeing that any speed regulation by shunt resistance specified can be carried out, and attending to any other points needing special notice. For the current of the motor of full load during this run it is usually sufficient to assume an efficiency and calculate back from the required brake horse-power: it is, that is to say, unnecessary to take a brake test of every motor, though this should be done as often as possible. When there is no specification as to the length of the temperature run, the writer is in the habit of taking as sufficient;

> One hour for a normal 1-b.h.p. frame:
> Two hours for normal 2-b.h.p. and 3-b.h.p. frame;
> Three hours for normal 4-b.h.p. and 5-b.h.p. frames;
> Four hours for normal 7½-b.h.p and 10-b.h.p. frames;
> Five hours for normal 10-b.h.p. to 15-b.h.p. frames;

especially if they are of standard winding and a considerable number of similar tests have been taken before. It is probable that no motor, however small it be, can reach a limiting temperature in one hour, but, on the other hand, if all the tests are made on the same length of run it is easy to say from experience if the motor is going to be satisfactory or not, and it is naturally very important from the manufacturer's point of view in these days to cut down the time of testing to the shortest which will leave him quite certain that the motor is good.

At the end of the extended run at full load or overload as may be specified (during which readings should be taken, at intervals of not longer than half an hour, of all instruments, speed, and behaviour at the brushes), the temperatures of various parts of the motor are taken as accurately as possible. The writer knows of no measurement which is less satisfactory than that of temperature taken in the ordinary way by a thermometer, with the bulb covered up by a piece of waste, felt, or putty. Even if, as is sometimes done, the bulb of the thermometer is wrapped up in leadfoil, and covered with a felt pad of a standard size, it is almost impossible to repeat a set of temperatures, within 5deg. or even more, on any small motor if another run be taken under exactly the same conditions as the first. The initial temperature of the atmosphere makes a difference, and even if on the two occasions the initial temperatures are alike, the condition of the surrounding atmosphere will cause the final temperatures to be higher or lower according as the air is stagnant or in motion. The difference is usually exaggerated if different observers take the two sets of temperature. The thermometer is the only means available for getting temperatures of the metallic parts, but for windings the method of calculation from increase of resistance is much more satisfactory, always provided that some common-sense is used, and the same temperature is not specified to be obtained by this method as by using a thermometer, as the latter measures superficial rise of temperature only, which is always less, and may be much less, according to ventilation facilities in the motor, than the average rise of temperature as calculated from increase of resistance. Consulting engineers are beginning to specify this means of measurement, but in some cases, unfortunately, they are transferring the old 70deg. rise into the new specification, which is absurd.

The insulation resistance should now be tested, both of the various parts of the motor and of the motor as a whole to its frame, which may be taken as "earth." This is most satisfactorily done by applying between the windings and the frame an alternating pressure of, say, twice the normal voltage of the machine with a minimum of 500 volts. To get this conveniently, a small transformer is used with a variable primary voltage and a variable secondary winding, and the secondary voltage can be estimated with sufficient accuracy by lighting up from it a set of incandescent lamps in series and observing the brightness of the filament. This would probably not be a suitable opportunity of using the delightfully naïve suggestion of a student whose examination paper the writer once had the pleasure of correcting, and who, in answer to the question, "How would you find out if there was a difference of potential between two terminals?" replied, "Put a man across the terminals." The writer considers an ohmmeter test of insulation resistance to be of little value compared with the other, as there may be cases in which a good result is got with the ohmmeter, while the insulation goes down altogether under the alternating voltage test; it is, in fact, taken mainly to satisfy some customers who are only happy if they can see some definite figure put down to indicate the goodness of the insulation, quite regardless of the possibility of error in the instrument used: and this seems to be fairly great in an ordinary ohmmeter which is sensitive to external fields.

In cases where brake tests are made, while the old-fashioned rope brake or one of its modifications is perhaps as accurate as any other, it takes a little time to rig up, and needs a considerable amount of attention to get good results, and the writer has lately tried instead one of W. G. Walker's air dynamometers, which consists essentially of a calibrated fan fixed directly on the motor shaft, the blades being adjustable so as to give varying torque, and consequently a considerable range of power is available. The disadvantage of the arrangement has been found to lie in the fact that for a given arrangement of the blades the horse-power absorbed is proportional to the cube of the speed, and thus, unless the driving voltage is absolutely constant, the variations in speed cause temporary variations of the third power in the result, which largely increases the error due to necessary small inaccuracies in reading. Further, the distance of the blades from the floor, as well as the nature of the base on which the motor is standing—some conditions allowing a greater disturbance to be set up by side draught than others—seem both to have some influence on the absolute accuracy of the result. On the whole, however, such an apparatus as this is most convenient, and this particular dynamometer has been found to give good results, which coincide with very fair accuracy with those got from a rope brake, when sufficient care is taken in the directions shown by experience to be necessary.

So far, this paper has been of a general nature, and might apply to any test shop. It may be of interest now to describe in some detail the arrangement of apparatus designed, as has been mentioned, by the writer for use at the works of Messrs. J. H. Holmes and Co. There is, let it be quite understood, absolutely nothing new in principle in any of the apparatus, but it is hoped that those who are interested in such work may find some suggestions here that may be of use in the future. The writer knows that a paper of this sort would have saved him a good deal of time in getting out his arrangement, but he was unable at the time to discover any source of information.

It would serve no useful purpose now to lay before you in detail all the suggestions of different methods that crossed one's mind in the preliminary consideration of the method to be adopted, as, for example, whether one large motor should be driven from the power-house at 110 volts, and should in turn drive three or four small generators of variable voltage which would supply the motors on test, or whether some other entirely different arrangement should be adopted. These, and many other points, came up for settlement, but the final decision, the wisdom of which one likes to think has been shown in practice, was to deal with each motor entirely through its own set of apparatus, and to have nothing common to all the motors being tested, except necessarily the supply from the power-house, between which and the test shop only one pair of $^{19}/_{14}$ cables is available, carrying 100 amperes at 1,000 to the square inch. These cables are brought to a small distributing board, with four double-pole fuses branching out from one double-pole main switch, each feeding one switchboard and other apparatus complete in itself for testing one motor. Thus, while the shop is arranged at present for testing four motors simultaneously, it will be sufficient to describe the apparatus for one motor, as the whole shop is simply made up of that multiplied by four in every particular.

Set out in a diagram, the apparatus for testing one motor is shown in Fig. 1. Referring to this, 1, 2, and 4 are three

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standard motor carcases of the size giving 10 b.h.p. at 1,000-1,100 r.p.m. The field of each is wound to go direct on 110 volts, and to have, with no resistance in series, the maximum possible number of ampere-turns for the particular size of field coil employed. The mains from the double-pole fuse already mentioned as being connected to the power-house on the distributing board are brought to a double-pole switch on this testing board, and connected thus through an ammeter, A, to the centre pair of a row of five pairs of terminals, T, any pair of which can be connected up by short wires, with suitable sockets on the ends, to any other pair, top to top and bottom to bottom or *vice versâ*. There are also two sets of four small terminals, T_1, connected up to the large power-house terminal, T, as shown, while a fifth terminal, T_3, is coupled on each side to the large terminal to the left of the power-house pair. The other small terminals, T_2, can be coupled directly by means of a short rod of copper to the T_2 are connected to their respective shunt field windings through an ammeter, A_1, on one pole, and on the other pole a single-pole switch and a resistance, W, consisting of 24 steps of about 20 ohms each. This is the same for all four field circuits. In 2 and 4 there are, in addition, resistances of 24 steps of one ohm each, so that the whole of this resistance, W_1, is a little more than one step of W. These give fine regulation of the shunt current in 2 and 4, as by their means any whole number of ohms from 0 to 480 can be obtained. Further, in the field circuit of 3, the motor on test, there are two additional resistances of about 500 ohms each, connected to three terminals, as shown, vertically above each other, this allowing one or both of the 500-ohm resistances to be put in circuit or cut out by being short-circuited by means of a copper rod sliding through the holes in all three terminals, and capable of being clamped in any position so as to put in circuit or short-circuit the desired resistance. Thus a total of about 1,500 can

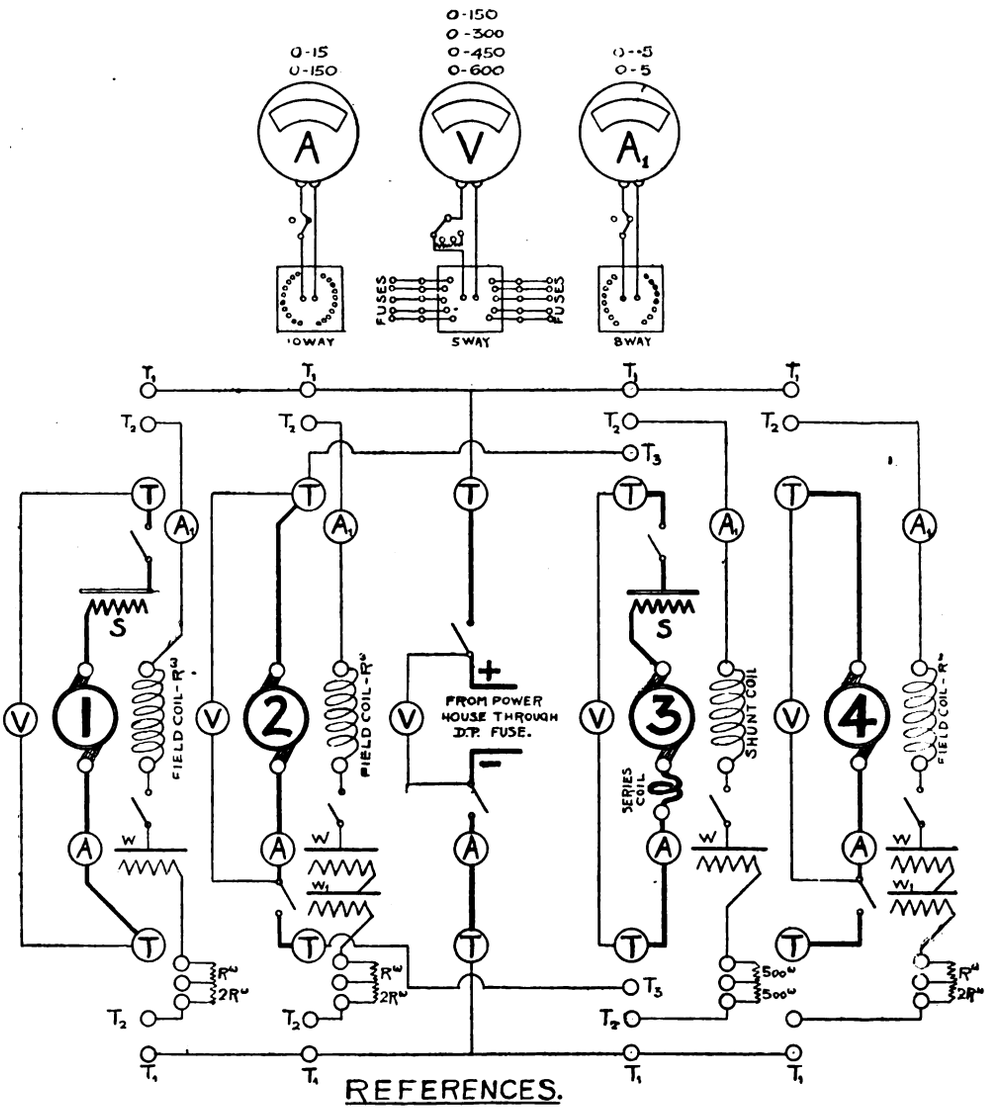

FIG. 1.

terminals, T_1, vertically opposite them, and it will be seen that the T_2 second from the right-hand end can be coupled either to this power-house T_1 row or to the T_3 joined to the large terminal next the power-house pair.

The motor on test is that marked 3. It is shown as compound wound, but may, of course, be shunt or series as well. It will be seen that between each pair of large terminals, T, with the exception of the power-house pair, there is connected the armature of one of the machines 1, 2, 3, and 4 through a single-pole switch, a starting resistance, S, of about 50 ohms, suitably graded in about 12 steps, and an ammeter, A, in the case of 1 and 3, while in circuit with 2 and 4 there is no starting switch and resistance, but only a single-pole switch, on the opposite pole from that in series with 1 and 3, and an ammeter, A. There is also a voltmeter, V, on each pair of terminals, coupled up in each case to be most suitable for the conditions—as motor or generator, that is to say—under which each machine will run, as will be evident from what follows. Further, the terminals be got in the shunt circuit of the motor on test, rising in steps of about 20 ohms, which is found in practice to be sufficiently small. There is a similar arrangement in the case of 1, 2, and 4, but the values of the resistance are R and 2 R ohms respectively, R ohms being the resistances of the 110-volt coils of 1, 2, and 4. These coils are always excited through T_2 coupled to T_1—that is, from the power-house voltage, whatever it may happen to be. It may happen that the testing part of the power-house plant is running at some voltage other than 110, for tests in other parts of the works, and in that case this motor test might have to be run from this voltage also. Hence it may be necessary to excite coils 1, 2 and 4 from a voltage of from 200 to 250 or of from 400 to 500. In the former case, by sliding the short-circuiting rod out from the top terminal connected to R, but leaving the other two still short-circuited, R is put in series with the field coils, also of R ohms resistance, and hence there are still only about the proper volts on the coil, the rest being absorbed in R.

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Similarly, if the power-house is working at the highest volts, it is only necessary to remove the short-circuiting rod altogether to get 3 R ohms in series with the R ohms of the coil, which will thus take only one-quarter of the total voltage, or again, about the right amount. It may also be necessary occasionally to use higher volts in the power-house if there happened to be on test four motors at once all of 15 b.h.p., as then the $^{19}/_{14}$ mains would not carry the requisite power at 110 volts. In that case, also, the resistances R and 2 R would come into use. All the apparatus shown in the diagram, and described above, including the carcases and coils of 1, 2, and 4, is a permanent part of the works testing plant. The movable parts are only the motor on test, 3, and the armatures for 1, 2, and 4, which are in every case standard, and taken from stock as required. The method of using all this apparatus is the next thing to be considered.

In cases where 3 is to work at the voltage available in the power-house, 1 and 2 are not used. The shunt of 3 is then excited from T_1, and its armature circuit is coupled directly across to the power-house terminals; this completes the necessary connections. Load is put on 3 by bolting it to 4, and having in 4 an armature which will generate the same voltage as 3 is working from. The terminals of 4 can then be coupled up directly to the power-house terminals, and when the voltage of 4 is adjusted by means of its shunt resistance, it can be switched in to run in parallel with the power-house generators. To vary the load in 3 is then simply a matter of adjusting the shunt current of 4, which is, of course, supplied from T_1. It is here that the use of the one-ohm steps in W_1 is found for getting small variations in the load of 3.

(*To be continued.*)

SOME POINTS RELATING TO STORAGE BATTERIES AND BOOSTERS.*

BY L. BROEKMAN, M.I.E.S.

Omitting from this paper detailed reference to the gradual developments which have taken place during the past in the art of producing reliable storage batteries, I address myself at once to such matters in connection with present-day cells, their function and management, as, I am pleased to believe, will prove of some practical interest. While naturally holding my own opinion as to the relative merits of different types and makes of accumulators, I shall endeavour to keep this in the background, and to steer clear of comparisons as much as possible. What are the features, mechanical and electrical, which come under review for stationary work, lighting, power, or both, when judging the rival qualifications of cells from various makers: (1) weight of electrodes; (2) efficiency and permanence of contact between conducting frame and active mass; (3) how expansions and contraction of active material are provided for; (4) means adopted to equalise activity of plates in every part: (*a*) porosity and (*b*) open structure—*i.e.*, "linked surfaces" *versus* "separated surfaces," owing to central web; (5) conductivity of framework, constant or diminishing; (6) relative capacity and mean pressures at various rates of discharge; (7) emergency discharge permissible; (8) normal and maximum charging rates, mean and maximum pressures; (9) volume of electrolyte and maximum density; (10) method of mounting sections; (11) supervision required; (12) price.

Given the battery which comes out best on points allotted under the above headings, its life, while retaining a high percentage of rated capacity, will depend largely on an adequate relation between duties demanded and normal output of cells, as well as on the intelligent observance of working directions. When, for example, a discharge to the full extent is taken from the cells daily in from three to six hours the active material will be in a soft state, and less adhesive. Sediment, therefore, is thrown down more freely, and replating becomes necessary sooner than when, under a less exacting *régime*, the new formation is allowed to assume a crystalline texture. The battery, in effect, is too small for its work. Far the better plan, both from technical and pecuniary points of view, is to provide for a margin in capacity on the safe side, a share of which is almost invariably claimed by afterthoughts and extensions without corresponding facility for increasing the battery output. On the other hand, accumulators worked regularly under normal conditions will be in a healthier condition, and give longer full service, than others subjected to protracted periods of idleness. From the fact that most battery makers are prepared to enter into contracts for upkeep at rates varying between 5 per cent. and 10 per cent. per annum, according to size, service, and locality, it can be accepted that the average life of a set of plates is not less than six years if the value of renewal sections throughout be taken roughly at one half the original cost of the storage plant, and running expenses for periodical inspections be borne in mind. These inspections are to the best interests of both user and manufacturer, and of much greater importance than is usually realised. Interruptions, whether arising from wrong management or from normal wear, are forestalled, and any needful repairs can, as a rule, be so timed as to cause a minimum of discomfort. To the manufacturer, whose reputation is at stake with every battery supplied, they afford opportunities to nip trouble in the bud. Even when no regular maintenance agreement has been entered into, such periodical inspections can, and should, be arranged for. "Fair use" and "proper attendance" remain mere figures of speech without some occasional check. The keeping of simple, but truthful, daily and weekly records is a great help, and strongly to be recommended, but to my mind there is nothing like the visit from the inspector—the more uncertain as to date the better—to keep things in good order.

The neglect, amounting to recklessness, under which some batteries are expected to thrive is astonishing. While at the makers' works scrupulous care is taken to use the purest materials only, and precautions are exercised at every step and turn during manufacture to guard against possible contamination, free and easy methods are the rule rather than the exception once the cells have passed out of their hands. For the sake of saving on carriage, users often obtain acid of doubtful quality from the nearest supplier, preliminary analysis being dispensed with, while water of any kind is considered suitable for making good evaporation. No battery maker would countenance such risks. Even the best soft well water undergoes changes periodically, and cannot be strictly relied upon; with rain-water everything depends on the district—where houses are in the vicinity of chemical works, or of the sea, the rain-water collected is decidedly unfit for use in a battery. Only pure distilled water (not condensed steam from boilers, hot-water pipes, etc.) is really safe for the purpose, and to grudge this relatively small expense is the worst possible economy in the long run. All acid should invariably be ordered from the battery firm. To discuss here the complex chemical changes and reactions which take place in a secondary cell during charge and discharge would occupy too much time. Magnificent text-books on the subject are available now, demonstrating that nearly all the difficulties of past years have yielded to research assisted by modern methods of electro-chemistry, and giving satisfactory explanations of many subtle and hitherto obscure phenomena. Limiting my remarks to the consideration of effects, produced or absent, according to the treatment of a battery by the user, one important point is to prevent the formation of white sulphate, $PbSO_5$, as distinct from the ordinary sulphate of lead, $PbSO_4$, which latter is the normal compound into which peroxide on the positives and finely divided lead on the negatives are converted during the discharge of a cell within the potential difference limits indicated by the makers. Below this safe point the action of the acid on the electrodes becomes greatly intensified, and continuing discharge habitually beyond it, or allowing plates in a discharged state to remain standing for any length of time in an attentuated solution, are the surest ways to produce white sulphate. When this forms between the metallic conductor and the active material, it practically insulates one from the other and lowers capacity. Being extremely difficult to reduce, and more bulky than the active material, it follows that enormous strains will be thrown on to the frames of the plates if there is insufficient free space to allow for the expansion of the active mass. If sulphating be taken in time, prolonged overcharging at half normal rate will improve matters, but on no account should such overcharges become an institution. Against doctoring the electrolyte by the addition of sulphate of potassium, sodium, or of caustic soda, users cannot be warned too strongly—this only leads to different and ineradicable trouble. Should any interruption occur in the course of the initial charge of a battery from a dry condition of the plates, notably during the first 20 hours—*i.e.*, before the specific gravity of the electrolyte has begun to rise again—the plates are particularly prone to become badly sulphated, and much trouble may result. Make sure, therefore, that the generating plant is in thorough working order before filling the cells with acid, and commencing a first charge. Prof. Ayrton, in one of his tests, has found that when the peroxide on the positives had fallen to 31 per cent. the cell very rapidly loses its E.M.F., which he attributed partly to the layer of sulphate excluding the mass beneath from further participation in the discharge, and partly to the appearance of peroxide on the negatives. Herr Liebenow, on the other hand, has conclusively proved by very simple means that the rapid drop of pressure which determines the exhaustion *pro. tem.* of a cell on discharge is almost entirely due to want of free acid. By continually urging acid through the pores of the negatives on to the positives, thereby reinforcing diffusion while maintaining level and density, he obtained nearly three times the normal capacity from the plates. During a rapid discharge, for instance, the SO_4 contained in the active material is used up at a much quicker rate than it can be replaced from the surrounding electrolyte. Hence the fall in pressure is sharp under continuous load; also, the recuperative effect is very marked when the current is interrupted, and the deficiency is made good by diffusion.

Coming, now, to the abnormal rise in potential difference towards the end of a full charge, and the fugitive high voltage given by cells immediately on breaking the charging circuit, commonly called "gas effect," this has been found to be due to the presence of unstable products, such as ozone and persulphuric acid, which only make their appearance to be decomposed at once. This high voltage, unfortunately, is quite short-lived, and available only when a discharge is taken immediately on switching off the charging current. An instance when that effect can be taken advantage of to the best purpose occurs when a battery is operated through a reversible booster, say on a tramway system, which, as a rule, provides frequent and marked positive and negative fluctuations. Under such conditions the watt-hour efficiency of batteries has been proved as high as 80 per cent. While on the subject of charging, I will briefly refer to the two principal methods employed: (1) with constant current; (2) with constant voltage. The former is almost invariable practice in the United Kingdom, while the latter is generally adopted in France. In point of time, for a *complete* charge, there is little to choose between the two. Applying a constant current at normal rate takes about eight hours to fill a battery. If charged with constant voltage, as much as 50 per cent. of the total charge is effected during the first hour, 75 per cent. after two hours, and 83 per cent. after three hours, but then the current is cut down very low, and it takes a long time to complete the remaining 17 per cent. With the constant-current method the best

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charging rate to adopt is at or near the normal indicated by the makers. The effect on the electrolyte, without being violent, is sufficient to promote a healthy action and uniform density, enabling reliable hydrometer and voltmeter readings to be taken, useless and harmful overcharging to be avoided. Overcharging frequently goes hand in hand with a low charging rate. Ten per cent. excess in ampere-hours over previous discharge, both operations metered for choice, is quite enough under ordinary circumstances, the charge being pushed on to a milky state of the acid, say, once every week or fortnight, and then continued for a length of time according to the depth of cells in use. Habitual overcharging is wasteful and decidedly detrimental, tending to cause excessive formation, to unduly increase sediment and thus to shorten the useful service of the plates, besides giving rise to violent spraying with its attendant evils if a high rate be maintained. When overcharging at a low rate is practised, the case is perhaps worse, because no outward manifestation takes place; formation of spongy lead on the negative plates then becomes the immediate trouble, bringing complication in its train.

In some castles and country houses, inhabited at long intervals only and then merely for brief spells, batteries are worn out practically by charging alone. An occasional artificial discharge, working the cells through the entire cycle and forming a fresh surface, would do them all the good in the world. Prior to any prolonged period of disuse it is essential to give an abundant charge to the battery, so as, *i.a.*, to provide the conducting framework of the positives with an unbroken film of peroxide, thereby reducing local action to a minimum. This film ceases to be protective if even a short discharge be taken from the cells subsequently—it is, therefore, best under the circumstances to disconnect the leads at the battery terminals immediately the charge has been completed. To remove the acid from the cells, after due preparation of the plates, is unquestionably the safest plan of all to adopt in such cases, but this needs care and entails some trouble; moreover, the battery cannot then be made available on a surprise visit. On discharge the capacity depends on the rate at which current is taken from the cells, so, for instance, in a well-constructed accumulator the yield of ampere-hours obtainable at the one-hour rate is approximately doubled if the discharge be spread over nine hours. Some of the following rough battery data may be found useful on occasions: Cells in glass boxes—weight in pounds, about one-half of ampere-hours at maximum capacity; space occupied—cells erected all on one level with narrow gangways, equals about 3 square feet per kilowatt-hour at maximum capacity; price, £4 per kilowatt-hour at maximum capacity. When glass boxes are used, "bolted" connections between cells have the preference to "lead-burned" joints, as the heat of the soldering jet, unless very carefully applied, is liable to crack the glasses; besides nursing, repairs and cleaning are rendered much easier with the former. Bolts and nuts must, however, be encased in non-corrodible metal, so as to afford thorough protection against acid spray. In determining the capacity of a battery for a given installation output of dynamo, parallel running, frequency of recharging, and probable extensions are factors to bear in mind besides the actually expected current consumption. A rule adopted by some firms, and said to work well, is that a battery for a private residence, capable of lighting continuously during three hours the total number of lamps installed, will deal comfortably with the average Saturday to Monday load, and last through a third night in winter at a pinch. This may be so, but it can only serve as a very general guide. An adequate reserve on emergency, when all lamps in the house may be turned on simultaneously, should never be encroached upon, which implies that 1·9 volts per cell must be regarded as the potential difference limit on low discharge for regular use.

The site of the accumulator house as regards accessibility, length of mains, and well-being of the battery is the next important consideration. Immediate proximity to stables or manure heaps has been shown to be detrimental to the life of cells on account of ammonia troubles. Mr. Vicarey read a most interesting paper on this subject recently before the Faraday Society, and I feel convinced that there is a great deal in his contentions. Vitrified brick laid on concrete and grouted with pitch makes a good battery-room floor, which should have a suitable slope for drainage. A natural draught from openings near the floor at one end and exits near the top at the other will usually provide adequate ventilation to free the room from acid spray, and to keep down temperature; for large batteries, heavily worked, it may be necessary to supplement this by a fan. Protect the battery from direct sun rays, but give the attendant the benefit of good day and plenty of artificial light, especially portable hand lamps. Water supply should be laid on and a sink fixed in the battery-room; space for a small desk for writing up and preserving records it is advisable to provide in the engine-house. Except in very much exposed localities, it is scarcely necessary to heat the battery-room during our mild winters; low temperature merely limits the capacity for the time being, but does no harm whatever to the cells. Let the cells be arranged all on one level if possible, with gangways at least wide enough to admit passing a carboy basket along. With glass boxes double tiers are admissible, but experience is altogether against placing cells beyond easy inspection and handling; also ample head room should be allowed above the cells. For battery pressure exceeding 250 volts the modern practice of double insulation—stands from earth and cells from stands—has effected a great reduction in the number of weak cells. Coming to accessories, trays filled with sawdust or sand are better for glass boxes than lead discs, as the latter do not evenly support the weight of the element. Hydrometers should read in single degrees on an open scale. It is best not to allow them to remain in the cells, where they are liable to become sticky and grimy after a short while, rendering them unfit for taking accurate readings. Cell-testing voltmeters of the cheap variety commonly met with are more or less a snare; almost any reading can be obtained with them according to the position in which they are held, their accuracy, moreover, being influenced by the number of times the instruments have been dropped. A neat and safe way of using a better class portable voltmeter with central zero, the needle swinging in a horizontal plane, is to attach the instrument to a short board, the lower side of which is provided with lead contact studs. By placing this board across the equalising bars of a cell, a slight pressure downwards will secure a reliable reading, which can be marked down at once on the note pad at the side. The time-honoured arrangement of hand regulating cell switches, with its shortcomings, still does duty in nearly all private house installations, and automatic switchgear for the purpose, both by reason of greater cost and complication, has been applied in isolated instances only.

When current to the lamps is invariably supplied from the battery alone, overcharging of end cells can be easily avoided. Not so when the dynamo is running part of the lights while charging the battery at the same time. Without adequate supervision some end cells then are liable to receive considerably more than their share of charge, while, if the outside load be heavy, the body of the battery may be kept short of current, possibly have to discharge occasionally. This destroys uniformity if it has not worse effects. Larger capacity cells for regulators are occasionally used to keep down the charging rate per positive plate, or paralleling several end cells on charge by means of a suitable switch to reduce their number, and the charging rate for the regulators is equally effective. Counter E.M.F. cells in one of the supply leads is another remedy, and a good one, yet rarely adopted. For any fair-sized installation, say of 500 lights and upwards, the additional cost of a semi-automatic reversible booster in place of a charging booster is not great, bearing in mind that the number of cells ordinarily required can then be reduced by approximately 14 per cent. Or, to put it in another way, 8 per cent. of the line voltage is about equal to the number of cells which can be dispensed with when the battery is discharged through a booster. As neither cell switches nor regulating leads are required then, further savings are made, which go towards cancelling the extra cost of the semi-automatic machine. The ease and delicacy of voltage regulation obtained with a booster is far ahead of the best that can be done by means of cell switches. If the pressure from a gas or oil engine-driven dynamo varies considerably so that the pulsations are reproduced in the lights, floating a battery across the line has the desired steadying effect. To that end set the cell switch for the correct line pressure, running the dynamo to give about 2 per cent. higher voltage as a mean. Of course, the cells must not be switched in parallel until the generating plant has settled down to its work at that pressure; this is a convenient way of husbanding the capacity of a battery for long runs. To obviate the necessity for a large number of leads with cell switches for high-voltage batteries, some ingenious devices have been described. One means is to connect every fourth cell at the right-hand end of the battery to a main cell switch, and to use the first three cells at the left-hand end for connection consecutively to an auxiliary regulating switch, the two switches interlocked. The saving in leads is obvious. One difficulty, however, is to guard against charging certain cells in the reverse direction if the number of cells in the charge circuit happen to be less than that discharging at the time.

The practice of starting internal-combustion engines by running the dynamo as a motor off the battery should be discouraged. Without special gear this puts an exceedingly heavy strain on the cells at a time when they are least able to bear it—viz., as a rule, when they are low down in the morning after a night's run. Two smaller batteries in parallel *versus* one large single set—the drawbacks to parallel working far outweigh the almost solitary advantage of having one battery available for use while the other is being cleaned or under repairs. Two full-sized batteries by all means, operated turn and turn about; this promotes a good crystalline formation, and results in higher capacity and longer life, but no parallel working if it can be avoided. In modern cells, moreover, so much free space is provided for sediment that the necessity for its removal does not arise until the plates are worn out. The removal of sediment from older-form cells is best entrusted to the makers, as they keep a staff experienced in that work, and because much damage may be done by neglecting the necessary precautions. Great care is required during the removal of the plates from the electrolyte, as the negatives oxidise quickly, heat up and shrink when exposed to the atmosphere; it is important, therefore, to prevent their becoming dry. Failure to obviate this will not only entail a subsequent full deoxidising charge of about 40 hours before the cell will give capacity again, but in shrinking the active material is liable to lose contact with the conducting framework, and to seriously impair the capacity of the negatives. For the removal of a few defective plates only in several groups utilise the good plates of one or more of these, putting entirely new groups into the latter cells. Old and new plates mixed in the same group do not divide the work equally between themselves, and then discharge into one another after the circuit has been disconnected. Such groups invariably go to pieces in a comparatively short time. Sometimes one single cell alone gives trouble in a battery, and on renewal of the plate section the question arises how to give the long initial charge without greatly overcharging the entire set of cells in the absence of a milking booster. This difficulty is minimised by asking the makers to forward the new section fully formed and charged, the negative group being packed in wet sawdust. When put into circuit during charge subsequently this will only take from 10 to 12 hours altogether to come up with the other cells; until it does so it must, of course, be cut out during discharge.

Celluloid or kindred substances are undesirable materials to employ in connection with storage cells, whether in the form of containing boxes, separators, or envelopes. Their behaviour is uncertain; notably in proximity to the positive element the tendency of celluloid is towards decomposition, and the eventual formation of sulphate. At one time xylonite was much used for fork separators, being cheaper than ebonite, but, besides obstructing the view between the plates, forks are liable to twist, and to defeat their object; hence they have been almost entirely superseded by glass tube or glass rod separators in stationary batteries. The introduction by the Chloride Company of

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board diaphragm separators, acting as a complete screen between plates of opposite polarity, marks, I consider, a most important step in the right direction. By rendering it impossible for any treeing to occur, scale or foreign substances to become lodged in the open spaces between plates, the liability of individual cells falling below par is practically excluded. No farther need to peer into cells prospecting for possible shorts; the certainty that, by reason of the efficient protection of electrodes, excrescences, if any, cannot develop and do mischief renders supervision very easy. To keep the cells clean, acid level and density right is really all the attendant has to do in the battery-room. An additional advantage of diaphragm separators is that by holding up the voltage, they raise the useful capacity of cells. This effect is readily verified by exchanging forks or glass tubes for board separators in any cell of low capacity the plates of which are, however, mechanically in good condition; after only a few weeks' regular use this cell will have redeemed its character completely—very likely will have become the strongest one in the whole set. Electrolyte liberal in volume and of 1 215 maximum density only is used, and as no attendant troubles from carbonisation of the wood or any other causes have been experienced in the course of close on five years' continuous employment under all conditions of work board separators have fairly passed the period of probation.

The field for the use of accumulators is constantly and rapidly widening, but by far the most important developments to record in the application of electrical storage are those in its relation to power purposes. Splendid work is being done in that department, and taking into consideration the large scope for batteries operating on variable loads with every prospect of thoroughly sound results, both from technical and balance-sheet points of view, the outlook is the very best. I have heard it stated over and over again that accumulators for power work have proved anything but successful in the past. Why? Because pressure regulation was exceedingly troublesome for one thing, but principally because in almost every single instance batteries were over-discharged day after day, and were then left standing in a run-down condition. Mr. Wordingham on one occasion summed up the situation neatly thus: "Batteries are so useful during light load, and again during heavy load, that the difficulty is to find time for charging them." That's it. Moreover, it must be plain that a heavy load will be far more trying to the cells when near the limit of their useful capacity than when they are fully charged. Not only were these obstacles to successful application cleared away for good with the introduction of the reversible booster, but much smaller batteries now are perfectly equal to the same service in which large batteries were ruined formerly. As a matter of fact, for rapid and frequent fluctuations, fairly continuous throughout any given period—now 200 per cent. above mean value, now down to zero—capacity is not essential, but robust plates able to withstand without detriment rapid charges at excessive rates, and to furnish the momentary peak discharges, whatever these may happen to amount to. Capacity, of course, is needed to do justice to rectangular peaks, to supply current for overtime work or week-end repairs (the generating plant shut down to save boiler and engine hours), and last, but not least, to constitute an unfailing stand-by in case of breakdown of the power supply when the battery takes up the whole load instantly, and keeps matters going until the defect has been remedied. With penalties for default on some tramways of £7 per minute, the value of this capacity, usually one hour at full load, can be readily figured out; in large manufacturing concerns the loss in wages and work through an hour's stoppage may be even more serious. In case of fire at night the battery will light the premises, supply current for running cars out of sheds, and be the means of saving valuable property generally. Then take the advantages from a battery-booster equipment to a combined incandescent lighting and power circuit through constant pressure—*i.e.*, steady light from lamps and uniform speed of motors, favouring best quality of work and highest output from tools or machines. One initial difficulty is met with in arriving at a true appreciation as to the character of load in a given industrial concern. The inefficiency of mechanical transmission by line shafting, gearing, and belts puts a fictitious value on the mean load factor, raising this frequently by 30 per cent. or more. Apparently, therefore, the load is fairly steady, and the engine diagram will prove economical working. But substitute electric motors, direct-coupled to heavy machinery, and driving short lengths of countershafting, preferably provided with ball or roller bearings, to which lighter tools are belted in groups, and the maximum demand will probably be 60 to 70 per cent. of the engine output, with a mean load factor in the neighbourhood of 40 per cent. Hence, with judicious application of battery and booster to take care of all fluctuations, a considerably smaller number of engine units need be run, or, conversely, extensions on a large scale can be effected in the works without entailing additions to the existing generating plant, or drawing on the reserve equipment. The economies in power production costs, wear and tear, etc., are manifest.

As regard first cost of installation, that of a battery, booster, and controlling apparatus is less than one half of the capital outlay caused by the provision of boilers, engines, etc., for equal service, while a covering rate to allow for upkeep is 6 to 8 per cent. The various types of boosters used with batteries, both for charge and discharge, may be classed as follows: constant-current booster—non-reversible; differential boosters—reversible, balanced currents; Highfield boosters—reversible, balanced voltages; solenoid controlled boosters—reversible, shunt field rheostat; carbon pillar booster—reversible, Wheatstone bridge principle.

Constant-Current Boosters.—These are specially suited to mills, factories, residences, etc., where the motor load is of moderate value, one generator having to deal both with incandescent lighting and power. In the ordinary way the switching on and off of motors will cause irritating pulsations in the lights, which the constant-current booster and battery prevent, the regulation being so close that the lighting voltage can be maintained within 2 per cent. The general arrangement is to connect all motors across one set of 'bus bars and all lights across another, the negative 'bus bar being continuous, and common to both sets of positive bars. The generator is then connected across the lighting 'bus bars, the battery across the motor ditto, positive lighting and positive motor bars being joined through the booster. This latter is provided with shunt and series coils so proportioned as to keep the load on the generator constant—viz., a definite value for lighting, and the mean only of the motor load. Any excess demand for power above the average is supplied from the battery, while during periods of low motor load the cells are charged automatically. Moreover, by installing end cells and switches for hand regulation, and making provision for cutting out the booster and directly connecting positive motor bars to lighting bars, the battery is placed across the entire system for use either alone or in parallel with the generator.

Differential Boosters.—Probably the first reversible machine ever put to work was that known as "up and down dynamo," invented by Mr. W. A. Chamen, and which represents the fundamental principle of all differential types. The booster armature was placed in series with the battery, the field being excited by means of a shunt and a series coil. The shunt coil was excited off the line and gave excitation in the charge direction, regulation being effected by a rheostat. The series coil carried the whole line current, or a shunted portion thereof, and was sufficiently powerful to overcome the shunt coil, and to furnish the requisite boost on discharge in addition. As during succeeding years an increasing demand for traction boosters arose, modifications of, and improvements on, the above principle were devised by several inventors. The shunt coil was excited off the battery, making the machine more automatic, but the excitation has still to be varied according to the state of charge of the battery. An armature reaction coil came into use, and an exciter was added to carry the differential coils, and its polarity was reversed according to the line load. Running at a pressure up to 100 volts, and being connected straight across the booster shunt coil (the booster a simple shunt machine) better efficiency resulted, but also increased magnetic lag due to the necessary double reversal.

Highfield Boosters.—The best known type in the United Kingdom is the Highfield automatic reversible booster, invented by Mr. J. S. Highfield. The principle of this machine is based on the battery volts rising during charge and falling during discharge. If, therefore, a constant pressure be arranged to oppose the varying voltage, and the field winding of the booster be placed in this circuit, it follows that the flow of current in one direction or the other, and the consequent reversal of the booster's polarity, is made directly dependent on the battery characteristic. In this way both the degree and the direction of the booster's activity are controlled by the difference between two voltages, one fixed, the other varying—which method at once appeals by reason of its simplicity and obvious efficiency. Motor, booster, and exciter are rigidly coupled together, the booster armature connected in series with the battery. The small shunt-wound exciter is regulated by a rheostat, and its design provides that its pressure is not materially affected by variation in load or slight changes in speed. Connected through the booster shunt coil across the poles of the battery, and in opposition to them, the exciter is now set to give the line pressure. The booster then acts as described, a series coil excited off the line, and therefore in sympathy, giving corresponding boost on discharge, and compensating for speed changes of motor and differences in exciter pressure when varying from no load to full load. This series field is adjusted by a diverter switch. A second series coil in series with the armature accounts in either direction for armature reaction. Another Highfield machine, the semi-automatic, is specially well adapted to lighting systems, in connection with refuse destructors, and for such uses generally where the fluctuations are not sudden or violent, and the battery may be either charging or discharging continuously, or, perhaps, float for a considerable time. These machines, automatic within given limits, depend in their action on the direction in which the current is passed through the booster shunt coil. By means of a rheostat the current in this coil can be varied to any desired extent, and the direction of it be reversed without breaking the field circuit. Series excitation, controlled by a diverter switch, is provided as in the automatic sets.

Solenoid Controlled Boosters.—In the solenoid-controlled booster the machine is shunt wound for its maximum boost, excited off the line, a reversing and regulating shunt field rheostat dominating the field winding. The rheostat itself is controlled automatically by a solenoid, round which passes the whole line current.

Carbon Pillar Machine.—The operation of the carbon pillar machine now introduced into this country depends upon the reversal of the booster field by the variation of resistance in a circuit connected upon the Wheatstone bridge principle. By the difference in mechanical pressure effected on two sets of columns, each consisting of carbon discs, the resistance of the circuit and thereby the direction of the current are changed. The fields of exciter and booster correspond to the galvanometer circuit of the Wheatstone bridge. A bar for varying the pressure upon the carbon columns is pivoted at the centre, one end being pulled down by a solenoid in the main circuit, counterbalanced by the tension of a spring at the other end. To accelerate the speed of reversal, the exciting value can be made three times as great as is required. These machines are particularly suited to deal with very violent and rapid load variations, and by their use the generator output can be maintained constant to within 2½ per cent., provided the battery is proportioned to supply the peaks, and to absorb the average load as charge when the line demand is zero. This careful proportioning of the load between generator and battery is the crux of successful working. In the case of a railway load, for instance, it will be preferable to allow of a variation in the generator output 25 per cent. above and 25 per cent. below normal. By means of a regulator in the booster shunt coil the set may be given a discriminating value—*i.e.*, charging up to a certain amount only—and restricting discharge until the generator output has reached a predetermined maximum. As regards working methods, the directions given with Highfield machines are merely to the effect that the set is to be handled in

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the same way as a generator. To parallel an automatic set, the exciter is brought to the same pressure as the line when the booster is switched in. To increase load on generator, raise dynamo pressure and decrease exciter voltage. Reverse this process to obtain the opposite effect. The diverter is adjusted when the machine is installed, and will need no further regulation unless the mean load is very largely increased, or when further generating plant is added.

In many combined lighting and traction stations it will be an advantage to have the battery and booster available on the lighting 'bus bars. To that end, a double-pole throw-over switch provided transfers battery and booster on the lighting system as a two-wire unit. For cases of emergency—as, for instance, if the balancer breaks down—an additional single-pole switch is installed to connect neutral battery to neutral 'bus bar after the booster has been switched out. The factor of safety this arrangement gives amply justifies the small extra outlay for switchgear. That self-contained accumulator cars for tramway traction have not given better working results in the past is by no means due entirely, as alleged, to the excessive cost of upkeep, and to the weight of batteries constructed 10 and 15 years ago. There were numerous contributory causes. Given a good track, efficient motors, and gearing, and present-day traction cells having an output of nine watt-hours per pound at the five hours rate of discharge, and quite a different showing will be made. Line batteries at a distance from the power station are applied most successfully for maintaining the voltage at its average, and for reducing the amount of copper necessary for transmission. The following comparison of actual working results will demonstrate this. Transmission distance about 7½ miles, 550 volts, at power-house. 400 volts minimum on line. Copper required without battery—350 amperes maximum transmitted; track drop 78 volts, line drop 72 volts; copper, 300,000lb. Copper as actually installed with battery—167 ampere maximum transmitted; track drop 37 volts, line drop 113 volts; copper, 130 000lb. Thus effecting a saving of over £4,000 in first cost and of £200 in annual charges all told except copper depreciation. Not only are fewer generating units required, but, through the relief from fluctuations, wear and tear thereof are materially reduced, and a reserve provided in case of breakdown.

The use of storage batteries on electric locomotives where an exposed conductor is inadmissible in mills, mines, and for shunting purposes on railways is considerably on the increase. Particulars were forthcoming recently of two accumulator locomotives supplied for service on the Great Northern and Piccadilly Electric Railway in London: Total weight, 65 tons, of which 31 tons battery; equipment, two motors, each 20 h.p. normal, 85 h.p. maximum; 80 cells, 180 amperes normal, 800 amperes maximum; speed, seven to nine miles per hour while hauling a load of 60 tons on the level. Figuring the power provided on the basis of 100 watt-hours per ton-mile, this will admit of two miles continuous haulage of full load with one complete charge of the battery. As usual in the "straight" storage system, facilities are provided for recharging the cells during intervals when the locomotive is standing by means of conveniently located charging plugs. In the mixed system—*i.e.*, battery operating only when trolley or third rail are precluded—the cells are generally recharged by direct transmission, and a relative small battery as a rule does duty.

The task imposed on accumulator makers to produce a battery capable of successfully withstanding the exigencies of use on electromobile was not an easy one, seeing that light weight and small space to be taken up, apart from such amenities as vibration, wash of the electrolyte, and frequent (occasionally rough) handling were the conditions under which a large and lasting output had to be given over a reasonably long period. The performance of 4,500 car miles completed, full capacity, no repairs to plates, and still running, weight efficiency nine watt-hours per pound of complete cell, shows, however, that makers were equal to the situation. Again, much of the credit as regards uniform behaviour and reliability of cells for this service, as well as for ignition purposes, is due, I contend, to protected electrodes; internal shorts in completely enclosed cells, tightly packed and connected together, are especially trying. The usual number of cells employed for vehicle work is from 40 to 44, so as to be divisible into four groups and to admit being charged from a 110-volt circuit. The motor then is wound for 80 volts. Sixty watt-hours per 1,000lb. total weight per mile is a fair average rate to use in computing the power to propel a given vehicle. This rate is called "wattage." A battery having a weight efficiency of nine watt hours per pound would be able to propel itself 150 miles with a wattage of 60. Should the same battery be only 25 per cent. of the total weight propelled, then it follows that it will run a 60-wattage car one quarter of 150 miles = 37½ miles. Conversely, if the mileage be specified on one full charge, say 50 miles, then the proportion of battery weight to total weight is found. In this case 50 : 150 = ⅓.

For recharging batteries from alternating-current circuits, electrolytic rectifiers, called "Nodon valves," have proved very satisfactory, according to Mr. Horace Boot's experience; also the cost of installation was £68 compared with £155 for a motor-generator of corresponding output. Zinc and aluminium alloy plates, in lead cells, with a saturated solution of phosphate of ammonium make up the combination. Mercury arc rectifiers supplied for the same purpose possess important features to recommend them, such as small space occupied, low cost, and the extreme ease of manipulation. Also the efficiency is remarkably high down to one quarter load. Operating from a 220-volt 60 cycle alternating-current circuit the efficiency came out at over 76 per cent. from one quarter to full load at a direct-current voltage averaging 80, and over 80 per cent. for direct-current voltage averaging 112. The wave form of current through the rectifiers is beneficial to the batteries inasmuch as more time is given for chemical action, gassing is reduced, and the charge will be found more efficient than from a continuous current.

It is by placing a modern standard cell side by side with a production of the early days that the true progress made in the construction of accumulators is best realised. Evolution has been slow, radical departure from established lines being, not without reason, distrusted by users, but for all that every single feature bears evidence of marked improvements tending collectively to ensure greater uniformity, wider working range, and longer life. These objects were one by one successfully attained, yet subject still to the necessary careful daily attention being bestowed on the battery. The next step was to secure for the user absolute reliability and freedom from internal cell troubles with a minimum of supervision, and efforts in that direction also have been completely rewarded, even beyond expectations. As I have endeavoured to show, mechanical protection of electrodes has brought with it a substantial increase in the watt and ampere hour output obtainable from a given depth of formation, a combination of benefits realised by simple means, and without either straining the capabilities of cells or enhancing their cost. This latest advance in accumulator practice effectually removes the disadvantages of open spaces between plates, while retaining to the full extent their real objects—insulation, ample volume and free circulation of electrolyte—and it is safe to predict that all who have had experience with the new method will insist on its application in every future instance.

FORTHCOMING EVENTS.

FRIDAY, DEC. 15.

Electro-Harmonic Society.—At 8 p.m., smoking concert.

Institution of Civil Engineers (Students' Meeting).—At 8 p.m., "Tests of Street Illumination in Westminster," by Mr. E. E. Mann, B.Sc., Stud.Inst.C.E. Mr. E. W. Monkhouse, M.I.C.E., in the chair.

Junior Institution of Engineers.—At 8 p.m., "Electric Mains for Power Transmission Work," by Prof. John T. Morris, M.I.E.E. (member).

Physical Society.—7 to 10 p.m., Exhibition, Royal College of Science, South Kensington.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., general meeting (at Newcastle-on-Tyne).

SATURDAY DEC. 16.

Junior Institution of Engineers.—At 10 a.m., visit to Messrs. Johnson and Phillips's works at Charlton.

Institution of Electrical Engineers (Manchester Local Section). At 2 p.m., students' visit to generating station.

MONDAY, DEC. 18.

Society of Arts.—At 8 p.m., "The Measurement of High-Frequency Currents and Electric Waves," by Dr. J. A. Fleming, D.Sc., F.R.S. (in continuation of previous courses on "Electric Oscillations and Electric Waves" and on "Hertzian Wave Telegraphy"). (Lecture IV.)

TUESDAY, DEC. 19.

Institution of Civil Engineers.—At 8 p.m., "Heat Economy in Factories," by Mr. H. A. Mavor, M.I.C.E.

WEDNESDAY, DEC. 20.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to inspect the works in progress for the extension to Euston of the City and South London Railway.

Liverpool Engineering Society.—At 8 p.m., "Portland Cement," by Mr. H. K. G. Bamber.

Royal Meteorological Society.—At 7.30 p.m., papers on "Kite Observations from a Trawler in the North Sea," by Mr. George C. Simpson, B.Sc., F.R.Met.S.; "Investigation of the Upper Air in the West Indies by Means of Kites," by Mr. C. J. P. Cave, F.R.Met.S., and Mr. W. H. Dines, F.R.S.: "Temperature Observations during the Partial Solar Eclipse, Aug. 30, 1905," by Mr. W. H. Dines, F.R.S.; "Comparison between Glaisher's Factors and Ferrel's Psychrometric Formula," by Mr. J. R. Sutton, M.A., F.R.Met.S.; "A Rapid Method of Finding the Elastic Force of Aqueous Vapour, etc., from Dry and Wet Bulb Thermometer Readings," by Mr. John Ball, Ph.D., A.M.I.C.E.

Society of Arts.—At 8 p.m., "The Aerograph Method of Distributing Colour," by Mr. Charles L. Burdick.

FRIDAY, DEC. 22.

Institution of Electrical Engineers (Manchester Local Section).—At 7.30 p.m., "The Electrical Equipment of Automobiles," by Mr. J. C. Ward.

THE ELECTRICAL ENGINEERS, R.E. (VOLS).

Orders for week ending Dec. 23.

MONDAY, DEC. 18.—"A" Coy.—Recruit drill, 6 p.m.
Technical instruction, 7 p.m.

TUESDAY, DEC. 19.—"B" Coy.—Technical instruction, 7 p.m.
Medical inspection, recruits, 7 p.m.

WEDNESDAY, DEC. 20.—"A Badge" examination.

THURSDAY, DEC. 21.—"C" Coy.—Technical instruction, 7 p.m.

FRIDAY, DEC. 22.—"D" Coy.—Technical instruction, 7 p.m.

Headquarters will be closed from 11 p.m. on Friday, Dec. 22, 1905, until 10 a.m. on Monday, Jan. 1, 1906.

J. H. S. PHILLIPS, Captain E.E.,
for O.C. E.E.R.E. (Vols.).

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE LONDON COUNTY COUNCIL POWER BILL.

At last Tuesday's meeting of the London County Council a resolution was passed which authorises an application to Parliament which, if successful, will place in the hands of the Council the responsibility for the supply of electricity in bulk throughout Greater London. The scheme involved is described in outline in the report of the Highways Committee, which we reproduce in full elsewhere in this issue. We also give the report of the Finance Committee with its guarded conclusion. The question of municipal trading is one on which we have decided views, and on which we differ considerably from the present attitude of the Progressive majority of the Council. For example, we strongly disapprove of the Council undertaking the steamboat service on the Thames, and we consider that the failure of this service from a financial point of view was only too assured from the first. Other attempts have been made to render a remunerative service, and the records clearly showed that the limited length of season and, to use an electrical expression, the poor load factor did not allow of a steamboat service paying on the Thames. In the present instance, however, we have to express our agreement with the County Council's Power Bill, and think it well to give the reasons. In the first place, the Council is the financial agent of the local authorities owning electric supply undertakings within its area, and has thus evidence at its disposal that the artificial boundaries between the various metropolitan boroughs do not conduce to economy in supply. Again, looking forward to the time when the provisional orders held by the existing electric lighting companies will terminate, the Council will then be called upon to finance the undertakings if purchased by the local authorities under the Electric Lighting Acts. They are hence directly interested in the fact that developments in electric supply are now rendering the works purchasable by any one authority incomplete in themselves. For instance, it is absolutely certain that the largest number of local authorities will at the date in question be able to purchase distributing systems only. The few remaining authorities would be able to purchase not only the distributing systems within their areas, but also generating stations of a magnitude which would be many times too large for the districts in which they are situated. It is obvious, then, that electrical progress has so modified the conditions of supply from those presupposed when the Electric Lighting Acts of 1882 and 1888 were drafted, that the purchase clauses in these Acts are almost nullified. The spirit of the clauses would, however, be met if the County Council were to be made the purchasing authority for the (present) bulk supply stations. If this course is to be adopted, it seems also reasonable that the Council should be allowed at once to give that bulk supply which is required for cheap power distribution within the London area. There may still be a few expert station engineers who claim that such a bulk supply is not needed, and that they with their smaller stations can produce electricity at as cheap a rate as that at which electricity can be supplied to them from a very much larger station on the banks of the Thames. We are afraid, however, that their opinions must give way to the verdict of the two committees (the House of Lords Committee and the House of Commons Committee) who considered the Power Bills last year, and recommended that the Administrative County of London Power Bill should be passed. It seems to us that this verdict, which by a few hours only did not become law, should also reassure the Moderate party on the London County Council and the Finance Committee as to the financial prospects of the scheme. It will be

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urged by some that the risk is one which, while a fit subject for private enterprise, should not be borne by the London ratepayers. This risk, as far as the local supply undertakings is concerned, is already borne by the London ratepayers. Again, it will be said that while the undertaking might be successful under the able guidance of Mr. C. H. Merz and his business friends from the North, it would be a financial failure like the Thames steamboat service if placed in the hands of a London County Council committee and the London County Council staff. The only reliable answer to this argument is the test of time, but a few figures, which, while not strictly comparable, are at least of interest, may give reason for our approval to the London County Council scheme. There is in the West of London a large tramway undertaking organised by Sir Clifton Robinson, whom we consider second to none in tramway organisation. From the figures given in Garcke's "Manual" for 1905, the London United Tramways undertaking had at the beginning of 1904 £1,890,063 of issued capital. They had also £1,031,000 of debentures, so that the undertaking, consisting then of some 37 miles of route, of which 35½ were electrified, had to pay interest on £2,921,063. This is equivalent to £78,676 per route mile. The system of electric traction employed by the company is the overhead trolley. In conjunction with these figures we would take those for the London County Council system for conduit tramways from the same volume and for the year ending March 31, 1904. For the tramways south of the Thames the Council had then spent £1,048,612 on electrical equipment, while the horse and cable systems purchased by the Council stood on their books at £1,075,617. This expenditure, amounting in all to £2,124,229, was represented by 43 miles of electrified line and averages £49,400 per mile of route. We do not pretend that these figures are comparable without making considerable adjustments which it is difficult to do in the space at our disposal at present. Allowing liberally for these adjustments we think it only fair to conclude that the Highways Committee, with the able assistance of their officials (Messrs. M. Fitzmaurice, A. L. C. Fell, and J. H. Rider) have proved that municipal tramway undertakings can be quite as economically installed and worked as company tramways. It remains to be noted that the Highways Committee have at present the charge over the scheme for bulk supply, for which powers are to be sought in the next parliamentary session.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PERMEABILITY OF IRON.

SIR,—I have often had difficulty in collecting ideas as to what actually happens in the case of a piece of iron placed in a field of magnetic force, H. Perhaps the following will be useful to some of your readers.

It is accepted that a piece of iron is composed of molecules which are themselves small magnets or seats of magnetic force which is always of the same amount whatever state the iron is in, although when the iron is unmagnetised these molecules are so arranged among themselves that they neutralise each other's action. Now, when the iron is placed in a field of force, this field produces a righting action on the molecules, causing them to set themselves more or less in the direction of the applied force. The result is that the force due to the molecules (each one of which has its own definite field) intensifies or adds to the applied force so far as points inside the iron are concerned. When, however, we consider points outside the bar, it is seen that as the lines emerge and turn back to complete their circuit through the S-seeking end, the result is that everywhere there actually exists a field which is the resultant of two fields, one due to the applied force, and the other the force due to the constituent molecules.

Now, since outside the iron the two sets of forces are more or less in opposition, the result is a distorted weakened field, whilst inside the iron, where the fields are in the same direction, the resultant is a strengthened field. Hence it would appear better to say, *not that iron has a great permeability for lines of magnetic force in the sense that it collects them together into itself*, but rather that the intensified field inside the iron, and the weakened field outside, is due solely to the reaction of the field due to the constituent molecules on the original field.

Again, considering the statement that a magnet exerts a demagnetising effect on itself. In measuring permeability, the specimen is always placed to form part of a closed magnetic circuit, and then a certain definite value of H applied produces at any point of the bar a definite value of B. Now in the case considered of a bar of iron in a field, H, there is produced a value of B in the middle which is about the same as that which would be observed in a permeability test on the iron. Near the ends, however, the value of B is less than this amount by a quantity depending on the leakage of lines from points on the sides. This corresponds to saying that the value of B near the ends is less than that which would be observed in the same iron due to the same value of H in a permeability test; or, in other words, the value of B actually observed near the ends is that corresponding to a smaller value of H. Hence near the ends there is a tendency to demagnetise the iron produced by the ends.—Yours, etc.,

THOS. F. WALL.

Karlsruhe, Germany, November, 1905.

ANSWER TO QUESTION No. 820.

SIR,—I see in your correspondence columns in the current issue that Mr. P. Weil has written objecting to a statement I made in my answer to Question No. 820 in the issue for Nov. 10. Below is the particular portion of the query under consideration:

"Does not the above point to the suggestion that if two motors of similar amperage give same torque, but that one has lower power factor than the other, the lower power factor one is cheaper to run from consumer's standpoint?"

I think it will be seen that this is all a question of efficiency, for supposing the amperes and volts the same in both cases, as is stated, it is quite a possibility for one motor to have a certain power factor and a certain efficiency and for another motor differently designed to have a slightly lower power factor but a better all-round efficiency. I think this should make the matter clearer. I now quote the part of my answer objected to:

"Of course, if two motors can be found to do the same work, taking the same current at the same pressure, one having a lower power factor than the other, from the consumer's point of view it is advisable to use the one with the lower power factor, but it will be found that in reality there is very little to be made out of it this way, and it would be well to see that really you are improving the efficiency."

I think my present fuller explanation of my ideas should show that my former statement was perfectly correct, and in it I intended to imply what I still think, that there is not likely to be much gained by using a motor of lower power factor, if any, but still it is quite a possibility.—Yours, etc.,

ERNEST R. ALEXANDER.

BRAZING CAST IRON.

SIR,—Could you or any of your readers give me any information as to the flux and spelter used for brazing cast iron, and, also, if a patent, where I can obtain them? If you can give me any information I shall feel greatly indebted to you.—Yours, etc.

J. E. H.

Pretoria.

KNIFE SWITCHES.—Messrs. Ferranti Limited have sent us a catalogue of their single-pole double-throw quick-break knife switches for currents up to 2,500 amperes, also a list of their triple-pole single-throw quick-break knife switches for currents up to 1,000 amperes.

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GLOVER'S HARDY PERENNIAL.

The copy of Glover's almanac for 1906, just to hand, is quite a gleam of sunshine to lighten the fog which pervades London at the time of writing this. There is much more original matter in the daily leaflets than in previous issues, and we are pleased to see that a refreshing humour pervades the bulk of the same. Take, for instance, the rules for laying electric cables which appear on the page for Jan. 4—a date when even the most hardened "first-footer" is supposed to have regained his equilibrium:

"On receiving a drum of cable at the station, have it lifted on to a lurry by means of a chain put round the cable itself. This fresco's the lead artistically."

"To unload the drum from a lurry—push it off. The makers like it. It is good for the drum."

"In running off lead-covered cable, select a course with plenty of sharp stones spread about. Put all the men on the end of the cable and drag it over the stones. If no stones are available, a heap of picks and shovels should be made. A live fire-devil will also be found useful."

"If possible, put a kink in the cable—four navvies should be able to do this in less than five minutes. Then straighten it out with a sledge-hammer and a plank."

"In laying solid, after the cable is pulled into the trench, let the gang walk on it for at least five minutes."

"If a pilot is being laid with a feeder, pull the pilot in first—then pull the feeder over it. This is good for the pilot."

"If a paper cable is to be cut, wait till the rain comes on. Then tape up with pure rubber and forget—this checks any tendency towards a too high insulation resistance."

The note at the bottom of the page that "Glover's make all types of joint-boxes" is a delicate hint that the above rules followed closely may lead to business. The sketch of

prehistoric cable-laying is excellent, and the striking likenesses of members of G——'s staff must appeal to all. The new proverb that "section pillars save sleeping draughts" is the outcome of experience as to the worries of main superintendents.

We conclude our extracts where the almanac begins. Thus for Jan. 1 we find the following 'On Business Prospects" (with apologies to Mr. Dooley): "An' phwat d'ye think is th' prospicts iv bisness this year an all?" asked Mr. Hennessy, wiping his mouth with his sleeve after drinking to Mr. Dooley. "It depends on phwat ye call bisness," replied Mr. Dooley. "William Shakespeare said, 'Bisness is bisness,' an' it may have been in his days; but he's wrong to-day. Bisness is profit; that's good bisness. If it's loss it ain't bisness at all; it's foolin'. Th' bisness iv last year was good f'r thim that profited be it, and bad f'r thim that didn't. Some iv th' folks 'll tell you that it was easy to git. So it may have been whin you're not anxious f'r a rayturn iv your money; but you can have too much iv that sort iv bisness. Others don't say nawthin', but perhaps they're th' folk who pulled off some iv the payin' orders. Th' people who write to th' pa-apers an' say they sold wan coil iv 1/18 to th' Muddlewick Borrow Council in competishun wid all th' other cablemakers forgit that their profit is mopped up be th' postage in th' letter. It's th' same wid sellin' as wid' buyin'; th' man who saved a few dollars be buyin' bad cable last year will lose 10 times th' amount be diggin' it up again this year. That's not bisness. But if he buys Glover's cables, that's ——." "Hold on," said Mr. Hennessy, "I asked ye f'r th' prospicts iv bisness f'r 1906" "Ask me again on December 31st," said Mr. Dooley, "an' I'll tell ye."

LONDON COUNTY COUNCIL POWER BILL.

The following is a joint report of the Parliamentary and Highways Committee of the London County Council on the supply of electrical energy in London and certain surrounding districts:

The Council on Nov. 14, 1905, resolved to seek statutory authority in the session of Parliament of 1906 to enable it to supply electrical energy in London and certain surrounding districts, and, in accordance with the terms of the resolution passed on that date, we now submit an outline of the scheme which we propose shall be adopted, and we place before the Council the draft of the Bill which has been framed to secure the objects in view. Our former report dealt generally with the importance of meeting more adequately the growing demands for the supply of electrical energy for general and for commercial use in a convenient manner and at cheap rates, and pointed out that it was generally recognised that this important object could only be secured by the establishment of a large central supply undertaking dealing with an extensive area.

Details of Proposed Scheme.

For some considerable time the Council's officers have been working under our direction upon the details of a scheme to be submitted to Parliament in regard to the Council's Bill of 1906. The work was entrusted to the chief officer of tramways and the tramways electrical engineer, but in view of the importance of the scheme, and in order that every detail in connection therewith should be put forward on a sound and practical basis, we thought it best that expert assistance should be retained to assist the Council's officers both in working out the scheme in its initial stages and by giving evidence in due course in support of the Council's Bill. For this purpose we secured the services of Sir William H. Preece, K.C.B., F.R.S., Past Pres.I.C.E., Mr. Robert Hammond, M.I.C.E., M.I.E.E., and Mr. John F. C. Snell, M.I.C.E., M.I.E.E. The officers have carefully considered the subject and have reported exhaustively thereon, and the several committees concerned have had personal interviews with the experts on the question. As the result, the officers, in consultation with the experts, have submitted to us a complete scheme, and they have been able to prove conclusively to our satisfaction that the scheme is feasible and practicable, and would not only be of great assistance to authorised distributors, but would also be of great public benefit. It should, we think, be pointed out that, under the scheme of the Administrative County of London and District Electric Power Company of last session, there was provision in the Bill to enable the company, under certain conditions, to compete in their respective areas with distributing undertakers. The scheme now submitted, however, has been framed on the basis of the Council co-operating with existing local authorities and companies and not competing with them by retailing energy without their consent. The proposals now put forward by us on these lines will, we are advised by the experts, enable electrical energy to be produced on the scale which it is now generally recognised is essential to economical generation, and supplied on terms as favourable as would be possible under any scheme.

The scheme provides for the temporary surplus of energy from the Council's tramways electricity generating station at Greenwich being supplied as required at the earliest possible date to some of the existing distributing undertakings. The

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Council is aware that the erection of the second section of the Greenwich generating station is already in progress, and, in view of the arrangements which have been made with regard to the early reconstruction of the Council's (northern) tramways, the large number of new tramways which the Council is authorised to construct, and the suggested tramway extensions, the whole capacity of both portions of the generating station—namely, 34 000 kw. normal—will not within the next five or six years be required entirely for tramway purposes. Our suggestion is, therefore, that advantage should be taken of this fact to press forward the work on the second section of the Greenwich generating station in order that, as far as possible, this station may for a time, as stated, meet certain of the demands for electrical energy which cannot be dealt with by existing undertakings. In the meantime it is proposed that a station shall be erected on land by the riverside at Battersea to be specially acquired for the purpose. This station will in the main serve for the supply of energy to distributing undertakings, and ultimately for the purposes of the Council's own tramways. This will ensure a very economical form of supply. The resolution of the Council of Nov. 14, 1905, did not contain specific provision for the establishment of this station to be included in the Bill of 1906. The site suggested for the proposed new station is situated on the south bank of the Thames near Grosvenor-road railway bridge, being part of the land belonging to the Metropolitan Water Board, and is shown on the cartoon plan which will be hung in the Council-chamber when this report is considered on Dec. 12, 1905. The site proposed to be acquired has an area of about 15 acres, and is estimated to cost £120,000, which includes all legal and other charges. It is proposed that a portion of the site which will not be required for the bulk supply undertaking shall be utilised for tramways urposes.

It is proposed that on this site, which was formerly used by one of the London water companies, a station of 80,000 kw. normal capacity shall be erected. The scheme which we have considered provides for this station to be built in three stages as the demand for energy increases—namely, that the first two quarters, comprising together 40,000 kw. normal capacity, should be put in hand as soon as the necessary parliamentary powers shall have been obtained, and that the third and fourth sections, each of 20,000 kw. normal capacity, should be added either consecutively or together, according as the increase in the demand may justify. While the temporary supply is being given for bulk purposes from Greenwich, it is proposed to charge the bulk undertaking with the average cost, including a proper proportion of the capital charges. So soon, however, as a considerable section of the Battersea station shall have been completed it will be more economical, from the point of view of distribution, to supply energy to the tramways from both Battersea or Greenwich stations to meet the demands for tramway purposes from the western and eastern sections of the county respectively. We would point out that it has always been the Council's intention to provide two generating stations for the supply of electric power for its tramways, one at Greenwich in the eastern half of the county, and the other to serve the lines in the western half of the county, such further station to be erected on a site which the Council specially acquired for the purpose at Pimlico. Other arrangements have, however, now been made for the utilisation of the Pimlico site, and our present proposal to erect the new station at Battersea is merely an extension of the Council's original scheme, while the Battersea site will be more economical and convenient in some respects than the Pimlico site. Moreover, owing to the much larger scale on which energy is proposed to be supplied, it will be possible ultimately to generate such energy for tramway purposes at a lower cost than would have been practicable under the original scheme. It will be possible in the majority of cases to utilise the existing and proposed tramways sub-stations as bulk supply centres, a course which will effect very considerable economy both in regard to capital expenditure and cost of maintenance. While surplus electrical energy is being supplied from the Greenwich station for bulk purposes, the bulk supply undertaking will, it is suggested, provide the necessary cables and ducts for transmitting the energy to the supply centres.

By adopting this scheme it appears to us that very important advantages will be secured which would not be possible in the case of any proposal contemplating the installation of an entirely fresh undertaking.

In the report of the subject considered by the Council on Nov. 14, 1905, it was pointed out that one important objection raised against the Administrative County of London and District Electric Power Company Bill of last session was that enormous powers would have been conferred on private individuals in respect of the breaking-up of streets and the interference in other ways with public property. It seems to us to be obviously desirable that rights such as these should only be in the hands of a public authority; moreover, as the Council is itself from time to time laying electric mains in various parts of London for tramway purposes, considerable convenience and economy will be effected by placing the two services in the hands of the same central authority.

We realise that in the near future the growing demands for electrical energy within the area of supply must necessitate considerable capital expenditure in the provision of additional plant and equipment to meet such demands, and we are satisfied that such expenditure can be incurred to the greatest advantage by the Council being empowered to supply electrical energy upon the large scale proposed rather than by extensions of existing undertakings in a manner which does not permit of production on the most economical scale.

Provisions of Draft Bill.

A draft Bill has been prepared by the Parliamentary Committee, and a copy sent to each member of the Council. There are certain provisions of special importance to which we would direct attention;

1. *Area of Supply.*—The total area of supply dealt with comprises 387 square miles, including the county of London (117 square miles) and an area surrounding London comprising 270 square miles.

2. *Powers of Supply.*—Powers are sought to enable the Council to supply energy (*a*) to authorised distributors, (*b*) to large commercial undertakings, such as railways, tramways, canals, docks, and waterworks, for use either wholly within or partly within and partly without the area of supply, provided that the Council shall not furnish a supply for use wholly within the area in which any local authority or company is authorised to give a general supply of electrical energy, without the consent in writing of such local authority or company.

3. *Erection of Generating Station.*—Authority is proposed to be sought to enable the Council to erect a generating station on lands at Battersea which are scheduled to the Bill for the purpose.

The inclusion of the Bill of authority to acquire property for the generating station at Battersea makes it necessary to suspend the operation of standing orders Nos. A 161 and 162. As the Bill must be deposited on or before Dec. 16, 1905, it will also be necessary to suspend standing order No. A 27, as otherwise the matter could not be considered by the Council until Dec. 19. In the special circumstance we believe the Council will be prepared to take this course. The solicitor has already advised, under standing order No. A 163, with reference to the whole question of the Council's power to promote its Bill and to acquire property for tramways purposes.

4. *Co-Working with Tramways Undertaking.*—Necessary clauses are included in the Bill to enable the Council to work the bulk supply undertaking in conjunction with its tramways undertaking.

5. *Revision of Prices.*—Provision is included in the Bill for the revision, in certain circumstances, of the prices charged by authorised distributors.

6. *Financial Clauses.*—Various financial clauses have been inserted in the Bill providing, *inter alia*, for the establishment of a reserve fund, etc., which are necessary to place the undertaking on a sound financial basis. Provision is also made in the Bill with regard to the allocation of surplus revenue from the undertaking in such a manner as to provide, in our opinion, the greatest possible security compatible with benefit to the consumers.

Conference with Local Authorities and Companies.

The Council will remember that on Oct. 24, 1905, it authorised us to make arrangements for a conference with representatives of the City Corporation and the metropolitan borough councils to consider this question, and also to confer with the companies concerned as we might think fit. We held a conference on the subject with the London local authorities on Nov. 20, 1905, and after a very full discussion of the matter, the conference, by a large majority, passed the following resolution: "That this conference of borough councils approves of the introduction by the London County Council of a Bill for enabling it to supply electricity in bulk, subject to the interests of borough councils' existing undertakings being safeguarded and the details of the measure proving to be otherwise satisfactory."

The conference expressed the desire to have a further opportunity of meeting and conferring in greater detail upon the Council's proposals, and it was arranged that the necessary facilities should be given for this purpose, the conference either being summoned for a second meeting or a full communication being addressed to each borough council dealing in greater detail with the Council's scheme. In framing the draft Bill we have endeavoured in every way to meet the desire expressed by the authorised distributors who have already established distributing undertakings that they might be safeguarded, and we hope that the Bill in its present form will secure that object. In the event of the Council approving the Bill, we propose to forward it for consideration to each of the borough councils, and, if necessary, to arrange for a further conference. We have also been in communication with the local authorities outside the county of London who are affected by the Council's

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proposals, and have had an opportunity of conferring with representatives of certain of the electric supply companies concerned.

We are continuing our negotiations with these authorities. In framing our scheme we have aimed at providing the most efficient and cheapest possible supply at the minimum cost, and, with a view to economy and to saving the Council capital expenditure, we have so drafted the Bill as to enable it to take advantage of any co-operation which existing undertakers in the proposed area may be prepared to give to the Council.

It is clear that if any such co-operation is forthcoming, as it would be given largely, at any rate, on capital already expended by such undertakers, it should lessen the Council's capital expenditure.

While we have not in our scheme counted upon any such co-operation, the saving to the Council in capital cost which might be effected thereby should not be disregarded in considering the scheme.

Financial Details of Scheme.

We have communicated with the Finance Committee in detail with reference to the scheme, and have placed before them all the facts relating thereto, in order to enable them to submit such report thereon to the Council as they may think fit.

Recommendations.

The recommendations which we now submit are :

(*a*) That the operation of standing order No. A 27, and of standing orders Nos. A 161 and 162, relating to the submission to the Council of schemes involving application to Parliament, be suspended on this occasion in order that the subjoined recommendation (*b*) may be considered.

(*b*) That authority be sought in the session of Parliament of 1906 to enable the Council to acquire compulsorily the site situated on the south bank of the River Thames at Battersea, shown in red colour on the plan submitted to the Highways Committee on Nov. 16, 1905, for the erection of an electricity generating station for the supply of electrical energy in bulk.

(*c*) That the London County Council (Electric Supply) Bill, 1906, submitted by the Parliamentary Committee, be approved; that the seal of the Council be affixed to a petition for leave to bring in the Bill; and that the Bill and petition, with any such necessary alterations (if any) in the Bill as the Parliamentary Committee may consider desirable, be deposited pursuant to the Standing Orders of Parliament.

T. B. NAPIER, Chairman of the Parliamentary Committee.
J. ALLEN BAKER, Chairman of the Highways Committee.

REPORT OF THE FINANCE COMMITTEE.

London County Council (Electricity Supply) Bill, 1906.

The Council will remember that in reporting on Nov. 14, 1905, on the proposal that the Council should seek powers in the next session of Parliament to supply electricity in bulk, we pointed out that we had not had before us any financial data to enable us to advise the Council as to the financial bearings of the proposal, and that it was, in our opinion, most desirable before the Council committed itself to the undertaking a definite scheme should be prepared and submitted.

In adopting the recommendations of the Highway Committee on this subject the Council added the following proviso : "Provided that before the introduction into Parliament of any Bill opportunity shall be afforded for full discussion in the Council of its provisions, especially as they affect the financial consequences of the scheme."

Since then a scheme has been prepared under the direction of the Highways Committee by the Council's officers, assisted by three well-known engineering experts, and we have been supplied with the details so far as they have been elaborated and with copies of the draft Bill, which the Council will be asked to approve.

We recognise that a great deal has been done by the Highways Committee in the limited time to furnish financial data, but we have not been afforded sufficient time to examine the estimates thoroughly, and as our report must be submitted on the 12th inst., we have confined ourselves to a consideration of the scheme from a broad financial point of view.

The two main financial considerations on which the Council will look to us for advice are (1) the estimate of capital outlay required, and (2) the possibility of the scheme being self-supporting.

1. *The Scheme of the Bill.*

We observe that the Bill is based upon the principle of supply to authorised undertakers and others throughout the area by agreement only, and that it is entirely of a permissive character. There will be no power for any authorised distributor or other person to demand a supply, and consequently no obligation on the Council to give it. The optional nature of the powers to be sought, if that option is maintained, may be held to lessen to a certain extent the financial risks which attend the undertaking.

The Bill appears to avoid competition with the existing undertakers (companies and local authorities) as regards the distribution of electricity, because it will not confer upon the Council the powers usually conferred on power companies enabling them to enter, under certain conditions, the districts of authorised distributors, or to bring pressure to bear upon such distributors to take a bulk supply. The result will be that the Council must look to existing distributors to push the development of the use of electricity for power purposes. We note, however, that Clause 35 of the Bill provides machinery which would enable manufacturers to obtain a supply through existing undertakers at cheaper prices than at present prevail, and would thus tend to assist the extension of the use of electricity.

Our attention has been directed to the extent to which powers of supply in the proposed area are already possessed and exercised by other bodies and companies. It seems that nearly the whole area is covered by local authorities or companies possessing provisional orders, and over a large part of the area bulk powers, practically identical with those proposed to be sought by the Council, have been granted by Parliament to certain power and electric companies.

The Council would not, therefore, possess any monopoly in the districts over which bulk powers are possessed by companies, but would have to meet the competition of those companies. In other districts, the Council will have no power to secure business except by coming to terms with the existing undertakers. In order to secure business, therefore, the Council must rely entirely on the cheapness of the price at which it can produce electricity. The significance of this fact, to which we refer again later on, will be apparent to the Council.

2. *Estimated Capital Outlay.*

The total capital powers sought by the Bill may be stated in round figures at £2,500,000. Details of this sum have been submitted to us. The expenditure of this amount is estimated to be spread over seven years to 1913. The amounts required in the first three years are estimated at

1907	£355 000
1908	545 000
1909	449,000

or £1,349,000 in all. The reduction of the proposed immediate capital outlay to these figures diminishes the objection which we feel to the increase in the Council's commitments on capital account, but the addition of £1,349,000 to the sums already required to be raised in the three years (1907-9) is a matter of important concern.

The establishment of a bulk undertaking by the Council for supplying the borough councils will, no doubt, reduce the amounts which these councils might otherwise require on loan for the extension of their generating plants, which sums would probably be borrowed from the Council and raised by the issue of London County consolidated stock. It is, however, necessary to point out that the erection of a large central bulk generating station involves the expenditure of a large amount of capital on transmission mains in order to convey the current to local centres, and that the net saving on capital outlay, although considerable, is reduced by this expenditure, the most important saving being made on working expenses. Moreover, the Council's bulk undertaking would deal with a much larger area than that covered by the undertakings of the metropolitan boroughs.

3. *Probable Financial Results of the Undertaking.*

We have had before us certain estimates of working costs and the probable growth of demand for electricity, but the figures are at present only of a provisional character, and we are advised that the publication of any estimates at the present stage might prejudice the Council's case before a committee of Parliament. We are consequently placed in a position of difficulty, because while we feel that the Council ought to have before it some means of judging as to the financial prospects of the scheme, we are unable for the reasons stated to submit any figures to the Council.

We propose to give further consideration to the estimates when they have been more fully worked out, and we may deem it necessary to report to the Council thereon at a later stage. It is essential, in our opinion, that whatever estimates are placed before Parliament in support of the Bill should have been thoroughly scrutinised by us, because such estimates practically commit the Council. It is true that before any liability is incurred and money voted by the Council under powers which may be obtained from Parliament estimates would have to be submitted, when the whole question could be thoroughly considered, but the Council would find itself, as it has done in other cases, committed in the main to the scheme and estimates already placed before Parliament. The Council will, therefore, see the necessity of the matter being thoroughly considered now.

While not in a position to make public at this stage any of the figures submitted to us, we may say that, from such consideration as we have been able to give to them, we anticipate that the Council would be able from one or more large central stations to generate electricity at a cheaper rate than it is now being produced at the small generating stations of most of the existing undertakers, and, moreover, that the Council, by

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working the scheme in conjunction with its tramway undertaking, would be in a favourable position for supplying energy in bulk and at a reasonable price. We cannot at present say whether the Council could supply at such low prices as would enable it to successfully compete for business with the large power and electric companies who possess powers of supply in bulk throughout a large part of the proposed area. This is, after all, the crucial question, because, as already pointed out, it does not appear that the Council will possess any monopoly, but will be mainly dependent for business, so far as we can see, upon its ability to sell at a price which would induce existing undertakers to take a supply from it. The selling price from time to time will depend upon a variety of considerations which at present are undetermined. A good deal will turn upon the load factor which can be obtained and the amount of support to be received from authorised undertakers. The price later on may be affected by the progress of knowledge in the methods of generating and transmitting electrical energy and the action of other companies and bodies, which cannot be foreseen.

The position which the Council will occupy in this matter has engaged our serious attention, and we cannot help thinking that the Council ought, before embarking capital in such an enterprise, to have some further security than it will apparently possess. We are not prepared at the moment to say what the nature of the security should be, but it would appear to lie in the direction of the Council making suitable and permanent arrangements with the existing undertakers. Having regard to all the contingencies and risks inseparable from an undertaking of this kind, we think that the Council will agree as to the expediency of seeking some security for its undertaking, particularly as we have not at present been supplied with definite information as to the amount of support which the Council is likely to receive.

Whatever conclusion may hereafter be arrived at as to the probable ultimate financial results of such an undertaking as the Council may obtain power to establish, we are of opinion that the Council must face the probability that during the early years the undertaking will show a deficiency which will have to be made good out of the rates, because from its nature some years must elapse before a sufficiently large amount of business can be secured to make the concern profitable.

4. *The Financial Provisions of the Bill.*

We have considered the purely financial provisions of the Bill, which, speaking generally, are, in our opinion, satisfactory. There are, however, four financial clauses on which the Council will desire to have our observations.

Clause 36 (2) of the Bill provides that the Council shall not be bound to commence payments into the sinking fund until the expiration of five years from the end of the financial year current at the passing of the Act. A period of seven years was allowed in the cases of the Holborn to Strand and Westminster improvements, but we concur in the proposal to ask for a postponement of five years only in the present case, and think that the assent of the Treasury may probably be obtained to this clause. We may point out that debt will have to be repaid, after payments to the sinking fund commence, in periods less than the usual by the number of years during which payments have been postponed. Thus capital expenditure, which would be repaid in 59 or 25 years in the ordinary way, will have to be repaid in 54 or 20 years after the expiration of the five years' postponement allowed.

Clause 42 provides that the Council may pay (to an amount not exceeding £105,000) out of borrowed money interest paid on capital during construction. This would be a novel power so far as the Council is concerned. We approached the Treasury with a similar proposal in connection with the Holborn to Strand Improvement in 1899, but their Lordships would not assent to it. We have, however, since our former report was before the Council, ascertained that there have been in recent years cases in which provincial corporations have obtained this power in the case of large water and dock undertakings which occupy many years in construction, and necessitate the payment of large sums of interest on capital before the undertakings produce any revenue. The views of the Treasury may consequently be somewhat modified, but the Council cannot rely upon obtaining this concession.

The Bill provides (Clause 39) for the creation of a reserve fund. No limit to the amount of the fund is fixed by the Bill, and it will be in the power of the Council to apply surplus revenue to build up an adequate reserve fund. Under Clause 38, which provides for the order in which revenue shall be applied, the provision of a reserve fund follows payment of working expenses and debt charges. Provision is then made for the repayment to the county fund of any deficiencies made good in previous years out of the county rate, but under the provisions of the Bill the Council is not bound to so repay the county fund in the first year in which a surplus is available, it being left open to the Council to use such surplus to form a reserve fund or to reduce prices. After deficiencies met out of the county rate have been made good the Council may, out of any surplus, take a sum not exceeding in any year 5 per cent. on the aggregate capital expenditure for the benefit of the London ratepayer, who, we may remind the Council, will, if the Bill passes in its present form, bear the whole financial risk of an undertaking dealing with an area over three times that of the county of London. Any surplus remaining after this 5 per cent. must be applied to reduction of charges, the Council being entitled to carry forward such balance on revenue account as is reasonably necessary.

The last clause to which we think attention should be called is Clause 43, which provides that the Council shall, after five years from commencing to supply from any generating station erected under the powers now sought, and each three years thereafter, fix the prices to be charged (other than those contained in any agreement or contract), so that, as far as practicable, no charge shall fall upon the county rate.

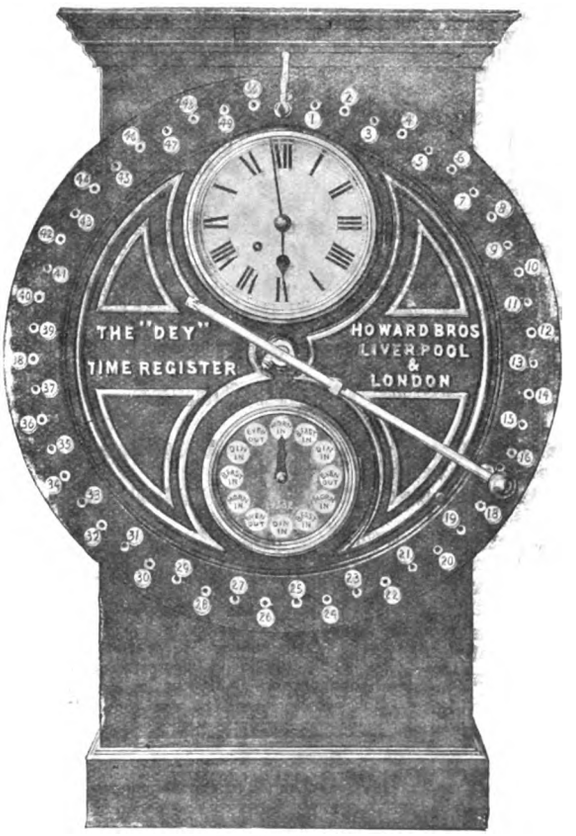
In conclusion, and looking to all the circumstances, we are impressed with the fact that financial risks are inseparable from an enterprise of this kind covering so large an area, and that if such risks mature, the burden will fall entirely on the ratepayers of London. Bearing this in mind, we are of opinion that if on the grounds of general policy the Council should finally decide to promote the Bill, every endeavour should be made to make arrangements with existing undertakers for the supply to them by the Council of electrical energy in bulk.

(Signed) WELBY, Chairman.

TRADE NOTICES AND NOVELTIES

The Dey Time Register.

Now that more attention is being given by employers of labour in this country to up-to-date methods, we need not apologise for referring again to the Dey time register, an excellent device for accomplishing its purpose. The chief feature of this machine is the weekly time and wages sheet, which is arranged to take the time of 50 employés, giving their numbers in numerical order with the whole of their "ingoings" and "outgoings" for the week on the line opposite their numbers, having extension columns for writing in the total number of hours worked, rate, amounts to pay, etc. These sheets can be ruled and printed to suit any requirements, giving "overtime in and out," and so forth, and are made in four sizes to fit their respective machines, for 50 hands, 100, 150, and 200. The weekly sheets require no transcribing, forming a complete time and wages book when filed in a guard book or cover. Daily sheets can also be used on the machine, but the weekly sheets are chiefly in demand. Further, an attachment can be fixed for the purpose of recording on cards the time spent by employés on particular jobs for the purpose of cost keeping; also for taking the time of messengers, carters, etc., on journeys. This attachment does not in any way interfere with the ordinary work of the machine for time-keeping, but has the advantage of time keeping and cost keeping on one machine. The latest form of this machine is entirely automatic and requires no attention for a week, the columns for "in" and



The Dey Time Register.

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"out" and from day to day being moved automatically. It is manufactured in England throughout by Messrs. Howard Bros., of 100c, Queen Victoria-street, London, E.C., and Liverpool, who have also recently introduced an automatic card machine for cost-keeping purposes which is very small and compact, requiring no attention for a week.

Catalogues, etc.

LUMINOUS ELECTRIC RADIATORS.—From Messrs. Baxendale and Co., Miller-street, Manchester, we have a list of their luminous electric radiators, including several entirely new designs.

STEAM PLANT.—We are indebted to Messrs. Mechan and Sons, Limited, Glasgow, for some pamphlets describing the "steam superheaters" of various types, "steam dryers," and "oil separators," which they manufacture under Prof. Watkinson's patents. The information given is both interesting and instructive, but cannot be dealt with in the space now at our disposal.

THE ELECTRICAL COMPANY'S PUBLICATIONS.—We have received copies of the following from the Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C.: Pamphlet No. 174, "Electricity in Shipbuilding Yards"; Leaflet No. 151/1, "How to Make Electric Light Cheaper by Means of Nernst Lamps"; Leaflet No. 191, "Region Small Arc Lamps"; Leaflet No. 194, "Small Motors."

HODGSON, WRIGHT, AND WOOD'S MANUFACTURES.—A number of lists are to hand from Messrs. Hodgson, Wright, and Wood, Century Works, Halifax, as follows: List No. 9 "main" and "battery charge and discharge" switches; List No. 10, "shunt-wound continuous-current protected motors"; List No. 11, "shunt or compound wound continuous current dynamos"; List No. 12, "shunt-wound continuous-current open-type motors"; List No. 13, "single," "two and three phase" motors fitted with ball bearings; List No. 14, "starting switches."

ANGOLD ARC LAMPS.—The General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., are just issuing a new booklet dealing with their Angold arc lamps and accessories. We notice the inclusion of a new pattern of lamp. This is of the twin-carbon type, and is suitable for indoor or outdoor lighting on high-voltage circuits, where lamps are required to run independently of each other. Mention may also be made here of a new pattern of balancing coil for use with alternating-current enclosed-type arc lamps. Prices have been reduced both for the lamps and accessories.

SHOWCARDS.—From the Simplex Steel Conduit Company, Limited, Westinghouse Building, London, W.C., we have received an artistically designed showcard giving a list of contracts where the company's material has been used during the first eight months of this year; also a small print of a large trade mark showcard, 21in. by 15in., which they are sending out to customers who require something for display purposes. The first-mentioned shows a record of work of which the company may well be proud. We understand they will be pleased to forward a copy to any of our readers who may like to have one.

APPOINTMENTS VACANT.

Electrical Engineer, Radcliffe Urban District Council. Salary, £150 to £172 per annum.

Assistant Lecturer and Demonstrator in Electrical Engineering, Leeds University. Salary, £175 a year.

Electrical Engineer, Pontypridd Urban District Council. Salary £91 per annum. Applications to the Clerk by Dec. 27.

Representative, South Wales district, for the sale of direct and alternating motors. Apply, Box F. Z., *Electrical Engineer* Office.

Shift Engineer, London station. Salary to commence, £2 per week. Applications to Box 574, Sell's Advertising Offices, London, E.C.

Junior Charge Engineer. Salary, 30s. per week, rising to 35s. Applications to the Borough Electrical Engineer, 335, High-street, Cheltenham.

NEW COMMITTEES.

The following additional committees have been appointed:

BACUP.—Electricity and Tramways—Aldermen Astley, Hardman, Hoyle, and Law; Councillors Mawdsley, Worwick, Green, and Greaves.

BERMONDSEY.—Electric Lighting—Councillor Pridman, chairman.

GILLINGHAM.—Electric Light and Baths—Councillor Holmes reappointed chairman.

HANLEY. — Electric Lighting — Alderman Costes, chairman; Councillor Schofield, vice-chairman; the Mayor; Aldermen Ellis, Hampton, Huntbach, O'Keefe, and Shirley; Councillors Bickley, Blackburn, Bratton, Jackson, J. Harvey, Kirkham, Mayer, Nuttall, H. B. Shirley, and Stanley.

HOVE.—Lighting—Alderman Clark; Councillors Abell, Bull, Davies, Genner, Mead, Nye, and Sayers.

YARMOUTH.—Electricity—Councillor Johnson, chairman; Councillor Nudd, mayor; Aldermen Mayo, Durrant, and Suffling; Councillors Arnott Bayfield, Beevor, Bellamy, Chamberlain, Freeman, Knights, Lawrance, Lee, Nightingale, Pitchers, and Traynier. Tramways—Alderman Arnold, chairman; the Mayor; Aldermen Mayo and Suffling; Councillors Arnott, Bayfield, Beevor, Grimble, W. H. Green, Johnson, Lawrance, Norfolk, Pitchers, Rushmer, F. J. W. Salmon, J. T. C. Salmon, and Tyrrell.

LEGAL INTELLIGENCE.

SWANSEA TELEPHONES.

An appeal is being heard by Lords Justices Vaughan-Williams, Stirling, and Cozens-Hardy by the National Telephone Co. from the judgment of Mr. Justice Buckley, who, in an action by the Mayor and Corporation of Swansea against the company to enforce the giving of "reasonable facilities for intercommunication" with their telephonic subscribers, held that the facilities offered by the company amounted to a refusal to give any facility at all within the meaning of the new Telegraphs Act of 1899.

The case for the company was that the Corporation demanded intercommunication in a way which would destroy both systems, and that it had offered to do the work in an efficient and economical manner, which would at the same time enable it to fulfil its obligations to its own subscribers. It was also argued that if Mr. Justice Buckley's decision were upheld, other corporations all over the country would start rival systems, and the business of the company would be ruined.

Mr. BUCKMASTER, K.C., who appeared for the Corporation of Swansea, said that the company had absolutely declined to allow the Corporation's subscribers to communicate with theirs except upon the terms that the Corporation should run from their central exchange at Swansea to each one of the company's sub-exchanges a new and totally independent route for the purpose of carrying all the messages that originated upon their system. They declined to allow the Corporation to use any part whatever of their junction lines or, as he understood it, their local sub-exchanges except for the purpose of putting in a wire.

Lord JUSTICE VAUGHAN-WILLIAMS pointed out that there was a demand on one side and an offer on the other, and the Court might come to the conclusion that both of the parties were wrong—that the Corporation had no right to ask for what they had asked, and that the offer of the Company was not sufficient.

Mr. BUCKMASTER said that if the Court held that the offer was not sufficient that would meet his point. The whole question was whether the company had refused to give proper facilities. That was all the Court had now to consider, though there might be further questions to be dealt with later. Everyone appreciated that this was not a case that stood by itself. It was one of the first cases in which corporations had been attempting to use the powers conferred upon them by the Act, and the conditions under which this communication was going to be made would affect not merely this Corporation, but corporations all over the kingdom that had obtained licenses. He could not help thinking that the case was being presented by the company in the interests of its shareholders, while the Act thought of the subscribers. What the company proposed was most unreasonable. It was quite clear that if the arrangement suggested by the company were adopted, the two systems would never come into communication. An obligation had been imposed by the Legislature on the company by reason of the fact that its monopoly had been extended, and the object of the Act was to provide that advantages should accrue to the public, and that it should not be possible for the company to withhold from the public the benefit of the use of its system simply because they had become members of another system. What the Act provided for was intercommunication of subscribers and not of systems. The company said that would make it difficult and would throw expense upon it, but the Act did not mind that. It only considered how it could best arrange that two sets of subscribers should get intercommunication. There was nothing unfair in that. It was said that the company's subscribers outnumbered those of the Corporation in the ratio of 1,500 to 700. If the company put its 1,500 subscribers into communication with the other 700, the Corporation would have to provide for just twice as much traffic as the company would, and if they had not made proper provision to take the increased traffic, they would have to do just twice as much work in the way of laying extra wires as the company would have to do.

Mr. ASTBURY, K.C., for the company, said that this was the first case that had come up for decision under the New Telegraphs Act, 1899, which gave a borough council the right under certain circumstances to compete with the National Telephone Co. The borough of Swansea had obtained a license until 1923, and had called upon the Telephone Co. to give what the Act called "reasonable facilities" for what was described as "restricted intercommunication." All that meant was, he submitted, that subscribers to one system should have an opportunity of communicating with the subscribers of the other, and not, as Mr. Justice Buckley held, that one system should be joined to the other. It was of extreme importance to the Telephone Co. that it should see that these facilities were given in such a way as would not disintegrate and ruin the system which was called upon to grant the facilities. The case was of vast importance to the company, for if Mr. Justice Buckley's construction of the Act was correct its business would, in the event of other claims of the same nature arising throughout the country, be lamentably disintegrated. There were many ways in which the facilities might be given, and all the Act said was that they should be reasonable. The Telephone Co. had taken the very best expert opinion, and claimed that by means of the facilities offered the work would be done efficiently and at the same time without unnecessary disturbance to its own system. The Corporation demanded intercommunication in a particular way and by particular means which the company said would destroy both systems. The learned judge had expressed himself strongly in favour of the Corporation's demand, and had gone so far as to hold that the facilities offered by the company amounted to a refusal to give any facilities at all within the meaning of the Act. If that decision stood, corporations all over the country would start telephone systems in rivalry with the company. That was

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what the company wanted to protect itself against. The company had 12 exchanges in Swansea and the Corporation now had five. The latter claimed that all they had to do was to bring a great bundle of cables up to the company's central exchange and demand that the company should put them on to the switchboards. Then the Corporation said if any of their subscribers wanted to telephone to any of the company's exchanges, the company would have to lay the necessary junctions and do the necessary work to take their messages through the central office. The company, on the other hand, said that the Corporation must carry their messages up to the switchboard to which their subscribers were connected.

The hearing was not concluded when we went to press.

BLACKPOOL-FLEETWOOD TRAMWAY RATING APPEAL.

In the King's Bench Division on Wednesday the case of the Blackpool and Fleetwood Tramroad Co. *v.* the Thornton Urban District Council was heard on the appeal from a decision of Quarter Sessions upholding a rate. In July, 1904, the Thornton Urban Council made a general rate, in which the appellants were rated at £706 on the tramway track in Cleveleys, £105 on a waiting-room, and £56 on an accumulator-house. The company appealed on the ground that they had been rated on the full annual value, whereas, as they contended, they were entitled to be rately on only one-fourth of the net annual value, the line being a railway. It was stated that the line was constructed wholly on land belonging to the company, and was hedged in from other land except where the line crossed the public roads. The appellants paid passenger duty, and they submitted that the line could only be worked as a railway. The justices were of opinion that the lands were not used as a railway within the meaning of Section 211 of the Public Health Act, 1875, and dismissed the appeal.

The LORD CHIEF JUSTICE said there was such a slight shade of difference between railways and tramways that it was sometimes difficult to distinguish them, but on the whole he was of opinion that the justices were right in this case, and that the appeal must, therefore, be dismissed with costs.

CARDIFF TRAM COLLISION.

At Cardiff County Court on Friday last (before Judge Owen and a jury) an action was heard in which Joseph Edward Coakley claimed £50 from the Cardiff Corporation in respect of injuries sustained by his little girl, who was knocked down by an electric car in Cathays in September last.

In the course of the evidence the car was said to have been running at top speed.

"What sort of speed is that?" queried his Honour. "There is a limit to everything—even to the speed of a motorcar."

Plaintiff's case, as represented by counsel and witnesses, was that the child came to grief as she was running across the tramway line in Orwys-road with some little boys, one of whom was her brother, to pick up a piece of coal. The injuries sustained were bruises on the left leg and left side of the head. A medical man said the child's clothes were torn and cut. There was a wound on the thigh 4in. or 5in. long. At one time it was a question whether the injuries would be permanent, but the little one had, happily, recovered.

It was alleged that the car pulled up almost immediately, and in defence it was submitted there was no case to go to the jury, and that there was contributory negligence on the child's part and on the part of the parents.

JAMES LENTHALL, the driver, denied the top-speed statement, and said he took every precaution—rang the bell, and the car was at once pulled up. The child was "impelled" in the direction in which she was going. She passed in front of the car, and was between the rails when she was knocked down on the off side. The girl showed no indication of making for the track, and were he to stop for every child he would never make any progress.

After more evidence HIS HONOUR said this was the first action against the city of Cardiff he had had the honour to try. The Corporation had no further right beyond laying the tramways to the King's highway. If an old woman sat in front of a car she was entitled to do it, and if the car ran over her the only remedy was to summon her for obstruction. His Honour said the question was a simple one, and put it to the jury whether the driver did all that a prudent man should have done.

The jury retired, and on their return brought in a verdict for the plaintiff for £50, the amount claimed.

CLAIMS AGAINST THE MERTHYR ELECTRIC TRACTION CO.

Two claims for damages were brought against the Merthyr Electric Traction Co. at Merthyr County Court on Friday last. In the first case the plaintiff, Thomas Thomas, sought to be compensated for damage done to a pony and cart, which were run into on the Brecon road by an electric car on July 12 last. His Honour found for the defendants, holding that there had been no negligence.

The plaintiff in the second case was a collier's boy, named Joshua Price, who claimed £5 in respect of injuries sustained through being struck with the handle of the ratchet brake whilst boarding a workmen's car at Pontmorlais on June 9, and judgment was given for the plaintiff for the amount claimed, with costs.

TELEPHONE DISPUTE.

At Brighton County Court on Friday last, before his Honour Judge Scully, the Corporation of Brighton sued Mr. S. G. Watson, surgeon, for £13. 14s. 7d. for fees, etc., in connection with the Corporation telephone service, incurred between June 1, 1904, and April 13, 1905.

The assistant manager to the Brighton Corporation telephone department, was first called on behalf of the plaintiffs, and he stated that on July 8, 1903, defendant sent in an application form for a private line.

The defence objected to the document being put in submitting that it was a memorandum containing all the terms of the contract, and ought, therefore, to have been stamped, and that, being unstamped, it could not be accepted by his Honour.

His Honour held that the document was not one that required a stamp.

Every item of the claim was then admitted, with the exception of one of £3. 5s. 6d. for moving the telephone from Islingword-road to Elm-grove.

Defendant explained that the Corporation would not accept less than the full amount, although he offered to pay all other charges except the disputed item.

Evidence as to the correctness of the disputed charge having been given, and Mr. Gardner having stated that the Corporation charged cost price for the work and materials, his Honour gave judgment for the plaintiffs with costs.

TELEPHONE CONTRACT.

The National Telephone Co. sued Mr. Amatt at the Portsmouth County Court on the 7th inst. for £3 for a year's contract for a two-party line telephone, and 2s. 6d. for the contract stamp and 8½. for postal facilities. Defendant said he did not make payment in advance because he did not receive plaintiffs' letters in time, and he was much inconvenienced at having the telephone suddenly cut off. Some stringent strictures were made by his Honour Judge Gye on the terms of the contract, and the company came in for much criticism. Judgment was given for plaintiffs for £3, and an order for 10s. a month was made.

COMPANIES' MEETINGS AND REPORTS

ARON ELECTRICITY METER.

The eighth ordinary general meeting of this Company was held on the 8th inst. at Winchester House under the presidency of Mr. H. Hirst, M.I.E.E., the chairman of the Company.

In moving the adoption of the report (a copy of which appeared in our last week's issue), the CHAIRMAN said the stock of meters, clocks, and meter parts, etc., stood over £6,000. That was due to two reasons: firstly, they had done an increased business; secondly, this stock had increased, particularly in their German business. There had been, during the last few months, serious labour troubles going on in Germany, and Prof. Aron did not know which industry might next be affected, and as he was drawing his supplies from various industries, he thought it wise, so that the Company should not suffer more than was necessary, to fill up his stock to the best of his ability. The meter business, as well as the electrical business generally, was (said the chairman) in a constant state of evolution, and it would be no use sitting tight on old patents if they did not constantly employ their staff, and wish to learn what others were doing and try to get ahead of them. The results of the fairly satisfactory report were due principally to the business carried on in Berlin, at the factory in Schweidnitz, and at the Company's branch in Vienna. Mr. Hirst said that in Germany Prof. Aron had worked very hard and very economically; he had used his influence even to the extent of obtaining orders by travelling a great deal himself. They had sold in Germany more meters than at any time during the existence of the Company. At Schweidnitz they had a most careful manager, who, by great care and economy had enabled the factory at Schweidnitz to make such reductions as were necessary in order to counteract the cheaper price at which they had to sell the meters last year. At Vienna for a year or two the business was receding, but was now recuperating. He told the shareholders that the directors had spent a lot of money to produce cheap meters, and he said that their small meter was finding favour. The business generally done in this country had been in connection with meters and apparatus where the price was not so important an object—double tariff meters, meters for standardising stations, standard instruments, and traction meters. He was particularly glad to say that some railway companies and traction companies were beginning to appreciate the importance of putting meters on their engines and cars in order to check the energy required for each engine or car, and to check the drivers as against each other. If that once finds popular favour, he thought that their meter was the only one that would give satisfaction. Continuing, he said: "We are not depending upon one type only, and in that direction we wish to continue. I do not even mind stating, although I am not particularly authorised, that we are at present studying petrol traction and the development of autocars, for the purpose of seeing whether we cannot find a useful outlet for our unemployed capital, on which we have sat tight up to the present, until our original business is again in a healthy state. We are prepared to spend a reasonable amount of money in this direction, and we hope next year to be able to put something tangible before you. If we have no results, we shall not be any the worse off."

Sir JAMES PENDER, Bart., seconded the motion.

The motion was carried unanimously.

It was resolved that the dividend of 4½ per cent. on account of preference dividend in arrear, as recommended by the directors, be paid.

FRASER AND CHALMERS.

The ordinary general meeting of the shareholders of this Company was held on the 11th inst. in London. The chairman, Sir JULIUS

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WERNHER, Bart., in moving the adoption of the report (copy of which appeared in our issue of the 1st inst.) regretted that the loss of revenue from the American company prevented the payment of the same dividend as the previous year. The reason for the falling off in the American business was, he explained, that the business had undergone a change which required large and extensive modifications, which had to be met out of the profits. The business at Erith has been as satisfactory as it was the year before. The Chairman said they had never been more busy than in the last six months of the year under review, and that they had been equally busy in the first half of the current year, while the prospects for the remaining portion of the year in regard to business are equally good. The fall in revenue from the American company amounted to nearly 4 per cent., but the directors decided not to reduce the dividend by 4 per cent., but to pay only 3 per cent. less. Continuing, Sir Julius Wernher said he did not consider that there was anything very alarming in that, because the large profits which were carried forward were real profits made on the business done in the past. The directors had not distributed by way of dividend the profits in full, as their idea had always been to keep a certain proportion in hand in order that they might be in a position to equalise the dividends should ever a shortfall arise. Another consideration which decided the directors to depart from their very conservative methods and to pay £2,000 out of the carry forward, was that the prospects of the current year were decidedly encouraging, so that they did not think that that encroachment on the carry forward would affect the next dividend.

Mr. R. ENGLISH seconded the resolution, which was then put to the meeting and carried unanimously.

A final dividend of 4 per cent., making 7 per cent. for the year, on the ordinary shares was declared; the retiring directors and auditors were re-elected; and votes of thanks were passed to the chairman, directors, manager, agents, and the staff of the Company for their services.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The report of this Company for the year ended July 31, 1905, to be submitted at the meeting on the 18th inst., shows a gross profit of £113,409. After providing for debenture and loan interest, depreciation, and the special expenditure enumerated below, a loss of £15,407. 10s. 10d. is shown after deducting the balance of £2,810 brought forward from last year. The special disbursements referred to are: exceptional expenditure under the Mersey railway contract, £43,550; balance of exhibition and sundry expenditures brought forward on July 31, 1904, now written off, £5,340; proportion applicable to the current year of excess cost and experimental expenditure on manufacture of new types of apparatus during that period, £25 000. Following the course indicated by the directors in last year's report, care has been exercised to have the works equipment efficiently maintained, and, in addition, a very considerable sum has been charged to profit and loss account for the maintenance of large machine tools and machinery, while all patterns and drawings, together with patents acquired, have equally been charged to profit and loss account. In view of this, the directors are of opinion that the sum of £16,500 provided for depreciation, which includes £5 000 in respect of the buildings themselves, is adequate. The balance of £225,000 of 4 per cent. mortgage debenture stock available for issue has been sold to the American Westinghouse Co., to be taken at 95 per cent. in the course of the year 1906. The volume of output from the works during the year under review was considerably in excess of that for the previous year, and a large saving in manufacturing costs and in selling and general expenses was effected. Competition is still very keen, and seriously affects the Company's business and outlook, but it is hoped by the directors that, with the revival in trade, this condition may improve.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The report of this Company for the year ended Sept. 30, 1905, to be presented at the meeting on the 19th inst., shows, after provision for doubtful debts, a net profit of £51,729. Adding £53 274 brought forward, and deducting £12 500 interim dividend paid in June, there remains a disposable balance of £92,503. The directors recommend a dividend of 15s. a share, making a total payment of 10 per cent. for the year, and leaving £55,003 to be carried forward. The general business of the Company shows an increase compared with last year, and although the price of raw material is still very high, the fluctuations have not been great, and therefore better prices have been obtained for manufactured goods. The cable department, besides having other smaller work in hand, is at present engaged in the manufacture of 1 300 nautical miles of submarine telegraph cable, which will be laid by the Company's cable steamer "Silvertown" between Shanghai and Manilla in March next. The "Dacia" and "Buccaneer" have been employed in cable repairing work during the year, and the latter is at present under charter. The works at Silvertown and Persan have been maintained in their usual state of efficiency, but considerable expenditure must still be made at Persan to provide for the economical production of goods for the French market.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING

The report of this Company for the year ended Sept. 30 last, to be submitted to the meeting on the 20th inst., states that traffic receipts show a reduction of £2,924 and the sale of electricity an increase of £490. The directors regret that the profits have only enabled them to pay the preference dividend to March 1, 1905, and they have carried forward the balance of revenue, £1,047. Two accidents took place during the year. The Company was fully insured against third-party risks, and therefore lost nothing by personal claims, but the accidents had a detrimental effect on the traffic receipts. Acting upon the suggestion contained in the report of Colonel von Donop upon the accident at Madeira Hill last August, the Company have made arrangements for exchanging drivers before arriving at Madeira Hill and the other steep gradients, so that in future none but their most experienced men will operate the cars on these parts of the system. The sum of £418, being the cost incurred in the unsuccessful promotion of a lighting order for Ramsgate, has been charged against revenue.

BRITISH ELECTRIC TRACTION.

The directors in their interim report state that since the date of the last report about 17½ miles of new or reconstructed tramways or light railways have been opened for traffic by electric traction, and the Bombay horse tramways, of about 17 miles, have been added to the list of associated undertakings. The total mileage of tramways, railways, and omnibus routes is now 439 miles, and the total traffic receipts of all the associated undertakings for the current year are estimated at £1,400,000, as compared with £1,254,061 for 1904. Electrical lines are now under construction at Penge and Croydon to Mitcham, near London, at Cavehill, near Belfast, in Middlesex (forming part of the large system of the Metropolitan Electric Tramways Co.), and in the Birmingham district. In spite of the fact that the Company has sold its interests in several undertakings to local authorities and others, upon which the return for 1904 was about £12,000, the directors expect that the aggregate return for the current year upon the Company's investments will be maintained. The directors anticipate that satisfactory profits will be made by the Company before the closing of the books on March 31 next, but, as the substantial profit receivable in shares of the Bombay Electric Supply and Tramways Co. has not actually been received at this date, the directors prefer not to declare an interim dividend on the ordinary shares for the present half-year. The Bombay company has successfully raised £600 000 in debenture stock and £600,000 in 6 per cent. preference shares, thus enabling this Company to meet its main obligations in regard to this enterprise. Energetic steps are being taken to carry out the conversion of the tramways to electric traction and to enable the Bombay company to deal effectively with the supply of electric light and power, for which there will be a large demand. The volume of business carried out by the Brush Electrical Engineering Co. during the current year shows a considerable increase. The rolling-stock and general engineering departments are expected to show improved returns, but owing to keen competition the margin of profit upon the manufacture of electrical machinery is small. The Brush Co. is largely interested in the tube railway authorised by Parliament to be constructed from the Marble Arch along the Edgware-road, but considerable uncertainty has prevailed in regard to the traffic question in London pending the issue of the report of the Royal Commission. In the meantime the construction has not been proceeded with. A further Bill will be promoted in the ensuing session, for which notice has been given, for an extension of time for construction, and also to authorise, as recommended by the Royal Commission, the construction of an underground railway from the Marble Arch to Victoria, forming an extension of the authorised Edgware-road tube railway.

NEW COMPANIES REGISTERED.

A T. Steel, Limited.—Capital, £10,000. Object: to carry on the business of electrical, automobile, and general engineers. Registered office: 27, Regent-street, Cheltenham.

British United Engineering Co., Limited.—Capital, £10,000. Object: to carry on the business of mechanical and electrical engineers, etc. Registered office: 175, Piccadilly, W.

National Radiator Co., Limited.—Capital, £50,000. Object: to carry on the business of manufacturers of radiators, boilers, and heating apparatus of all kinds, electrical and water supply engineers, etc.

Santa Rosa Rubber and Prospecting Syndicate, Limited.—Capital, £5 000. Object: to acquire any estates suitable for the production of rubber in Brazil or elsewhere. Registered office: 69, Moorgate street, E.C.

Traction Unification, Limited.—Capital, £10,000. Object: to undertake any business relating to the application of natural, animal, or mechanical power, or to traction, haulage, conveyance or other similar operations.

Liberian Rubber Corporation, Limited.—Capital, £270,000. Object: to adopt agreements with the Consolidated Rubber Syndicate, to acquire, cultivate and turn to account lands in the republic of Liberia or elsewhere, to plant, use, and grow rubber, etc.

British, Foreign, and Colonial Automatic Light Controlling Co, Limited.—Capital, £100,000. Object: to acquire patents, licenses, concessions; to carry on the business of mechanical electrical engineers, etc. Registered office: 55 Broad-street, Bristol.

London and General Power Supply Co., Limited.—Capital, £60,000. Object: to carry on the business of an electrical undertaking and in particular to provide, in the first instance, the financial necessities of the St. Neot's Electric Power Bill through Parliament.

Mundakayam Valley Rubber Co, Limited.—Capital, £15,000. Object: to acquire any lands, estates, buildings, factories, works, rights, and easements in Ceylon, India, the Straits Settlements, or elsewhere, and to carry on the business of cultivators of and dealers in indiarubber, etc.

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Lens Lamp Co, Limited.—Capital, £60,000. Object: to take over the business carried on at 150, King's Cross-road, London, as the Bohm Lens Lamp Co.; to adopt an agreement with B.N.C. Limited, and to carry on the business of lamp manufacturers, glassblowers, electricians, etc. Registered office: 7, Great St. Helens, E.C.

Shanghai Electric Construction Co, Limited.—Capital, £320,000. Object: to enter into contracts with Messrs. Bruce Peebles and Co. and Dent Bros. and Co. relating to the acquisition by this company of the benefit of two contracts between the Council for the Foreign Community of Shanghai and Bruce Peebles and Co., relating to the construction and working of certain electric tramway lines in the foreign settlement of Shanghai, etc.

Liens Registered.

N.S. Electric Storage Co., Limited, Greenwich.—Lien registered Dec. 4 for £4,000 6 per cent. debentures. No trustees. Charged on the undertaking and all the property and assets, present and future.

Perth Electric Tramways, Limited, London, E.C.—Lien registered Dec. 6 for £600 6 per cent. debentures, part of £50,000. Amount previously issued, £39,000. Charged on the undertaking, property, and uncalled capital, subject to first debenture stock for £200,000.

Musselburgh and District Electric Light and Traction Co., Limited.—A trust deed dated Nov. 13, 1905, to secure £60,000 debentures, has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Trustees: Sir Nathaniel Nathan, Kt., The Cottage, Edenbridge; and M. R. Pryor, 48, Leadenhall-street, E.C.

PERSONAL.

Mr. J. C. Howell has been engaged as electrical adviser to Llanelly for a period of five years at a fixed salary.

The Nelson Town Council have appointed Mr. Murray Bolton Henry engineer and tramways manager at a salary of £200 per annum.

Mr. Henry Joseph, A.M.I.E.E., is leaving the Folkestone Electricity Supply Co., Hythe, in order to take up the post of engineer and manager to the Melton Mowbray Electric Light Co.

It is reported that Mr. Harry Richardson, the electrical engineer at Dundee, has been offered an appointment ranking high in his profession by one of the great electrical engineering firms in England.

Mr. D. F. Gorrie (son of D. Gorrie, Esq., head of the well-known firm of D. Gorrie and Sons, laundry and dyeworks engineers and coppersmiths, Perth) has been appointed chief draughtsman to the Industrial Engineering Co., Hyde, Manchester.

We learn that Mr. Bertram S. Giles, M.I.E.E., has been appointed by Messrs. Mather and Platt chief representative for London and the South of England for their electrical and hydraulic departments. Mr. Giles was previously employed for nearly 17 years by Messrs. Mather and Platt at their Salford Ironworks.

We are informed that Mr. John Cowan has resigned the managing directorship of the Stirling Boiler Co., of Motherwell and 25, Victoria-street, Westminster. The directors have appointed Mr. E. G. Constantine, A.M.I.C.E., M.I.Mech.E., of Manchester, to be managing director, and he will enter upon his duties at Motherwell on Jan. 1. Mr. Cowan still retains his interest in the company, and will continue to be chairman of the directors.

Mr. Gilbert C. Vyle, A.M.I.E.E., mechanical and electrical engineer, has resigned his post as works manager and assistant to the general manager of the telephone department of the General Electric Co.'s works at Salford, and has established himself at 14, Ridgefield, Manchester, as a consulting engineer for telephones and all systems of electric signalling. He is also specialising in works organisation and the manufacturing details necessary for the economic production of light and intricate mechanical and electrical apparatus.

Mr. Morton Beales was on Saturday evening, Dec. 2, most kindly entertained at a farewell dinner given by his friends at the British Westinghouse Co. upon his resigning his position of district office manager with that company in order to take up the position of manager to Messrs. Bruce Peebles and Co. Mr. Beales had been connected with the Westinghouse Co. for the last three years, and previous to that he was commercial engineer to Messrs. J. G. White and Co., having resigned his position with the Ferranti Co., on whose staff he had been for nearly 10 years. His address will be 1, London Wall-buildings, the new offices of Messrs. Bruce Peebles and Co.

On Saturday last the members of the Robertson private fire brigade held their second annual dinner at the Brook Green Hotel, when a very enjoyable evening was spent. Mr. Wilson (the works manager) was in the chair, and Mr. Driver (the assistant manager and superintendent of the fire brigade) occupied the vice-chair. After dinner the evening's entertainment took the form of a smoking concert, during which several toasts were proposed. Mr. Wilson said that the members of the fire brigade were recognised by the firm to be the most trusted of their employés. He thought that at this year's London private fire brigade competition they had missed carrying off the championship cup through their over-confidence, although they were to be congratulated on taking away one first and two second prizes. Mr. Rushworth, of Merryweather's (chairman of the London Private Fire Brigades' Association), replied on behalf of the visitors.

The annual staff dinner of the Portsmouth Corporation telephone department, which took place on Friday evening at the Clarence Hotel, Albert-road, proved a successful and enjoyable function. About 60 members and friends attended. Mr. C. M. Gardner (manager) presided, and apologised for the absence of Councillors W. T. Dittman, H. R. Pink, and J. Timpson, the consulting engineer (Mr. A. R. Bennett) and Mr. M. T. Maidment. "The Staff of the Portsmouth Corporation Telephone Department" was proposed by Mr. Harding and responded to by the chairman, who spoke highly of the individual and collective efforts of the officials connected with the undertaking. Mr. J. Teasdale, chief clerk, also replied, and said he believed the success of the undertaking was due in no small measure to the unflagging devotion and skill of the manager. He also referred to the admirable services rendered to the department by Messrs. W. J. Knox (outside superintendent), D. Macintosh (inside superintendent), T. H. Hillard (wayleave officer), and the Misses Paul and Bennett.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Swindon.—The Electricity and Tramways Department require tenders for three double-deck cars. Tenders by Dec. 19.

Heckmondwike.—The District Council are about to invite tenders for the installation of a plant for purifying the water for boiler purposes.

Grimsby.—The Corporation require tenders for contracts contained in Specifications No. 35 39 and 43-45, for electrical plant, cables, and buildings. Tenders by Jan. 5, 1906.

Madrid.—The Public Works Department require tenders for a concession to construct and work an electric tramway between Santander and Astillero. Guarantee, 8,195 pesetas. Tenders by Jan. 30, 1906.

Manchester.—Tenders are required for transformers and switchboards. Specifications may be obtained on payment of £1. 1s. (returnable) from the electricity department of the Corporation. Tenders by Dec. 19.

Launceston (Tasmania).—Tenders are invited for the supply of 500 or more electric meters and for maximum demand indicators. Tenders to Mr. C. W. Rocher, town clerk, Town Hall, Launceston, Tasmania, by 12 noon on Jan. 15.

Sofia (Bulgaria).—Tenders are invited for the electric lighting of the Government Cadet School. Tenders by Jan. 19. Offers must be addressed in the Bulgarian language and be accompanied by a deposit of 5 per cent. of the amount of the tender.

Derby.—The Tramways Committee invite tenders for the supply and delivery of materials and construction of works in connection with the conversion of existing single line into double line from Deadman's-lane to Navigation Bridge. Tenders to the Town Clerk by 9 a.m. on Dec. 19.

Spain.—The *Gaceta de Madrid* contains a notice inviting tenders, which will be opened at noon on Jan. 30 at the Directorate-General of Public Works, Madrid, for the concession of an electric tramway between Santander and Astillero. A deposit of about £208 is required to qualify any tender.

Brussels.—Tenders are required for the electric lighting of the marine hospital. Conditions may be obtained from the Secrétaire général de l'administration des hospices et secours de la ville de Bruxelles, Boulevard du Jardin botanique, hôpital St. Jean, Brussels. Tenders by Jan. 5, 1906.

Castlerea.—The Rural District Council invite tenders for the construction of works for lighting the town of Ballaghaderreen: (1) builders' work; (2) hydraulic turbine plant; (3) electrical work. Specifications and particulars may be had from Mr. C. Mulvany, M.I.C.E., Engineer's Office, Athlone, on payment of £1 as a deposit, returnable after receipt of bona fide tender. Tenders by Dec. 23.

Southport.—Tenders are to be obtained by the Town Council for the supply of a battery of accumulators and a booster to be worked in connection with the traction sets; a shaping machine is to be purchased for the workshop; and the electrical engineer has been instructed to rewind the field magnets of three alternators as soon as convenient, and to provide an atmospheric exhaust to the No. 3 traction set.

RESULTS OF TENDERS.

Burslem.—The tender of E. M. Evans and Co., at £104. 17s., has been accepted for fitting the St. John's Market for electric light.

Oulton Broad.—The Urban District Council have accepted the tender of the Oulton Broad Electricity Co., at £4. 2s., for installing the electric light in the Council room.

Tonbridge.—The Urban District Council have accepted the tender of the Rhodes Electrical Manufacturing Co., of 70, Bishopsgate-street Within, London, E.C., for the supply of motors.

Stafford.—The Town Council have accepted the tender of Baxendale and Co., Manchester, for the supply of wrought-iron tubes and fittings for the ensuing 12 months, for the Electricity Committee.

London County Council.—The tender of C. Wall Limited London, for erection of car-shed at Poplar required in connection with the electrical working of the first section of the northern tramways, at £29,006, has been recommended for acceptance.

Larne (Ireland).—The Urban District Council have accepted the tender of the Larne Electric Light Works, Suffolk House, Laurence Pountney-hill, Cannon-street, E.C., at £450, for the lighting of the public streets and roads of Larne for three years.

Birkenhead.—The tender of A. Reyrolle and Co. has been accepted for the supply and delivery of motor starters in accordance with the specification of Mr. Wm. Bates, A.M.I.C.E., borough electrical engineer, Birkenhead, during the period of 12 months commencing Jan. 1, 1906.

Pembroke.—The London Electric Firm, Croydon, have received an order from W. Lucy and Co., of Oxford, for 45 complete sets of their "one working part" arc lamp lowering gear for the street-lighting of Pembroke, in Ireland, the consulting engineers being Messrs. R. Hammond and Son.

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Salford.—The tender of the Buxton Lime Firms Co. has been accepted for the supply of the limestone chippings required in connection with the laying of cables across the David Lewis recreation ground, delivered at the Ordsall-lane railway siding, at the following prices: 1½in. chippings at 4s. 7d. per ton, and ¼in. chippings at 6s. 6d. per ton.

Contracts Closed.—Portland Coaling Depot: the contract for conduits, feeder and arc lighting cables, underground boxes, and lamp pillars has been placed by H.M. Admiralty with Johnson and Phillips, of Old Charlton, Kent. **East Indian Railway Co.**: the company have accepted the tender of Johnson and Phillips for the supply of motors, transformers, and complete electrical plant for Lillooah.

A.B.P. Accumulators.—The A.B.P. Accumulator Co., Parkfield Works Stockton-on-Tees, have booked the following orders for their S type of cells: 480 cells, 13 plates, for Dumbarton; 25 5 ditto, Derby; 55 17 ditto, Oxford; 110 25 ditto, Croydon; and 54 9 ditto, Tain, N.B.; also 54 cells, 23 plate, OS type, Ealing; 54 sections, renewals, Newcastle; and 108 cells, 7-plate, L type, South Africa.

Clacton.—The Urban District Council have accepted the following tenders in connection with the electric power station: Davey, Paxman, and Co., horizontal two-cylinder engines with Parker dynamos, £3,676; Spagnoletti, switchboard, £600; Johnson and Phillips, cables, £4 098 11s. 9d.; D.P. Battery Co., accumulators, £1,450. The tender of Mr. J. McKay for buildings, at £2 743, subject to certain modifications being made in the specification, has also been accepted.

London County Council.—The following tenders have been received for supply of conductor tee rails, for the London County Council:—

Frodingham Iron and Steel Co., Frodingham, near Doncaster*	£8 250	0	0
Bolckow, Vaughan, and Co., Middlesbrough	8 550	0	0
P. and W. MacLellan, Glasgow	8,612	10	0
Steel, Peech, and Tozer, Sheffield	9,050	0	0

* Recommended for acceptance.

BUSINESS NOTES.

TRACTION.

Dundee.—The official inspection of the overhead equipment for the new tramways took place yesterday.

Salford.—A sub-committee will consider a readjustment of tramway fares between Salford and Pendleton.

Batley.—The local tradesmen are agitating in favour of continuing the running of cars from Birstall into Batley market on Saturday nights.

Liverpool.—At a meeting of the Council an amendment to the minutes of the Trams Committee for a reduced Sunday car service was rejected.

Leicester.—The annual supper and concert in connection with the Corporation Tramways Employés' Sick Benefit Society was held on the 12th inst.

Chesterfield.—The chairman of the Tramways Committee has informed the Council that the annual report of the committee will be presented in March.

Hythe.—By a large majority a town meeting has decided for a system of trams to be run through High street instead of another route that had been proposed.

Poole.—A large meeting of the ratepayers was recently held, when a protest was raised against the proposal to erect a bridge at Sandbanks in connection with a proposed light railway.

West Ham.—Notice was given of a resolution, to be moved at the meeting of the Council on Tuesday, that 30 of the Council's tramcars be fitted with covered tops as an experiment.

Edinburgh.—The Kingsland Electric Traction Co., we understand, are prepared to experimentally electrify the Mound route on the stud system, provided the sanction of the lessees is obtained.

Fareham.—Another trial run with the new cars was held last week and passed off very successfully. Though no date has yet been fixed for the formal opening, it is stated that it will take place before Christmas.

Islington.—The London County Council propose to proceed as rapidly as possible with the electrification of the tramways between Aldwych and the Angel, and the reconstruction of the Islington tramways.

Swindon.—It was announced at the meeting of the Town Council that the radial type of car had been adopted because it would carry 20 per cent. more passengers. The covering of the car-shed will cost about £300.

Bradford.—When an electric car was passing down Trunciffe, Wibsey, a man was crossing the road. He failed to get past before the car was upon him, and he was knocked down and received very serious injuries.

Northwich.—The Urban District Council have resolved to oppose the application of the promoters of the Warrington-Northwich Light Railway for an extension of time wherein to acquire lands for the construction of the railway.

Leigh.—The Council have appointed a sub committee to consider and report as to whether the tramways authorised by the Act, 1903, should be constructed with a view to their being worked by the Corporation or leased to a company.

Coventry.—A Board of Trade inquiry will be held respecting the complaints made by occupiers of premises in Smithford-street as to the tramway traffic through the street, and also concerning the proposed method of minimising the causes of complaint.

Bath.—The new Midland bridge was opened on Tuesday, the 12th inst., by Alderman Taylor, chairman of the Electric Traction Committee. The bridge is of fine proportions, and supersedes a smaller one. The electric tramway company contributed £11,000 towards the cost.

Dunfermline.—At a meeting of the Town Council a motion to take a *plébiscite* of the ratepayers to ascertain if they were in favour of municipalising the tramways, before the Council give consent to the Scottish Electric Traction Co. applying for a provisional order, was rejected.

Hastings.—A controversy is being carried on in the local Press relative to the merits of the overhead trolley and underground conduit systems of electric traction. It will be remembered that the tramways company are promoting a Bill which is for the erection of overhead equipment.

Paisley.—At a meeting of the Council on Wednesday it was resolved that the Council should appeal to the Board of Trade against the Paisley District Tramways Co. ceasing to run cars from the east to the west end of the town, and also having stages shorter than allowed by Act of Parliament.

Perth.—The Town Council have resolved to erect shelters at the tramway termini at Stone, Cherrybank, Craigie, and Dunkeld-road, some of the old horse cars to be converted for this purpose. The Town Council have adopted the Tramway Committee's recommendation for a reduction of children's fares.

Huddersfield.—At a specially convened meeting of the Town Council it was resolved to promote a Bill in Parliament to authorise the construction by the Corporation of further tramways in the borough, and to enable the Corporation to maintain and work such tramways as part of their tramway system.

Kingston-on-Thames.—The Town Council have postponed until Dec. 19 the consideration of the report of the Highways Committee in regard to the non-compliance of the London United Tramways Co. with the requirements of the committee, and of the question as to the institution of legal proceedings against the company.

Wigan.—In moving the confirmation of the minutes of the Electric Lighting and Tramways Committee at the last Council meeting, the chairman said the proprietors of the Horwich tramways had agreed to sell to the Corporation the stretch of line extending from the Wheat Sheaf in Standish to the Oak Tree in Coppull for £27,000.

Southport.—The Council have decided to discontinue the service of cars between Curzon-road and Ash-lane. There is now a 10 minutes' in lieu of a 12 minutes' service run on the inner circle route, and the following additional fares are now charged: between Blowick and Curzon-road, 2d.; between Curzon-road and St. Luke's-road, 1½d.

Burslem.—The tramways company have refused to accede to the request of the Corporation for the introduction of ½d. car stages. With regard to the proposed joint conference with Stoke with reference to complaints concerning cars, the Council have adjourned the conference in order to give the tramway company time to make the promised improvements.

East Ham.—At a meeting of the East Ham Council it was reported that the North Metropolitan Tramways Co. had intimated that they were prepared to accept £23,000 for their lines and depôt in Romford-road, East Ham, provided the Council undertake to complete the purchase before Jan. 31 next. It was decided that an offer of an amount be made to the tramway company.

Musselburgh.—Musselburgh and District Electric Tramways Co. have arranged a new set of fares for their system, which will take effect on and after New Year's Day. The all-the-way fare, 2d. for a three-mile run, will remain in force, but the intermediate stages, for which ½d., 1d., and 1½d. are charged, are lengthened, 1½-mile stages being given for 1d., and two-mile stages for 1½d.

Birkenhead.—It was stated at the last Council meeting that an accelerated traffic in the afternoon on the Oxton and Claughton Circle routes had been justified by the increased takings, but that there was no necessity for a faster service in the morning. The Mersey Railway Co.' motor 'bus service was inaugurated on the 11th inst. The four 'buses which are on the streets cost £900 each.

Darlington.—The Tramways Committee reported to the Council at their last meeting that the net loss on the year's working had been £1,400, or £27 per week, equal to a 2d. rate. This, however, did not include depreciation, which might be put down as something about 5 to 7½ per cent. This was under the ½d. fare system. Passengers had increased 20 per cent., but the receipts had only increased 1½ per cent.

Colchester.—The Tramways Committee have considered the manager's report as to the ticket system of collection of fares in lieu of boxes, and the introduction of intermediate stages, and resolved *nem. con.* to recommend that the ticket system be adopted, a sub-committee being appointed to fully consider the best means of working the system. The work of constructing the tramway along Military and Old Heath roads is proceeding satisfactorily.

Ayr.—The Town Council, at their meeting on the 11th inst., unanimously agreed to appoint a committee to report on the advisability of extending the tramway line to Hawkhill and Whitletts, also as to the necessary capital outlay, the working expenses, and the probable income from such extension. The Tramways Committee recommended the purchase of a tower wagon for the execution of repairs from Messrs. R. W. Blackwell and Co., at a cost of £65.

Metropolitan District Railway.—A further reduction of fares came into force on Monday last. Many of the "Cross-London" fares between that company's stations and the Metropolitan Co.'s Inner Circle stations has been reduced to 4d. first-class and 2d. third-class

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for the single fare. Return fares are also greatly reduced. Similar reductions have also been made in fares between District Railway Inner Circle stations and Baker-street, Portland-road, Gower-street, etc.

Croydon.—At a meeting of the Town Council on Tuesday last it was unanimously decided not to accept the offer of about £4,000 a year in rent, upkeep charges, and share of the profits for a renewal of the tramway lease to the British Electric Traction Co. The company's lease expires next year. The question of municipalisation will be considered at a future meeting, but Alderman Stapleton, chairman of the Tramways Committee, said the committee regarded complete control by the Corporation as the only alternative to the company's offer.

Rochdale-Littleborough.—To celebrate the successful completion of the construction and reconstruction of tramways between these two towns, a dinner was held in Littleborough on the 6th inst., at the invitation of Mr. W. H. Ormerod, J.P. In reply to the toast of the undertaking, the Mayor said that on all the sections the total receipts up to date from March 31 were £27,445. 15s. 4d., giving a car mile of 9·30d. The total number of passengers carried during that period was 5,630,186, and the car miles run were 626,415.

Macclesfield.—A deputation from the East Cheshire Tramways Co. submitted to the Electricity Committee of the Council particulars of a scheme for a system of tramways in the town. It is proposed to construct the line from Hazel Grove to Macclesfield first and then to construct the Macclesfield line through a number of streets. The gauge will be the standard gauge of 4ft. 8½in. The route in the borough has been selected with a view to avoiding any street widening. As regards the supply of electricity, the promoters are willing to take it in bulk from the Corporation at a reasonable price. The promoters have not taken any powers in the draft Bill deposited by them to deal with the question of street widening. The scheme will be submitted later in writing. The motor 'bus scheme has been abandoned by the Corporation.

Aberdeen.—The number of passengers carried by the cars for the week ending the 2nd inst. was 283,155, an increase of 11,467, and 45 cars and 219 men were employed as against 39 and 207 respectively. The mileage rate over the system was 9·9d., the same as in the corresponding week of 1904, and the rate on the different routes was: Woodside, 10·4d.; Circular, 11·5d.; Mannofield, 11·7d.; Bridges, 8·5d.; Bayview, 10·0d.; Ferryhill, 7·9d.; Torry, 7·7d. The expenditure for the week on electricity and wages was £569. 1s. 2d., an increase of £28. 17s. 4d. The passenger fares for the 27 weeks of the financial year total £38,830. 12s. 7d., a decrease of £1,412. 4s. 2d, while the expenditure on electricity and wages for the same period amounts to £15,734. 5s. 4d., a reduction of £2,426. 5s. The Tramway Sub-Committee met again to define the duties of the tramways manager shortly to be appointed.

Bournemouth.—The Town Council have rejected a motion for running Sunday trams. It was recommended that the tender of Messrs. S. Brown and Sons for the erection of a tramway shelter and convenience, at £888, should be accepted. The Council approved of the instructions to the surveyor by the Tramways Committee, the surveyor to obtain specifications and estimates for two motorcars, and submit to the next meeting. The borough surveyor reported to the Tramways Committee that in order to put the existing track on the Poole Light Railway in proper condition it would be necessary to expend about £3,000, which sum would include new points and crossings. It was recommended that he be instructed to proceed with such works as were absolutely necessary to maintain the track in proper working order. The traffic manager also reported that in order to run the summer traffic satisfactorily on the Poole Light Railway between the County Gates and Poole it would be necessary to construct two new passing places and lengthen two existing passing places. It was recommended that the Poole Corporation be called upon to provide these additional passing places. The Council has agreed to these recommendations.

Newcastle.—A boy, in attempting to cross the roadway, was knocked down by a passing tramcar, despite the attempts of the motorman to pull up the car. Somehow or other the cowcatcher, it is stated, failed to act, and the vehicle passed over the little fellow's legs. The car had to be reversed before he could be extricated. An inquest was held recently into the death of an old man who was knocked down by a tramcar. A verdict of accidental death was returned, no fault being found with the driver, the coroner remarking that the men were very careful in their driving. They had a very difficult and arduous duty to perform, and they did it as well as could possibly be expected. A meeting of the representatives of the Tramway Workers' Union and the representatives of the Tramways Committee of Newcastle Corporation was held on Tuesday to consider the questions in dispute between the men and the Tramways Committee. After a long conversation the men agreed to withdraw their claim for extra payment for Sunday labour. On the other hand, the representatives of the Corporation agreed to withdraw their new regulation for the men to work 11 days per fortnight. The other questions relating to ordinary working hours were referred to arbitration.

Belfast.—The report of the Board of Trade representatives in regard to their recent inspection of the new tramways is, we understand, very satisfactory. In all, 31 miles of track have now been passed, and it is expected that the cars will be running over the remaining portion of the track in a few days. Horse traction has been finally brought to an end, and up to the present the new system has been working smoothly, there being no accidents, whilst slight defects in the controllers caused by damp are being remedied. On the first day of running 22,000 ½d. tickets for children were purchased. At a meeting of the Tramways and Electricity Committee of the Council on Monday, a number of suggestions were made to the general manager, Mr. Nance, all of which he has promised to consider carefully. With regard to the lighting of the tramway poles, the committee have requested the contractors to carry out the work. The committee decided that, with the approval of the Corporation, a bonus of £300 should be offered to Mr. Cutler and £200 each to Mr. M'Cowen and Mr. Nance. A further resolution was passed to the effect that Mr. Munce, assistant city surveyor, and Mr. Pinkerton, surveyor's department, should each get a bonus of £100, and that Mr. Lewis, who was clerk of works during the carrying out of the contract, should be given £20.

Hammersmith.—The Law and Parliamentary Committee of the Borough Council have had before them a letter from the Fulham Borough Council stating, with reference to the proposal of the London County Council to pave with granite setts the tramway track of the authorised tramways between Hammersmith and Fulham, that it has repeatedly urged upon the London County Council the desirability of substituting wood blocks between the lines, and suggesting that the Borough Council might communicate with the London County Council and request the Hammersmith representatives on that Council to support such proposal. The committee recommend that a further representation be made to the London County Council in opposition to the proposal to pave the tramway tracks with granite setts, and that, if possible, arrangements be made for a joint deputation from the two Councils concerned, to attend before the committee of the London County Council which is dealing with the matter. With reference to the suggestion of the Borough Council that the construction of the authorised tramway should be proceeded with with a view to providing work for the unemployed, the London County Council have replied that until the street widenings and bridge reconstruction works are completed it will be impossible to proceed with the construction of the tramways.

Great Yarmouth.—The Tramways Committee have reported to the Town Council that a copy of the Board of Trade regulations with respect to the use of the electrical power on the overhead trolley system has been received by them. The committee declined to accede to an application by the adjutant of the 2nd V.B. Norfolk Regiment for volunteers in uniform to travel at a reduced rate when going to and returning from parade at the drill hall and rifle range. After the fishing season, the terminus of Fish Wharf route will be at the barrack gates on Admiralty-road. The terminus of the Gorleston Quay route will be extended to a point opposite the lighthouse on the Gorleston Quay. Arrangements are to be made on two evenings in January, on the occasion of a dinner to the employés, for working the Yarmouth and Gorleston tramway services so as to admit of half of the employés being released from duty on each evening, and to allow collecting boxes to be placed in the cars for public subscriptions, no personal canvass by the men being sanctioned. A meeting of the Joint Tramways and Electric Lighting Committee resolved that the Electric Lighting Committee should return the equivalent of ½d. per unit for all electricity used for tramway purposes for the year ended Sept. 30, 1905, and for the year ending Sept. 30 1906, current for tramway purposes should be charged at 2½d. per unit. The Tramways and the Electric Lighting Committees agreed to this arrangement. This was agreed to by the Town Council.

Tramways in America.—A report by Mr. A. L. C. Fell, the chief officer of the London County Council tramways, on his visit to America to inspect the tramway system of the United States, was issued on Wednesday. He has tabulated the information received respecting the most interesting points in the more important of the cities visited, and has compared these with similar features of the County Council undertakings. The general impression gathered by Mr. Fell was that American engineers and their financial supporters are much more inclined to take the view that where there is a main road out of a city, or a possibility of connecting two cities, there should be a street tramway to develop the district. In many instances the undertakings do not prove a financial success for some years, but the country is being developed so rapidly that the risk is only a small one when the ultimate results are taken into consideration. The greatest incentive to the quick development of street railways in America is the fact that on the inter-urban lines the speed in the majority of cases is unlimited. Several times Mr. Fell travelled at the rate of 50 miles an hour with perfect safety on tracks laid at one side of the road. In most of the smaller cities the trackwork is of the cheapest possible character, and, apparently, that is all that is necessary until the undertaking is in a position to instal the work in a more permanent form. The condition of the paving in some of the cities which Mr. Fell visited is disgraceful, and would not be tolerated in this country. This fact, it is pointed out, should be taken into account when comparing the operating costs with those of similar schemes in London.

St. Neot's Power Scheme.—A syndicate has been formed to promote a Bill in Parliament to carry out an electric power scheme, generally known as the "St. Neot's" or "Railway" power scheme. A joint-stock company has been registered with a capital of £60,000 to provide, in the first instance, the financial necessities of the enterprise during the passage of the Bill through Parliament, and the names of the members of the syndicate which appear on the register as signatories to the memorandum of association are a guarantee that any necessary capital will be forthcoming for the ultimate construction of the electric works and mains. The directors of the syndicate are stated by the articles of association to be Mr. Stanley Boulter (chairman), Mr. George Kitchin, and Mr. H. A. Vernet. The objects of the Bill are the supply of electric energy in bulk to railways, metropolitan borough councils, and existing electric supply companies. The promoters are, we understand, directing their attention mainly to the supply of the great London railways, for the electrification of whose suburban traffic it is estimated that fully 700,000,000 units will in the near future be required; but negotiations are also pending for supplying in bulk municipal and other electric undertakers. The promises of support which the St. Neot's scheme has received from railway companies show that the latter are fully alive to the importance of having obtained such a strong group of capitalists who are ready to assist the railways by providing the money necessary

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for a great electric power scheme which will obviate the necessity of the railway companies themselves adding to their own capital; while at the same time, by means of such a large installation and the other advantages already mentioned, a lower price per unit can be ensured than by independent organisations. It is expected that the direction of the St. Neot's Parliamentary Co., which will be formed after statutory powers are obtained, will largely consist of railway directors, who will thus keep closely in touch with traffic requirements.

London County Council.—At the meeting of the London County Council on Tuesday last, on the recommendation of the Parliamentary Committee to proceed with the Tramways Bill, Sir R. M. Beachcroft pointed out that the Bill contained proposals for the construction of new tramways in districts where the local authorities had refused to contribute one-third of the cost. In those circumstances, he asked if it was not waste of money to go forward with these proposals. Sir T. Brooke-Hitching said he believed the tramways did not pay, although he was unable to get the information he wanted from the Highways Committee. His opinion was that motor omnibuses had come to stay, and that the money they spent on tramways would result in a loss. Mr. Allen Baker, M.P., said the tramways of the Council on the south side of the Thames, notwithstanding many difficulties, showed a substantial profit. Colonel Colville said that the intention apparently was to join up the northern and southern systems by means of the Aldwych subway, but they would only be able to have single-deck cars through the tunnel. He felt that the motor omnibuses which could carry the passengers through Kingsway would kill the Council's trams, as in the case of the latter passengers would have to change from two-decker to one-decker cars. Mr. Waterlow denied that they would lose on this service. It was intended to use trailers through the subway, and thus enable them to cope with the traffic. It was agreed to proceed with the Bill. The Highways Committee recommended that the electrification of 22½ miles of tramway north of the Thames be proceeded with at a capital cost of about £800,000. The recommendations of the committee were adopted. It was proposed by the Highways Committee that the estimate of expenditure on capital account of £32,000, submitted by the Finance Committee, be approved in respect of the roadwork and platelaying (including rails) for the reconstruction of the existing tramways in Vauxhall Bridge-road, and the construction of tramways over the new Vauxhall Bridge, for the underground conduit system of electrical traction; that expenditure on capital account not exceeding £5,300 be sanctioned for the provision of track and slot rails, etc., for the reconstruction of the tramways in Vauxhall Bridge-road, and the construction of tramways over the new Vauxhall Bridge, for the underground conduit system of electrical traction; and that the offer of J. Mowlem and Co. to execute for the sum of £4 995 the roadwork and platelaying in connection with the construction of tramways over the new Vauxhall Bridge for the underground conduit system of electrical traction be accepted. With regard to the acquisition of a site at Holloway, the committee recommend (*a*) that the operation of the standing order relative to proposals involving expenditure on capital account of sums exceeding £5,000 be suspended in order that the subjoined recommendations may be considered; (*b*) that the estimate of expenditure on capital account of £21,000, submitted by the Finance Committee, be approved in respect of the acquisition of a site at Holloway for the erection of tramways buildings required for the electric working of portions of the Council's northern tramways; (*c*) that the freehold interest of the Tufnell and Caledonian Park Syndicate in the property in Pemberton-road and Pemberton-terrace, Holloway, known as the Caledonian football ground, be acquired for the sum of £20,000, subject to the condition that the main wall of the buildings on the northern boundary shall not be erected at less than 15ft. from the boundary wall in the rear of St. John's-park-mansions; that the valuer and the solicitor do complete the matter, allowing, in addition to the amount named, the necessary legal and other expenses; and that the seal of the Council be affixed to the agreement for the purchase. The committee also recommend that the conditions set out in the letter from the City Corporation indicating the terms upon which the Corporation would be prepared to promote a Bill in the parliamentary session of 1906 for the widening of Blackfriars Bridge and for the construction of tramways thereon, be accepted. The work of erecting a generating station at Greenwich is proceeding satisfactorily. It is hoped that the first portion of the station will be opened early next year. It will serve for the whole of the tramways south of the Thames which have been reconstructed for electrical traction, and also for the following further routes: the existing tramways from Wandsworth to Westminster Bridge and St. George's-circus, *via* York-road, Battersea Park-road, etc., including the lines in Falcon-road; the new tramways between Tooting and Wandsworth, *via* Garratt-lane, etc.; the extension of the existing electric tramways at Greenwich along Woolwich-road to Tunnel-avenue, and the new lines in Blackwall-lane; the tramways between New Cross-road and Catford, *via* Lewisham High-road, High-street, Lewisham, etc.

LIGHTING AND GENERAL.

Coventry.—No alteration is at present to be made in the present scale of charges for electric energy.

Burslem.—Sanction has been received to the borrowing of £5,500 for the extension of the electric lighting main to Tunstall.

Houghton-le-Spring.—The laying of cables for electric lighting in the Urban District Council's district is about to be commenced.

Taunton.—An inquiry has been held into an application of the Town Council for sanction to raise a loan of £4,844 for electric light purposes.

Rhymney.—The private syndicate formed for the purpose of lighting the Rhymney Valley with electricity will not proceed with their application for powers this session.

Dunoon (Argyleshire).—The Town Council are considering a proposal to build a refuse destructor and electric power plant at an approximate cost of £10,000.

Underground Telegraph Cable.—The underground telegraph cable has been brought from Manchester to Leeds, with the intention of ultimately carrying it to Newcastle.

Ascot.—The Ascot District Gas Co. are applying for a Bill to enable them to extend their limits of gas supply and to supply electricity throughout certain portions of their area.

Dundee.—The Town Council have decided in relation to applications for wayleave for poles by the National Telephone Co. to continue the existing arrangements—viz., a charge of 1s. per pole.

Chertsey.—The Rural District Council have received a letter from the Board of Trade relative to the Woking Electric Supply Co.'s order, and a further notice from Messrs. Foote and Milne.

Bradford-on-Avon.—The Rural District Council are consulting Mr. Geo. Pearson, of Bristol, with regard to the system adopted by the Somerset Electric Light Co. for the laying of cables and wires.

Cannock.—The minute of the Electric Lighting Committee which committed the Urban District Council to an experimental scheme to light the centre of Cannock at a cost of £3,000 has been approved.

Heckmondwike.—The Law and Parliamentary Committee have investigated the subject of meters at the power station, and are communicating with the Yorkshire (Woollen District) Electric Tramways Co. on the subject.

Australian Cables.—The Commonwealth House of Representatives, which has previously ratified the agreement with the Eastern Extension Telegraph Co., has now passed it with the amendment made by the Senate.

Tiverton.—The Town Council are presenting to the Local Government Board their objections to the Board's cancelling their electric light order, and also the grant of an order to the National Provincial Electricity Company.

Steel Chimneys.—We are informed that Messrs. Thomas Piggott and Co., makers of pipes, tanks, and steel structures, have just successfully completed two steel chimneys in South Wales, one 175ft. high and the other 125ft. high.

Epsom.—Six new applications, equal to 239 8-c.p., making a total of 9 184 8-c.p. for private lighting alone, have been received. During the last year the total number of 8-c.p. lamps increased from 7,085 to 9,154, an increase of 30 per cent.

Tredegar.—At the last meeting of the District Council a letter was read from the Board of Trade intimating that the electric lighting provisional order of the Council had been revoked, as the Council did not intend proceeding under the order.

Hartlepool.—The National Telephone Co. have obtained permission to place their wires underground in return for an annual payment of 13 guineas. The Northern Counties Electric Supply Co. are making some alterations in the street lamps.

Parton (Cumberland).—The Parish Council have appointed a committee to interview the Lowca Engineering Co., who are extending their electric plant, and have suggested that some arrangement might be made for the lighting of the village.

Brighouse.—It has been decided to at once provide three more telephone trunk wires between Brighouse and Huddersfield Post Office, thereby doubling the present service, and also provide two more wires between Brighouse and Huddersfield exchanges.

Hanley.—The Town Council have empowered the electrical engineer to purchase such short lengths of cable as may be required for extensions on the same terms and conditions as before upon satisfying himself that the rates are based upon the current market prices.

Broughty Ferry.—The estimate for lighting the parish church clock by electricity is much below that of gas, and the matter is under consideration. The current generated for November shows an increase of 2,712 units compared with the corresponding month of last year.

Liversedge.—The District Council have decided to withdraw the electricity supply scheme which had been previously adopted, estimated to involve an expenditure of £2,500. Application will be made to the Board of Trade for the period covered by the provisional order to be extended by 12 months.

Eastern Telegraph Co.—A dividend is announced at the rate of 3½ per cent. per annum, less income tax, on the preference stock for the quarter ended Dec. 31, 1905, and an interim dividend of 1½ per cent. on the ordinary stock, free of income tax, in respect of profits for the quarter ended Sept. 30.

Camberley.—An application from the York Town and Blackwater Gas Co. for consent to the company's application for a provisional order to supply electrical energy for private and public purposes, in accordance with Section 92 of the York Town and Blackwater Gas Act, 1904, is under consideration.

Newcastle.—At the last meeting of the Newcastle and Gateshead Chamber of Commerce it was stated that the chamber had agreed to write to the De Forest Wireless Telegraph Co. saying they would support any movement the company might have for placing a receiving stations at the mouth of the Tyne.

Warrington.—The following scale of charges for electric energy supplied for power has been adopted: load factor 40 per cent., charge 1d. per unit; 50 per cent., ·94d.; 60 per cent, ·88d.; 70 per cent., ·82d.; 80 per cent., ·76d.; 90 per cent., ·70d.—intermediate values of load factor being worked out proportionately.

Swansea.—The Electric Lighting Committee have received letters from consumers complaining of the high price of electrical supply. The Mayor, speaking at a meeting of the committee on Thursday, said electric light needed care in its use, but where the light was used night and day certain concessions would be made.

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Fulham.—A conference of those borough councils who voted in favour of the proposal of the London County Council to introduce a Bill for enabling them to supply electricity in bulk is to be held at the town hall, Fulham, on Monday next at 3 p.m.

Buxton.—The Electricity Committee of the Urban District Council are favourable to the holding of an exhibition, provided a sufficient number of exhibitors can be obtained. Free current to be supplied, and skeleton stalls provided. Exhibitors are to do their own draping, and charges will be made for stall space and for advertising.

Electrical Exhibition.—The Charing Cross, West End, and City Electricity Supply Co. have organised an exhibition at 85 Fenchurch-street, E.C., which is to be of a permanent character, of the various machines, apparatus, and appliances by means of which electric power and energy have been made available for domestic and business purposes.

Larne.—The tender of the Larne Electric Lighting Works for public lighting has been accepted at £450 per annum. This includes the lighting of 14 arc lamps and 132 incandescent lamps from dusk to midnight, of nine arc lamps and 28 incandescent lamps from midnight to dawn; also to light throughout the months of May, June, and July.

Brighton.—A protracted inquiry has been held into the application of the Town Council for sanction to borrow £38,500 for electricity purposes and £5,909 for the purchase of the Star Foundry site, and for the erection thereon of buildings in connection with their electricity undertaking. The committee of ratepayers offered considerable opposition.

Electric and General Investment Co.—The directors have declared the following interim dividends: at the rate of 6 per cent. per annum on preference shares for the six months ending Dec. 31, being 3s. per share; and at the rate of 10 per cent. per annum on the capital paid up on the ordinary shares, being 1s. per share for the six months ended Nov. 30.

Glasgow.—The Electricity Committee recommend that application be made for further borrowing powers to the extent of £240,000 at least. It is proposed to put down three additional turbine generators of 4,500 h.p. each, as the tramways department will in course of time require all their current for tramway purposes, and will, therefore, not be able to supply supplementary current to the Electricity Committee.

Bermondsey.—Councillor Pridmore, in presenting the report of the Electric Lighting Committee at the last Council meeting, gave details which showed that the undertaking was making most satisfactory progress. Councillor Vezey stated that the undertaking was in a far better condition than when he undertook the chairmanship, nearly two years since. In every detail the works showed very satisfactory progress.

Boston (Lincs.).—The question whether the Corporation should seek to extend its order for electric lighting or allow a company to step in and do the work came before the last Town Council meeting, and it was decided that the Paving and Lighting Committee should endeavour to make the best terms possible with any company that may seek to obtain a provisional order for the supply of electricity within the borough.

Hampstead.—The Council recently revised the charges for current for lighting, and at the last meeting decided to reduce the price for electric current for power from 2d. per unit to 1d. per unit, with a minimum charge of £1 per quarter per kilowatt installed, or, at the option of the consumer, to 1½d. per unit without a minimum charge. It was also decided to reduce the charge for current for heating from 2d. to 1½d. per unit.

Inquest.—An inquest was held at Consett last week regarding the death of T. H. Thomas, aged 40, who was apparently killed by an electric shock in the blacksmith shop of the Pelton Fell Colliery on the 28th ult. The expert evidence seemed to show that 254 volts would be the highest voltage to which the deceased was subjected when handling a fusible lamp. The inquest was adjourned to allow a post-mortem to be made.

Cromer.—The annual report of the engineer on the electric light undertaking to June 30 shows that the estimated capital expenditure during the next two or three years, with a provision of £3,580 for house services, etc., will amount to £11,000. Application will probably be made for sanction to a further loan of £11 000 in connection with the electric light undertaking. Inquiries are to be made with reference to the special charges now being made by the contractors to consumers.

Yarmouth.—The Council have approved of the principle of establishing a showroom and office in a central position in the town for the purpose of displaying electrical appliances for heating and lighting. The same would also be used as an inquiry office. The resident engineer reports that during the month two new consumers have been connected to the mains, representing 252 8-c.p. lamps. There are now connected to the mains 660 consumers, representing 32,668 8-c.p. lamps.

Gomersal.—At their last meeting the District Council received a letter asking for consent to a provisional order which is being promoted by a private company for the distribution of electricity in Gomersal. The company stated that they would fix the maximum price at 6d. instead of the usual 8d., and if they obtained the order with the Council's support they would pay the Council's reasonable costs, and provide a supply in Gomersal at the earliest date. Nothing was done in the matter.

Longton.—The number of units generated for the six weeks ended Nov. 23 was 11,849 against 9,929 for the corresponding period of last year, being an increase of 19 per cent. An expert is to be engaged to value the gas and electricity works for poor-law assessment purposes. The chairman, vice-chairman, Councillors Brewer, Brookhouse, Derbyshire, and Taylor have been appointed a sub-committee to consider the question of electricity extensions and charges for current both for lighting and motive power purposes.

Southport.—A sub committee has been empowered to settle the price at which electricity can be supplied for the purpose of working the pumps at the new sewage disposal works. The plan of the electrical engineer for the erection of the necessary buildings to contain a new battery of accumulators has been adopted. The Tramway Committee have agreed to provide for trial purposes a new wattmeter to be used in conjunction with the present traction meters.

Hammersmith.—Sixteen additional consumers, representing a maximum of 1,761 8 c.p. lamps, have been connected to the mains, and six consumers have been disconnected, the present number of consumers taking current from the mains being 1,746. The Council are buying from the Bat Electric Co. 50 10-ampere meters which were hired from them for the purpose of the exhibition at Olympia in October last, at £1. 17s. per meter, the company foregoing the fee of 5s. each for the hire of the meters during the exhibition.

West Bromwich.—The dispute between the Corporation and the tramway company has been settled. At the last Town Council meeting a view was expressed that under the revised agreement the Corporation would stand the risk of losing £624 a year, the cost of 100,000 units of electricity which the company would not require. In the year ending Sept. 30 the tramway company had taken 1,039,536 units at £7,330. It was feared that if the company were using smaller cars, and were running those at less frequent intervals, their current bill would be reduced.

Basford (Notts).—At the last meeting of the Guardians the question of economy and improvement in the lighting of the workhouse was discussed on the presentation of a report from the Visiting Committee recommending the installation of electric light on the premises, and the provision of the necessary power for producing the same in the most economical manner. The estimated cost was mentioned as £2 000, and the committee suggested that Mr. Betts, architect, should be instructed to prepare plans. The report will be considered at the next meeting.

Sunderland.—The Town Council have decided to borrow £18,000 for extensions to the electricity station. Mr. Alderman Bruce, chairman of the Electricity Committee, stated at the last meeting that they had been very successful, and at the end of the current year they would have a net profit of £3,000. The demand had increased enormously, owing to engine works and shipyards taking current for motive power. Amongst others, one firm had stated that the cost of electricity had been £300 per annum less than steam, and several others had found a great financial gain.

Gillingham.—We understand that the Council have decided to extend their agreement with the Kent Electric Power Co. to Aug. 31, 1906. The price charged for current is to remain as at present—viz., 2 5d. per unit—the company being able to work up to a maximum load of 450 kw. The engineer has reported a total of 47,663 8 c.p. lamps with 265 consumers connected, and that applications had been received for the equivalent of 268 8-c.p. lamps. Several new public lighting mains are to be laid. The agreement with Chatham has been referred to the Council in committee.

Salford.—The electrical engineer is preparing details of his proposals for increasing the plant at the electricity works in order to meet present and future demands for electric current. Five additional reverse-current circuit breakers are to be purchased from Cowans Limited at the price of £8 each. Additional cables will be laid in the Eccles New-road area for improving the pressure of current supplied to consumers in that district at an estimated cost of £2,112 15s. A recommendation by the electrical engineer to add additional switches to the lighting and power switchboard at a cost of £170 has been approved.

Edinburgh.—The report of Mr. John F. Simmance, A.M.I.C.E., M.I.M.E., on the gas and electric lighting of Edinburgh states that the former was supplied at over 24 candles, the average variations being a minimum of 2ft. and a maximum of 4¼ft. He considers that the electric current is eminently satisfactory in the centre of the city, but shows great variation in the Portobello district. He expresses disapproval of the incandescent gas lighting. Of the gas expended in the lamps, at least 40 per cent. was wasted. For the want of a small additional sum for mantles and maintenance, 40 per cent. of the cost was thrown away.

New Issue.—The British, Foreign, and Colonial Automatic Light Controlling Co. Capital, £100,000. Object: to acquire as a going concern the goodwill of the business of the business of the Automatic Light Controlling Co. and the patents and rights of Mr. John Gunning's inventions for lighting and extinguishing all descriptions of gas lamps at a predetermined time or predetermined times, and for improvements in apparatus for opening and closing electric circuits at predetermined times. The object of the mechanism, the subject of the inventions to be acquired by the company, is the automatic lighting and extinguishing of public, private, or other lamps, whether their light be derived from gas, electricity, or other illuminant.

Fraserburgh.—At the last Council meeting Mr. Alexander submitted the following summarised report as to the electric lighting of the town from the tool works: "The Council pay to the company the sum of £4,000 to meet the cost of constructing additional plant required, and the company to supply the town with the electrical energy at 2d. per unit for the first two years and at 1½d. thereafter. The cost of constructing the necessary underground cables would be £4,000, so that the Council would have a capital expenditure of £8,000, and the area to be treated embraces 81 street lamps, for which they at present pay £67. 10s. per annum." The matter has been deferred for further consideration.

Dunfermline.—Further correspondence ha taken place between Provost Macbeth, Dunfermline, and the Fife Electric Power Co., and

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also with the National Gas Co. and Tangyes Limited, regarding the question of supplying electricity to the Corporation. The Fife Electric Power Co. have now offered the following terms under a 10 years' agreement: under 100 000 units, 1⅜d. per unit; 100,000 to 200 000, 1¼d.; 200 000 to 300 000, 1⅛d.; 300,000 to 500,000, 1d.; 500,000 to 750,000, ⅞d.; 750 000 to 1,000,000, ¾d. The National Gas Co. estimate that the price would be as follows: 127 500 units, 1·7d. per unit; 200,000, ·947d.; 750 000, ·624d.; 1,000,000, ·504d. No allowance is made in either estimate for the cost of distribution.

London Gazette.—The Otto Electrical Manufacturing Co. (1905) has been wound up voluntarily, and Mr. E. H. Fletcher, 14, George-street, Mansion House, London, appointed liquidator. The Imperial Electric Lamp and Battery Syndicate has been wound up voluntarily, and Mr. A. Stevens, 105, Gresham House, Old Broad street, London, appointed liquidator. The first meeting in the estate of J. W. Smith, electrical engineer and contractor, 55, Bolton-road, Darwen, will be held at the Official Receiver's offices, 14, Chapel-street, Preston, at 10.30 a.m. on Dec. 18. A receiving order has been made out on creditors' petition in the estate of W. Leslie, electrical engineer, lately carrying on business at 22, Bangalore-road, Putney.

Battersea.—The proposed new charges for meter rents are as follows: If any consumer's quarterly account amounts to less than 12s., a meter rent of 3s be charged. Should a consumer's account exceed 12s. but be less than 15s. during any quarter, such sum shall be charged for meter rent as will bring the total up to 15s. No meter rent to be charged to consumers whose quarterly account exceed 15s. If more than one meter is fixed on a consumer's premises, the above conditions shall apply separately in respect of each meter. The net amount to be paid by the County of London Electric Supply Co. relative to the supply of electrical energy in areas transferred under the provisions of the London Electric Lighting Areas Act, 1904, is £595. 5s. 4d.

Islington.—At the last meeting of the Borough Council, in reply to a question as to the charge upon the rates for each arc lamp for the half-year ending March 31, 1903, and the half-year ending March, 1905, the borough treasurer said for the former half-year it was £32. 15s. 9d., for the latter half-year £37. 12s 11d. At to-night's meeting the Finance Committee will submit a report in regard to the proposed extension of arc lighting in the streets of the borough at a cost of £21,011, expressing the opinion that, having regard to the uncertainty which at present surrounds electrical undertakings in London, and to various circumstances affecting the Islington undertaking in particular, the Council should not sanction the further large capital expenditure now proposed by the Lighting Committee.

Hastings.—The income of the electricity works for the year ended Dec. 31, 1904, was £19 467. 18s 5d., and the expenditure £19 351. 5s. 10d., leaving a net profit of £116. 12s. 7d. The accumulated deficiency brought forward from the previous year was £4 468. 8s. 11d. This was reduced during the year by the sum of £1,125, raised by means of a general district rate, and the net profit referred to of £116. 12s. 7d., leaving a deficiency carried forward at Dec. 31, 1904, of £3,226. 16s. 4d. This account shows a marked improvement over the previous year, when the net deficiency was £951. The interest and sinking fund charges absorbed 48·24 per cent. of the total income. The capital expenditure during the year amounted to £4 987. 10s. 2d., bringing the total at Dec. 31, 1904, up to £136 819. 9s. 5d.

Southwick.—The Urban District Council have decided to enter into a contract with the County of Durham Electrical Power Distribution Co. for the lighting of certain streets. The contract is to commence at the expiration of the present contract with the Sunderland Gas Co. in July next. The terms of the contract with the Distribution Co. has been left in the hands of a committee, on the understanding that the initial cost of providing the necessary plant be spread over a period of five years. It appears that the company will charge £280 for putting up the lamps and providing all the material for the lighting of the roads. They are willing to accept payment of this initial cost by yearly instalments covering a period of five years. After deducting the value of the old lamps, the net annual charge comes to £141. 16s., against £145. 7s. for the annual cost of lighting the same roads by gas.

Ayr.—The Ayr Harbour Trustees have of late had under consideration a proposal to generate current for the electric lighting at the harbour, and have obtained a report on the subject from a consulting engineer, who has also dealt with the probable cost of supplying current for the new lamps, the Trustees propose to erect on the south side of the harbour and certain additional lamps for the north side and wet dock. The recent charge made by the Ayr Corporation is £21 per lamp, and about 17 additional lamps are required, the additional lamps and cables being provided by and remaining the property of the Trust. The Town Council have offered to supply current to the Harbour Trustees at the rate of £18. 10s. per lamp, on condition that no fewer than 31 lamps are erected; and that on the same terms and conditions now applicable to the existing lamps. This charge to come into operation so soon as the whole lamps are in use.

Cardiff.—Western Mail-chambers have become a centre for electrical, machinery, and allied firms. This is, the *Western Mail* says, no doubt, due to the central position of the chambers, which are situated in St. Mary-street, close to the Great Western Railway Station. The firms which have offices in the Western Mail chambers include: Clay Bros. and Co., electrical engineers; Electrical Co., lighting and machinery; Callender's Cable and Construction Co.; Crompton and Co., electrical engineers; British Insulated and Helsby Cables; Sinnot and Stracey, civil engineers; H. T. Wales, mining and civil engineer; Vacuum Oil Co.; Uskside Engineering and Rivet Co., colliery engineers; Plowright Bros., colliery screening plant; Ospell Fan Co., colliery fan manufacturers; Simon Carves Limited, coke ovens and coke-washing plant; Penman and Co., boilermakers; Last, Son, and Co., metal brokers; Frank B. Last, analytical, metallurgical, and consulting chemist; G. Hamilton and Co., machinery auctioneers.

Tonbridge.—It has been decided to adopt from March 31 next reduced charges for street-lighting by electric lamps as follows: Each arc lamp £20 per annum for the year ending March 31, 1907, to be further reduced to £18 for the year ending March 31, 1908. This will effect a reduction for the first year of £90 and for the second £126 in the charge for arc lighting. The charge for all electric lamps to be reduced from £3. 15s. per half-ampere Nernst lamp to £3. 12s. 6d. per annum, equivalent to a total reduction of £7. 5s. on the existing 58 lamps, with a further reduction to £3. 10s. per annum after March 31, 1907, in the case of all converted gas columns. This offer has been made on condition that all gas lamps on the line of electric cable shall be replaced with electric Nernst lamps, subject to the gas company's minimum of 200 lamps being maintained. Arrangements are to be made for a suitable man periodically to inspect consumers' installations, with a view to advising them with regard to the lighting and lamps generally. The engineer reported that this can be done without loss (and probably at some profit) to the Council.

Morley.—The borough electrical engineer (Mr. J. E. Ellis) in his last report states that the output from the electricity works for the month ending Oct. 31 was 17,030 units, as compared with 16,504 the same month last year, showing an increase of 526 units. The actual units sold to consumers by meter was 11 894, against 10,258 the corresponding month of last year, being an increase of 1,636 units. Thirty lamps had been connected during the month, the lamps connected to date numbering 13,154, and the motors now connected equalled 27½ h.p. The following have been appointed the committee to examine the accounts prior to the monthly meetings: the chairman, vice-chairman, Alderman J. H. Smith, and Councillor G. E Baines. The consideration of the question of the provision of tanks and apparatus for feeding the boilers with the waste water has been deferred until the next meeting. The borough electrical engineer is about to arrange for an exhibition of electrical appliances to be held in the King's Hall during May, the committee to provide the current for the exhibits free of charge, but to incur no further responsibility.

West Ham.—In a recent report the electrical engineer points out, with reference to the agreement entered into with Jeyes' Sanitary Compounds Co. for a supply of current for power purposes on the Hopkinson system—viz., £1 per kilowatt demanded, plus ·7d. per unit for all current consumed—that he finds that in this particular case the system of charging for the quarter ended September last worked out very much against the consumer, the average price being 8½d. This was due to the fact that their machines had only been running experimentally, instead of being engaged on regular work. The company is to be allowed a flat rate of 1⅜d. per unit until such time as their machines are working at their normal load. The engineer also recommends, with reference to the hire of motors, that the consumer's rental be 15 per cent. per annum on the cost of the motor supplied, which covers the Corporation for capital charges, depreciation, repairs, and maintenance; and that as by this payment the consumer has covered these costs on the motor, he be charged by the ordinary rate in force for the supply of current for power.

Hounslow.—An inquiry has been held into the application by the District Council for sanction to a loan of £11,500 for the purposes of extensions of the electric lighting system. Mr. H. J. Baker (clerk to the Council), Mr. J. Enright (the Council's consulting expert), Mr. Bond (the electrical engineer), and Mr. W. J. Lobjoit (chairman of the Electric Lighting Committee) attended. The application included £1,262, the amount spent in excess of the loan of £35,000 sanctioned in June, 1903, and £10,238 mainly in connection with additional mains. Mr. Baker explained that the great bulk of the excess in expenditure was due to the need for two more boilers, the wisdom of which had been shown by the way they had helped to overcome breakdowns on the part of the original boilers. The actual outlay to be made on mains was £7,434. At the time of the first inquiry held in connection with electric light, it was estimated that in the first year there would be consumption equal to 9,000 c.p., but the actual to the end of the first year was 14,272, which showed that the forecast of the Council was more than justified. They believed, therefore, they were justified in making extensions, particularly as the district north of Hounslow was increasing. Eight hundred and eighty-four pounds was charged for lamps, of which 25 would be arc standards, and the rest incandescent globes fitted to existing gas standards. Other expenses would be spread over extra dynamos, and the construction of a 27ft. deep well and storage tanks raised on columns high enough to distribute all over the works. It was known that a good supply of water could be obtained, and the Council, by sinking the well, believed they would eventually save a great deal of money. With reference to revenue coming in, the Council was doing very well. In November, 1904, when the concern was opened, there were 3,952 equivalent 8-c.p. connections of all kinds. In November last there were 13 628, and to the present day there were applications for connections amounting to 14,272. The charge per unit was 5d., subject to discounts, and 3d. per unit where supplied in bulk.

Portslade.—Portslade, Southwick, and Shoreham are making combined endeavours to obtain provisional orders retaining in their own hands the power to supply the district with electricity. The Chairman, at the last meeting of the Portslade Urban District Council, said that the joint committee had met the Brighton Committee recently. It had previously been decided, subject to the approval of their several Councils, that they should apply for the provisional orders, that they should borrow the money, and that the Brighton Corporation should be asked to supply the electricity at a price to be agreed. The Corporation were also to be asked to lay the cables, and it was also understood that Brighton were to have a lease of the three orders, paying as rent the whole of the loan, the whole of the sinking charges, and the cost of the provisional orders, so that not a penny of the whole expense came upon their rates. No objection was

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offered, and they got as far that, and thought a month or two ago they were going to get the provisional order this next session. Owing to the fact, however, that the Board of Trade said it was necessary to insert in the order the name of the company which would supply the electricity, if they were not going to supply themselves, they had to abandon their intention of applying for the order until next year, as they had not concluded terms with Brighton, the price not having yet been settled. Brighton had offered them something, but it was not just what they wanted. But there was now another difficulty. The town clerk was advised by his parliamentary agents that they could not apply for provisional orders and let Brighton supply them with electricity, but that Brighton must apply with their consent. Their (the joint committee's) parliamentary agent, however, advised just the contrary, and that they could obtain the provisional orders. The matters were gone into at the meeting with Brighton, and it was concluded with this difference between them and the question of price, which they wanted to get as near the Brighton price as possible. He thought they were all agreed they should protest against Brighton taking the provisional order unless it was forced upon them.

Derby.—The electric light mains are to be extended from the works of Messrs. Handyside and Co. to Messrs. Holme and Co.'s mill in Bath street. In answer to a question by Mr. Clifford Newbold with reference to engines that had been pulled out of the electric lighting station up to March last, Mr. Alderman Butterworth replied, at the last Council meeting, that altogether up to the present time eight plants had been removed from the use for which they were installed. There were first three sets of 50 h.p. each. The original value it was impossible for the committee to say. The fact was that the whole of the bills relating to the establishment of the electric light works were not in the hands of the Corporation, but in the hands of the engineers and advisers for the works. Some years ago he remembered that a former committee made application to have these bills. An application was made to the firm of engineers for the bills to be placed at the disposal of the Corporation, but the Corporation were only offered the privilege of inspecting the bills at the firm's offices. That was not accepted, and he supposed the engineers were within their rights in retaining the papers, seeing they formed one of the bases on which the engineers issued their original certificate. So he could not give the exact value. The committee estimated the value of the three sets he had mentioned at £1,200. Then there were removed two sets of 100 h.p., approximate value £1,200, and there had also been three sets of 40 h.p. each, and their original value would be somewhere about the same amount—viz., £1,200. The total cost of the eight plants was estimated at £3,600, and this worked out at nearly £10 per horse-power. The operation of the sinking fund had written off about half this amount, leaving to be accounted for the sum of about £1,800. Parts of these plants had been sold at various times for £265. Two plants had been taken by a firm who supplied the committee with transformers, they in exchange giving transformers to the value of £320. The committee considered it an excellent exchange, and this was reported to the Council at the time the transaction took place. The committee had already given instructions for £650 to be taken from the reserve fund to wipe off the debt on three plants for which the committee had no further use. The last three sets were removed during March to make room for works carried out at the present time. The figures he had given left the sum of £565 not yet written off but represented by engines in the stores which it was intended to sell as opportunity arose, and whatever loss occurred on the transaction would be written off out of revenue. But if mention was made of a small portion of machinery moved from a large concern like this, he had a right to go further and speak of other portions of machinery and appliances which had been renewed, brought up to date, and paid for out of revenue. The whole of the street arc lamps, 78 in number, had been replaced and brought up to a higher efficiency than they were originally out of revenue account, over £1,200 having been spent in recent years. After the old lamps had been used for nine years they were replaced by lamps of greater efficiency, and it would lengthen the life of that particular part of the machinery by 10 or 11 years. Then, again, there was another matter in connection with the change over to direct current made in the centre of the town. During the last two years over £2,000 had been spent out of the revenue account in modernising the system of mains, and as a result there was now a more efficient system of mains than 10 years ago. The foundation beds on which the old plants were fixed had been utilised in carrying the steam-turbines and other extension plant, and any necessary alteration of these had been done out of revenue. The total cost of service connections for the year ending March last was between £400 and £500. This was a perfectly legitimate capital expenditure, and sums for this purpose were applied for and granted by the Local Government Board each year. A short time ago he had occasion to allude to the shortness of memory of some members of the Council. In April last Mr. Newbold, by his presence, assisted to pass a resolution by which the committee were empowered to ask the Local Government Board for £600 for this very purpose. It was an annual expense which had never yet been refused by the Local Government Board.

London County Council.—On Tuesday it was agreed to lend the Hackney Borough Council £1,200 and the Stoke Newington Borough Council £16,925 for electric light installations. A report on the proposed Bill giving powers to the Council to supply electricity in bulk was submitted by the Highways and Parliamentary Committees. The total capital powers sought by the Bill, with which we deal in another column, amount to about £2,500,000. Next week the Highways Committee will recommend that they be authorised to take any necessary preliminary steps, including the invitation of tenders, for the execution of the several works necessary for the erection and equipment of the second portion of the Greenwich electricity generating station and sub station. The recommendations are as follows: (*a*) that the estimate of expenditure on capital account of £186,000, submitted by the Finance Committee, to cover the cost of the erection of the second portion of the Greenwich electricity generating station and the Greenwich sub-station, be approved; (*b*) that the estimate of expenditure on capital account of £250,500, submitted by the Finance Committee, in respect of the provision of the plant, machinery, and other equipment for the second portion of the Greenwich electricity generating station and the sub-station in connection therewith be approved; (*c*) that the capital estimates of £2,000, £15 000. £18 500, £1,500, and £30,000, approved by the Council on Oct. 13, 1903, July 26, 1904, March 14 1905, and Arg. 1, 1905, in respect of preliminary works and expenditure in connection with the erection and equipment of the second portion of the Greenwich electricity generating station and the Greenwich sub-station, be cancelled; (*d*) that the Highways Committee be authorised to take any necessary preliminary steps, including the invitation of tenders, for the execution of the several works necessary for the erection and equipment of the second portion of the Greenwich electricity generating station and sub-station. The Council on May 26 and June 23, 1903, decided to require the Kensington and Knightsbridge and the Brompton and Kensington Electric Lighting Companies to provide and maintain stations, in accordance with the provisions of the companies' orders, for the testing by the Council's inspectors of the electrical energy supplied to consumers by the companies within their areas of supply. Similar provisions relative to the establishment of testing stations are contained in other orders, but in most cases the Council has not been in a position up to the present time to call upon the undertakers to fulfil their obligations as regards the provision of testing stations. We have since been in negotiation with the County of London Electric Supply Co. with a view to the establishment of such stations in its areas of supply south of the Thames. No definite decision has yet been arrived at by the company upon the matter, and in the meantime we think that the company should be formally required by the Council to provide testing stations. It is proposed that a notice be served upon the County of London Electric Supply Co. requiring them, in accordance with the provisions of the Wandsworth, Southwark, St. Olave, and Camberwell Electric Lighting Orders, 1892, 1892, 1895, and 1896 respectively, as confirmed by the Electric Lighting Orders Confirmation Acts of 1892 and 1896, (*a*) to provide and maintain testing stations with proper and suitable instruments of a pattern to be approved by the Board of Trade; (*b*) to connect such stations, by means of proper and sufficient electric lines, with the company's distributing mains; and (*c*) to supply energy thereto for the purpose of testing. Notices under Electric Lighting Acts and orders have been agreed to as follows: City of London Electric Lighting Co., of intention to lay mains along a portion of Gravel-lane; County of London Electric Supply Co., to lay high and low tension mains along Collier-street and along Claremont square and Amwell-street; Metropolitan Electric Supply Co., under the Mid-London Order, 1889, to lay mains along portions of the Strand and Aldwych and along Castle-street; South Metropolitan Electric Light and Power Co., to lay low tension mains along and across Shooter's Hill-road and across a portion of Blackheath, and along portions of St. Mark's-road and Gilmore-road, and across High street, Lewisham, and along portions of Court Hill-road, Hither Green-lane, and Ladywell Park-terrace; Westminster Electric Supply Corporation, to lay mains along Laundry-yard and a portion of Horseferry-road.

PROVISIONAL PATENTS, 1905.

DEC. 4.

25084. Improved sand gear for electric tramcars and the like. Harry Lawrence Kenworthy, 42, Forest-road, Lower Edmonton, London.

25085. Safety electric car step. Henry Fielding, 153, Dantor-road, Hooley Hill, near Manchester.

25114. Electric lock. Tom Hildred Scrimshaw, 94, Meadow-lane, Leeds.

25131. Improvements in switchboards. Claude Kennedy Mills, 23, Southampton-buildings, Chancery-lane, London. (Marie Vitous and William Pierson Hammond, United States.) (Complete specification.)

25147. Improvements in connection with the regulation of alternating-current motors. Elektrizitäts Aktien-Gesellschaft vorm. W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 2, 1904, being date of application in Germany.) (Complete specification.)

25153. Improvements in appliances for protecting electric apparatus against currents of excessive strength or voltage. Soc. Industrielle des Téléphones, Constructions Electriques, Caoutchouc Cables, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 13, 1904, being date of application in France.) (Complete specification.)

25169. Improved means for operating the controlling switch of electric vehicles. Louis Krieger and Cie. Parisienne des Voitures Electriques (Procédés Krieger), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, March 9 1905, being date of application in France.) (Complete specification.)

25171. Improved means for controlling an electric motor. Louis Kriéger, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 24, 1905, being date of application in France.) (Complete specification.)

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25172. **Improvements in or relating to electrically-propelled vehicles.** Louis Kriéger and Compagnie Parisienne des Voitures Electriques (Procédés Kriéger), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 24, 1905, being date of application in France.) (Complete specification.)

25173. **Improvements in electrically-propelled vehicles.** Louis Kriéger and Compagnie Parisienne des Voitures Electriques (Procédés Kriéger), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, May 30, 1905, being date of application in France.) (Complete specification.)

25174. **Improvements in electric furnaces.** Soc. Anon. Electro-metallurgique (Procédés Paul Girod), 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 4, 1905 being date of application in France.) Complete specification.)

DEC. 5.

25224. **Improvements in cases for electrical measuring instruments.** Edgar Isaac Everett and Kenelm Edgcumbe, Collindale Works, Hendon, London.

25236. **Improvements in and relating to Nernst lamps.** Allgemeine Elektricitäts Ges., 27, Chancery-lane, London. (Date applied for under Patents Act 1901, Dec. 5, 1904, being date of application in Germany.) (Complete specification.)

25257. **Improvements in or relating to arc lamps.** Frantisek Jarecek, 111, Hatton garden, London. (Complete specification.)

25283. **Improvements in electromagnetic band brakes for vehicles.** Henri Dolter and Gustav Mertens 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 5, 1904, being date of application in Germany.) (Complete specification.)

25287. **Method of and apparatus for striking electric arcs between electrodes.** Albert Johan Petersson, 322, High Holborn, London. (Complete specification.)

25288. **Improvements in electric signalling apparatus.** Alfred Francis Street, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

25295. **Coin-actuated electrical advertising device.** Howard William Chinnery, George William Chinnery, and Florence Chinnery, 97, South-avenue, Southend, Essex.

DEC. 6.

25347. **Improvements in electric cut-outs.** John Henry Christopher Brooking and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

25353. **Improvements in apparatus or devices for generating electricity on motorcars or motorboats.** Joseph Taylor, 33, Chancery-lane, London.

25361. **Improvements in electrically-driven hydraulic pumps for operating lifts, cranes, and the like.** Percy John Crundall Day and Bernhard Wiesengrund, Temple Bar House, Fleet-street, London.

25365. **Improvements in trolleys or current collectors for electrically-driven vehicles.** Sydney Brittain Forwood, 6, Lord-street, Liverpool.

25383. **New or improved receiving apparatus for explosive submarine and land mines operated by electric waves.** Ferdinand Schneider, 31, Bedford-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 23, 1905, being date of application in Germany.) (Complete specification.)

25392. **Improved apparatus for illuminating photographic studios with electric incandescence lamps.** Philipp Georg von der Lippe, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25393. **A device for limiting the speed of series alternating-current electromotors.** Elektrizitäts Akt.-Ges. vorm. W. Lahmeyer und Co., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901 Dec. 27 1904, being date of application in Germany.) (Complete specification.)

25405. **Improvements in and relating to systems of electrical distribution.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

25406. **Improvements in motion-checking devices especially applicable to steering mechanism of vehicles.** The British Thomson-Houston Company, Limited 83, Cannon-street, London. (General Electric Company, United States.)

DEC. 7.

25412. **A new or improved vacuum tube or tubes for the production of violet or ultra-violet rays X-rays, or other rays or combination of rays on high or low tension currents.** John Cunningham Bowie and John Henry Phelps, 1, Montgomery-street, Cardiff.

25415. **An improved method of controlling the trolley poles of electric cars and the like.** Solomon Henshaw and Joseph Swindells, 350, Catherine street, Ashton-under-Lyne.

25471. **Improvements in electric switches.** Francis Joseph James Gibbons, 22, Southampton-buildings, Chancery-lane, London.

25484. **Improvements in or relating to mouthpieces for telephones.** Paul Jacques Mantle, 33, Chancery lane, London.

25490. **Improvements in and relating to wireless telegraphy.** Sir Oliver Joseph Lodge, Knight, and Alexander Muirhead, 323, High Holborn, London.

25502. **Improvements in contact-breaking devices for the magneto-electric ignition of internal-combustion engines.** Dresdner Gasmotorenfab. vorm. Moritz Hille, 31, Bedford-street Strand, London. (Date applied for under Patents Act, 1901, May 22, 1905, being date of application in Germany.) (Complete specification.)

25512. **Improvements in and relating to controlling apparatus for electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25513. **Improvements in electric motor control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

DEC. 8.

25521. **Improvements in electric switches.** Arnold Greaves Hansard and Henry Sinclair Watson, 53, Victoria-street, Westminster, London.

25522. **An improved method of connecting split or inspection fittings used in the erection of tubing for electric or other work.** William Clayburn Williams, Eidsforth, Park-avenue, Bridlington.

25525. **An electrical automatic signalling apparatus for tramways.** Matthew Rathborne and Henry Fielding, 92, Stockport-road, Denton, Lancs.

25533. **A new or improved monetary recorder for use in combination with the ordinary telephone instrument.** Joseph Henry Langley and Ernest William Mason, 4, St. Ann's-square, Manchester.

25550. **An improved electromagnetic power hammer, drop stamp, or press.** Thomas Henry Large, 154, St. Vincent-street, Glasgow. (Complete specification.)

25561. **Improvements in and relating to methods of cooling and ventilating electric machines.** Siegfried von Ammon, Oswaldestre House, Norfolk-street, Strand, London.

25570. **Improvements in circuit breakers and indicators for use with electric alternating-current circuits.** Leonard Andrews, 38, Deansgate, Manchester.

25581. **Improvements in means or apparatus for electric lighting.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

25612. **Improvements in Rontgen-ray apparatus.** Wallace Cranston Fairweather, 65, Chancery-lane, London. (The firm of C. H. F. Müller, Germany) (Complete specification.)

25614. **Improvements in fuse and switch mechanism.** Callender's Cable and Construction Company, Limited, and John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London.

DEC 9.

25615. **Improvements in electric arc lamps.** George Davis, 15 Victoria street, London.

25636. **Improved means for preventing the "live" wires of electric tramways from descending to the common danger of pedestrians and others when broken or severed.** Samuel Sims, 17, Hanover-street, Keighley, Yorks. (Complete specification).

25641. **Improvements in and relating to electrical distributing systems.** Leonard Andrews, 38, Deansgate, Manchester.

25669. **Improvements in and relating to conduits or casings for electric conductors.** Richard Henry White Knight and Ludwig Nagel, 323, High Holborn, London.

25670 **Improvements in or relating to secondary or storage batteries.** The N S. Electric Storage Company and Job Thomas Niblett, 139, Queen Victoria-street, London.

25676 **Improvements in electric controlling devices for cars.** James Barry Keighley McCollum and John Wycliffe Lowes Forster, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 28.

1904.

26686. **Electric telegraphs.** Siemens Bros. and Co., Limited, and Grimston.

26748. **Apparatus for controlling telegraphic recorders and other instruments.** Marconi's Wireless Telegraph Company, Limited, and Priddle.

27400. **Systems of electric motor control.** British Thomson-Houston Company, Limited. (General Electric Company.)

27844. **Method of controlling electric lifts, elevators, conveyors, or any similar contrivance having a moving car and stations** Jacoby.

28687. **Means or apparatus for automatically starting, controlling, and stopping single or multiphase alternating-current electric motors.** Carr and Birch.

1905.

523. **Electric oil and like switches.** British Thomson-Houston Company, Limited. (General Electric Company.)

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571. Method of and apparatus for indicating or checking the efficiency of electric train or car driving. McLellan and Merz.

1073. Prepayment mechanisms. British Thomson-Houston Company, Limited. (General Electric Company.)

3289. Electric heaters. British Thomson-Houston Company, Limited. (General Electric Company.)

3327. Electrolytic meters. Hookham and Holden.

3814. Structure of accumulator cells. Leitner.

6267. Imitation candles for electric light. Drake.

6400. Hangers or ears for overhead electric wires. Simpson.

6755. Mercury vapour electric lamps. Lee.

6822. Electrical switches. Tucker.

8704. Means for supporting telephone receivers. St. John.

8890. Detector for use in wireless telegraph system Shoemaker.

8890B. Wireless telegraph receiving apparatus. Shoemaker. (Date applied for under Rule 5, Patents Rules, 1905, April 27, 1905.)

12962. Regulating rheostats and motor starters for electrical purposes. Fletcher.

12536. Electric incandescent candle fittings. Pope.

12875. Electric arc lamps. British Thomson Houston Company, Limited. (General Electric Company.)

13706. Electric motors for use with either alternating or continuous currents Allgemeine Elektricitäts Ges. (Date applied for under International Convention, July 4, 1904.)

16945. Apparatus for automatically making and breaking an electric circuit for lighting and extinguishing electric lamps at certain hours varying with the seasons. Capt. Lecoultre. (Date applied for under International Convention, Sept. 3, 1904.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	9/16- 1/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	2½-2¾
—— 4 per cent. Mortgage Debenture Stock	100	..	85-89
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-⅞
—— Non. Cum., 6 per cent. Pref.	2	..	1-2
—— 4½ per cent. 1st Debenture Stock	100	..	96-100
—— 4½ per cent. 2nd Debenture Stock	100	..	84-86
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5⅛-5⅜
Crompton and Co.	3	..	2-2½
—— 5 per cent. Debentures	100	..	97-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅜-1⅝
—— "A" Shares, 01-017,139	5	..	2-2½
—— 5 per cent. Debentures	100	..	92-97
—— 4 per cent. Deb. Stock, Red.	100	..	85-90
Electric Construction, Nos. 1 to 112,100	2	..	¾-⅞
—— 7 per cent. Cumulative Pref.	2	..	1½-2⅜
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-9⅜
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-100
W. T. Henley's Telegraph Works, Ordinary	5	..	12½-13⅛
—— 4½ per cent. Preference	5	..	5⅛-5⅜
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18½-19½
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10½
Telegraph Construction and Maintenance	12	..	32½-34½
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	12½-12⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10½-10⅝
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11½-12½
—— 4½ per cent. Debenture Stock, Red	100	..	107-109
Bromley (Kent) Electric Light and Power Co.	5	..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	9 10
—— 7 per cent. Preference	5	..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9-9½
—— Nos. 60,001-80,000	5	..	8¾-9¼
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13⅝
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	104-107
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	5¾-6¾
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	6¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100	..	103-105
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— ditto (1905) 40,001-80,000	5	..	4¾-5
Chelsea Electricity Supply	5	..	5-6
—— 4½ per cent. Debentures	100	..	110-112
City of London, Ordinary	10	..	11½-12⅝
—— 6 per cent. Cumulative Pref.	10	..	13½-14½
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	103-105
County of London Electric Supply, Ordinary	10	..	8¼-9¼
—— 6 per cent. Cum. Pref.	10	..	12¾-12⅞
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	112-115
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	102-104
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5¼-5⅜
—— 6 per cent. Cum. Pref.	5	..	5¾-6¼
—— 4½ per cent. First Mort. Deb.	100	..	107-109
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	87-92
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100	..	101-104
Havana Electricity, 1-15,000	10	..	9-10 xd
Hove Electric Lighting, Ord., 1-13,000	5	..	8¼-8⅜
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅛-1
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	10¾-11¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	98-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	3	..	1¾-2¼
—— 6 per cent. Pref.	5	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	9¼-10¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5¼-5¾
—— 3½ per cent. Mortgage Debenture, Red.	100	..	97-99
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,000	5	..	8-8¼
—— do., 57,0.0-75,000	5	..	8-8¼
—— 5 per cent. Pref., 1-57,000	5	..	6¼-6⅜
—— do., 57,0 0-75,000	5	..	6¼-6⅜
Notting Hill Electric Lighting	10	..	14¼-15¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6⅜-6⅞
—— 4 per cent. Debenture Stock	100	..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3-3¼
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	12¾-13¼
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4¼-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5-5¼
Westminster, Ordinary	5	..	11¼-12½
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	5¼-5½
Electric Tramways.—			
Anglo-Argentine, 5½ per cent Cum. Pref., 1-260,007	5	..	5¾-6¼
—— Ord.	5	..	8¼-8¾
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	142-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	105-107
Barcelona Tramways, Ord., 1-20,000	10	..	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9¼-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13¾ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	96-98
British Columbia Electric Railway Co., Ord. Def.	100	..	121-124
—— Ord. Pref.	100	..	109-113
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	106-109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	..	8-9
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10¼-11¼
—— 5 per cent. Perpetual Debenture Stock	100	..	120-123
—— 4½ per cent. 2nd Deb. Stock	100	..	98-100
Buenos Ayres and Belgrano Trams.	5	..	3⅜-3⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	..	107-109
—— Prov. Cert., all paid	100	..	102-106
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,268	5	..	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-108
Cape Electric Tramways, Nos. 1-480,000	1	..	⅜-1¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4¾-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	101-103
Cork Electric Tramway and Lighting Co., Ordinary	10	..	14¼-15¼
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14¼
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2¼-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	83-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	10-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-108
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	¼-1¼
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9¾-9¾
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	101-104
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9¾-10¼
—— 4½ per cent. Debenture Stock	100	..	101-104
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £587,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c.
Electric Railways.—			
Central London, Ordinary	100	—	93-95
—— 4 per cent. Pref.	100	..	101-103
—— ,, ,, deferred	100	..	85-88
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	£100	—	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100 ..	45-47
—— 4 per cent. Debenture Stock	100 ..	105-103
—— 5 per cent. Pref. Stock '91	100 ..	119-121
—— ,, ,, ,, '95	100 ..	117-120
—— ,, ,, ,, '01	100 ..	114-116
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10⅛
—— Ordinary, 1-50,000	10 ..	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700,,	— ..	97-98 xd
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	97-98 xd
Waterloo and City, Ordinary	100 ..	94-97

Name.	Amount paid.	Last price
Telephones.—	£	£
National Telephone, Preferred	100 ..	110½-111½
—— Deferred Stock	100 ..	108-110
—— 6 per cent. Cum. First Pref.	10 ..	13-15
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅛-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	98-100
—— 4 per cent. Deb. Stock, Red.	100 ..	104-106
Oriental Telephone and Electric Company	1 ..	1-1⅛
—— 6 per cent. Cum. Pref.	1 ..	1 3/16-1 5/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d
Aberdeen Corporation	Dec. 9	1,1 0	1,070	+ 119	- 1,592A	25½	20⅝	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 2	172	174	- 2	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 10	1,030	933	+ 91	- 642	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 2	389	337	+ 52	—	2	2	,, 31	17,133	4,709,738	265,525	·86	14·5	8,866	—
Blackburn Corporation	,, 6	885	733	+ 146	+ 1,466	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,035	7·44
Blackpool Corporation	Nov. 2	340	350	- 10	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Dec. 9	159	158	+ 1	- 1,033	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 10	1,736	1,625	+ 170	+ 2,9.9	40	38	March 31	95,766	20,235,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 6	1,211	762	+ 449	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 9	4,015	3,585	+ 429	- 5,450	96	77	,, 31	330,085	47,108,000	5,033,392	1·172	10·927	2,396	—
Brighton Corporation	,, 10	753	719	+ 39	+ 435	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 8	4,705	4,534	+ 171	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 9	1,087	943	+ 144	—	10 60	10·60	March 3	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 10	261	294	- 33	- 1,399	8½	8½	,, 31	17,950	3,878 269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 9	1,845	1,870	- 24	+ 46	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 9	151	165	- 15	- 615	8·5	8·5	Dec. 31	10,713	2,935,00‡	359,756	—	7·14	—	5·18
Central London Railway	,, 9	7,166	7,099	+ 67	- 814	6	6	,, 31	347,538	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway.	,, 10	3,295	3,3 2	- 17	+ 283	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	,, 7	413	430	- 17	+ 616	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6 64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 9	181	172	+ 9	—	4½	4½	,, 3.	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 8	86	100	- 4	- 394	6½	6½	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T., electric cars Dublin S. District, Electric	,, 8	4,769	4,516	+ 2 3	- 381	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dundee City Tramways	Nov. 29	886	777	+ 1·9	+ 1,477	2‡	2‡	May 15	44,695	11,611,525	933 006	·90	11·49	1,943	7 13
East Ham Corporation	Dec. 9	7·0	535	+ 187	+ 3,535	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 9	15,320	13,418	+ 1,912	+ 22,963A	144½	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 2	1,337	1,155	+ 182	+ 1,894	35	35	,, 3:	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 9	2,134	2,037	+ 97	+ 819	27	26	,, 31	112,651	27,102,921	2,910,693	1	9 29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 6	101	93	+ 8	- 726	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 9	5,100	5 118	+ 412	—	89	89	March 25	298,233	64,223,646	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 9	1,944	1,659	+ 284	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 2	10,314	9,691	+ 623	+ 9,639	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 10	1,389	1,384	+ 5	- 1,540A	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 2	13,254	11,8·6	+1,·78	+70,5·1	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 9	129	,33	- 4	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 7	81	87	- 6	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 9	12 526	11,400	+1,126	+ 21,671	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10 73	4,289	6·99
Metropolitan District Railway	,, 10	8,076	7,576	+ 502	+ 3 417	21	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 3	17,130	16,812	+ 318	+ 1,8·8	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 2	124	102	+ 22	+ 451	—	2‡	,, 31	6,159	1,972,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 9	3,713	3,493	+ 220	+ 3,045	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 10	1 689	1 349	+ 240	+15,513	—	34	,, 25	65,553	13,466,245	1,503,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 9	1,419	1,333	+ 116	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	,, 7	555	542	+ 14	- 481	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 9	766	389	+ 3·7	—	6½	4‡	,, 31	14,881	2 837,110	336 517	1·24	9·24	1,102	7·98
Rotherham Corporation	Nov. 9	5:4	497	+ 37	—	9½	7‡	,, 31	23,563	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	Dec. 11	4,150	3,749	+ 401	+ 8,814	70‡	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 10	4,·42	4,374	+ 488	+ 9,076	65‡	52½	,,	240,565	63,952 283	6,047 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 6	862	8·6	+ 56	+ 357	—	18	,, 31	49,365	9,294,771	1,108,369	1·27	11 02	—	7·83
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 8	759	408	+ 351	+ 6,703	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 10	1,178	1,058	+ 120	+ 1,680	20	20	,, 31	64,858	15,364,463	1,495,685	1·004	10·36	—	6·37
Swindon Corporation	Nov. 29	161	126	+ 35	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	
Wallasey U.D C.	Dec. 9	723	620	+ 123	+ 954	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·64
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 7	1,897	1,023	+ 874	+27,401	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 6	744	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 miles of interlacing track. a Train mile. b Per mile of single track. A Half-year's figures.

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NOTES.

Dick-Kerr Engineering Society.—On Saturday last the members of this society held their first social evening, which took the form of a smoking concert, all the songs being rendered by members of the society. A very enjoyable evening was spent. Mr. Cox, of the testing department, was in the chair.

Northampton Institute Engineering Society.—The third fortnightly meeting of this society was held on the 15th, Dr. C. V. Drysdale in the chair. Mr. A. E. Jolley read a very interesting paper on "Points in Connection with the Testing of Electrical Machines." In the course of his paper the author dilated largely on the subject of error in electrical measuring instruments. He also pointed out the difference between accurate laboratory testing and commercial testing. The paper was followed by a discussion.

Trade Marks.—A correspondent in the *Globe* draws attention to an evasion of the Merchandise Marks Act, the seriousness of which it is hard to exaggerate. Certain electrical instruments are imported from France with the words "Made in France" stamped on them. But the stamp in question can easily be removed, and underneath appears the legend "Made in England." Accordingly, the unsuspecting purchaser believes that he is using home-made goods, when, in fact, not even the lying inscription has been made here. This appears to be a form of dishonesty which is becoming all too common among unscrupulous manufacturers abroad which is difficult to characterise in sufficiently strong terms.

Electro-Harmonic Society. — At this society's smoking concert last Friday evening a pleasant feature was introduced. During the interval, the chairman, Mr. John Gavey, C.B., presented prizes to the executive committee of the recent electrical exhibition in commemoration of their great success at Olympia. Mr. Cunliffe Owen was presented with a gold chronoscope, and Mr. C. S. Northcote with a gold combination matchbox and sovereign case, while each of the committee and the secretary received a gold matchbox. Mr. Gavey said that the exhibition had created a demand for electrical things which were before unknown to the public, and that the industry had received a strong impetus thereby. Mr. Owen responded on behalf of the recipients.

Royal Meteorological Society.—The monthly meeting of this society was held on the 20th inst. at the Institution of Civil Engineers, Great George-street, Westminster, Mr. Richard Bentley, F.S.A., president, in the chair. Mr. G. C. Simpson gave an interesting account of his attempt to fly kites for meteorological purposes from the mission ship attached to a deep-sea fishing fleet in the North Sea. These observations, which were made in July and August last, were carried out on behalf of the Joint Kite Committee of the Royal Meteorological Society and of the British Association. The other papers read at the meeting were: "Temperature Observations during the Partial Solar Eclipse, Aug. 30, 1905," by W. H. Dines, F.R.S.; "Comparison between Glaisher's Factors and Ferrel's Psychrometric Formula," by J. R. Sutton, M.A.; and "A Rapid Method of Finding the Elastic Force of Aqueous Vapour, etc., from Dry and Wet Bulb Thermometer Readings," by John Ball, Ph.D.

Electric Tramways in Japan.—It is stated that the Yokohama Electric Tramway Company have closed a contract with the Japanese engineering and contracting firm of Messrs. Takata and Co., Tokio, for some additional rolling-stock. Six No. 21-E Brill trucks, having a gauge of 54in., wheel base 6ft., diameter of wheel 30in., axles 3¾in., have been contracted for. Upon these trucks will be mounted 18ft. closed car bodies, the length over platform being 25ft. and the width from out to out of sills 6ft. These car bodies will be built in Japan, and the trucks will be arranged to take Sterling brakes, which have been ordered from America. The motor equipments for the trucks have been ordered from the Westinghouse Electric and Manufacturing Company, and consist of six double motor equipments, each of two Westinghouse 12-h.p. and 25-h.p. railway motors, the motors to be nose suspension, and complete with suitable gears, gear cases, pinions, etc. Each equipment will be supplied with two Westinghouse No. 211 brake controllers, and will also be supplied with double trolleys, with 14ft. poles, the distance between trolley wires being 18in. A large order for spare gear and motor parts has also been placed with the Westinghouse Company. For the trucks of these cars, Messrs. Takata and Co. have ordered six pairs of Van Dorn automatic drawbars No. 5, with ball joint, suitable for pulling a trailer weighing 20 tons. The greater portion of the equipment has been ordered from America, and it seems evident, judging by the number of contracts which are placed in that country and on the Continent, that our electrical manufacturers are not benefiting from the development of Japan.

Electric Locomotive Tests.—The *Street Railway Journal* gives the results of some tests on energy consumption recently conducted in Switzerland with a 45-ton single-phase converter electric locomotive built at the Oerlikon Machine Works. The values given are the averages of a large number of readings which were taken at the terminals of the trolley line at the primary station:

Speed.		Weight of train, including locomotive,	Grade	Energy
Kilowatts per hour.	Miles per hour.	in metric tons.	per cent.	consumption in kw.
42	25·0	45	0	90
42	25·0	45	0·8	139
37	22·9	120	0	90
37	22·9	120	0·8	129
32	19·8	160	0	190
32	19·8	160	0·8	235
30	12·4	250	0·8	320

The locomotive takes current from an overhead contact line at 15,000 volts, and is equipped with a single-phase synchronous motor, direct connected to a direct-current generator, which drives the direct-current motors and axles. The locomotive which is being given a test run had made up to Oct. 1 4,850 km. (3,031 miles), corresponding to 486,000 ton-kilometres. During these tests no difficulties have arisen either with the locomotive or with the overhead line, in spite of the high voltage used.

Long-Distance Telegraphy.—The electrical engineer's branch of the General Post Office, Melbourne, Australia, furnishes an account of long-distance telegraphic work on Australian lines on Sept. 24. The circuit nearly encircled the continent, from Cape York on the north-east tip to Broome on the north-west. The length was 6,601¼ miles, in which there were 13 repeating stations. The experiments were begun at 11 a.m. Melbourne, Sydney, Brisbane time, which under the prevailing zone system was 9 a.m. at Perth. Adelaide, Melbourne, Sydney, Brisbane, and Townsville were in attendance and ready at the former hour, and greeted each other. Cape York was then joined to the circuit, the signals to and from being clear and firm. Owing to an unexpected delay at Eucla, which is a main repeating station situated on the Great Australian Bight, communication between Perth and Melbourne and the other capitals was not possible until 12 noon, but when this was possible there was no difficulty in speaking through to Cape York freely and well: Broome, a duplex station, 1,466 miles distant from Perth, was then connected to the circuit, and it and Cape York passed the time of day and carried on a con-

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versation for 15 minutes, at a key speed of 20 words per minute, without the least sign of lag in the signals. Broome stated that the temperature was 100deg. in the shade there, while Cape York set it down at 80deg. at that end. The signals passed from one terminal station to the other splendidly, annihilating distance in a most pronounced manner, and amply demonstrated to the satisfaction of all concerned that through telegraph working from one end of Australia to the other was a practicable feat. With the arrival of this successful issue the terminal stations were taken off, the intermediate circuits were dismantled, and the experiments came to an end.

Printing-Machine Noises.—An interesting case was heard in the Court of Appeal on Friday last, which in view of the extending application of electricity for driving printing machines is worthy of more than passing attention. The particular question raised by the case was whether a person electing to reside in a trade neighbourhood, such as a neighbourhood occupied by the printing and allied trades, is entitled to complain if he finds the noise is substantially increased. The appellants were Messrs. Polsue and Alfieri, printers, who sought a reversal of a judgment of Mr. Justice Warrington, who found that a substantial addition to the noise created a nuisance, and, therefore, granted a perpetual injunction. Lord Justice Vaughan Williams, in the Appeal Court, said that even if the night noise caused a serious disturbance to the plaintiff and his family, it would not be a private and actionable wrong provided the noise arose out of carrying on the work in the particular and established manner of the trade of the district. He also said that plaintiff's compensation for submission to the noises lay in the fact that he entered the district to gain a livelihood by supplying his wares to the people who made the noises. Lord Vaughan Williams said he did not think Mr. Justice Warrington had applied the principles established by preceding cases, but that was not sufficient ground for reviewing his decision. The other judges concurred in this, and the appeal was dismissed. The machine complained against was of the Miehle type, driven from a 7½-h.p. motor coupled direct and fixed upon a concrete bed. The evidence of experts showed that the machine was much quieter than many of its kind, whilst others in the neighbourhood averred that the nuisance complained about did not, in fact, exist. It would be as well to have an authoritative judicial expression of opinion on the rights of the parties.

Three-Phase Railways in America.—The first electric railway to use three-phase alternating currents in America will, says the *Electrical World and Engineer*, run between London and Port Stanley, Ontario, Canada, and it is expected to open one part of the line for service in about two months. This railway, besides being the first exponent of the three-phase system, has another feature of special interest. The length of line now under construction is 27 miles, split into two sections of 18 miles and 9 miles, to be run with three-phase currents. Between these two sections there is a third one of about two miles, belonging to the St. Thomas City Railway, and run by direct current. The cars of the interurban road will run over the direct-current section too, being furnished with a special equipment permitting this. The motor stator has a three-phase winding arranged in such a way that it may be fed with 1,000 volts alternating current or 500 volts direct current. The rotor has a commutator and four sliding contact rings, it being a two-phase armature when running with alternating current. Each car will have two of these motors, of an aggregate rated horse-power of 130. The series-parallel control will be used for direct-current work, and the single cascade control for alternating-current running. The trains to be hauled will weigh 35 tons, and run at a maximum speed of 30 miles per hour. The line has several very heavy and long grades up to 5 per cent. The transmission and distribution E.M.F. is 10,000 volts, three-phase. This railway represents a novel application of the Ganz system, as it is a combination of alternating current and direct current that will enable the interurban road to enter the cities and its cars to pass over the street railway lines. It is expected that the railway company will soon extend its line east as far as Hamilton, a distance of 85 miles, using the same system.

Uses of Electricity.—Mr. S. E. Fedden, general manager of the Sheffield Corporation electric supply department, recently delivered an instructive lecture on "Electricity" to the members of the Sheffield Society of Architects and Surveyors. He emphasised the importance of electrical engineers instructing their customers to appreciate the advantage of good lamps over second-rate ones. We are glad to observe that engineers of corporations and supply companies are realising this necessity, and the list of instructions to consumers recently issued by the Chesterfield electrical engineer, to which we called attention a few weeks ago, is, so far from being an exception, the recognised practice among up-to-date supply corporations. Mr. Fedden made some practical remarks anent the arrangement of electric fittings in houses and shops, which, he said, showed utter disregard of fitness and a complete ignorance of the first principles of illumination. There was room for specialists in this class of work who could give more attention to the arrangement of lights with a view to economy. He combated some of the extravagant statements made by vendors of gas and gas appliances in support of their claims. Occasionally definite cases were cited where a saving had been effected by the substitution of some of the most recent forms of gas lighting, but it was generally found that the customer had contented himself with less light. In electric lighting great economies could be effected, and if these economies were adopted electric light accounts would go down. Moreover, there were other advantages. It was said that by introducing electric light Mr. William Whiteley, of London, saved £5,000 per year on painting and whitewashing. There was also the question of health. He was able to say, from practical experience, that in Sheffield in nearly every case where electric light had been installed in a church or chapel there had been a saving as compared with gas.

The Steam-Turbine.—The evolution of the steam-turbine, the general theory of its working, and some of the chief features of the flow and expansion of steam, and the conditions essential to economy, were touched upon in a paper on the steam-turbine prepared by the Hon. C. A. Parsons, C.B., F.R.S., and Mr. G. G. Stoney, M.I.C.E., and read before the meeting of the Institution of Civil Engineers on the 5th inst. After describing and discussing the chief characteristics of the three types of steam-turbine, which practically cover the whole field of useful turbine inventions, a table and diagrams were shown to illustrate the manner in which steam consumption is influenced by the size of the plant and the degree of vacuum obtained. The importance of a good vacuum to the economical working of steam-turbines was urged, and the authors pointed out certain special conditions and arrangements which must be observed in order to obtain a vacuum of 27½in. to 28in. An apparatus called a vacuum augmenter was described, which has been designed by the authors, and which consists of a steam jet placed in a contracted pipe between the condenser and the air pump. With this apparatus, a total net reduction of steam consumption of about 8 per cent. at full load has been obtained. Various applications of steam-

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turbines for driving pumps and for working fans for colliery ventilation and blast-furnace work were also alluded to. The remainder of the paper dealt with the application of the steam-turbine to marine propulsion. The various phases in the development of the steam-turbine for this purpose were traced, and the several vessels to which it has been applied were described. The experience gained from the cross-channel steamers and yachts showed that turbine vessels possess the valuable characteristics, that the propellers do not race in a heavy seaway, that the vessels maintain their smooth water speed to a remarkable extent in heavy seaway, and that they start, stop, and manœuvre promptly. The paper was illustrated by drawings showing the arrangements of turbine machinery suitable for an Atlantic liner, a cross-channel steamer, and a warship.

Books Received.—"Dynamo-Electric Machinery," by Prof. Silvanus P. Thompson, seventh edition, vol. 2 (E. and F. N. Spon, Limited, London. 30s. net). The present edition has been practically rewritten, and out of the 800 pages contained in the sixth edition less than 100 pages have been retained. This has been necessitated by the vast extension of alternate-current machinery which has taken place during the last nine years. The book is profusely illustrated, and contains a copious index.—The December issue of the "Tyneside Electrical Pioneer" is a specially prepared Christmas number, and the cheering cover and text are appropriate for the season. This little magazine is published by the Newcastle-upon-Tyne Electric Supply Company, Limited, whose enterprise has done much towards the extension of electric lighting in their district, and in its pages are some interesting little articles.—The September issue of the "Technology Quarterly and Proceedings of the Society of Arts" (America) contains a number of interesting papers and notices.—The *Journal* of the Western Society of Engineers (Chicago) for October contains a report of the International Railway Congress of 1905, and a paper by Mr. James R. Cravath on "Illuminating Engineering," together with other contributions and abstracts.—In the December number of the *Wisconsin Engineer* there are a number of interesting papers, including one by Mr. F. E. Turneaure on the "Progress of the College of Engineering," from which we see that the electrical laboratories are being enlarged and additions to standard equipments in the dynamo laboratories are being made, with considerable improvements in the department of electrical testing.—The December number of the journal of the Central Technical College Old Students' Association, known as the *The Central*, makes a belated appearance, due to the fact that one of the editors has only recently returned from South Africa. It contains a portrait of Prof. W. E Ayrton and articles on "Electromagnetic Separation of Ores" (illustrated) by Mr. C. J. Guttmann, the "Castleblaney, Keary, and Armagh Railway," by Mr. K. Rise-Oxley, etc. The Harvard Engineering *Journal* for November includes contributions on "Hard-Drawn Copper Wire" by Mr. T. B. Doolittle, and the "Distribution of Pressure and Current over Alternating-Current Circuits" by Dr. A. E. Kennedy.

German Patent Practice.—Complaints are made by American inventors at the treatment of their German patent applications, and the report of Consul-General F. H. Mason, in which he makes comparisons between the United States *v.* German Patent Office practice, shows justifiable grounds for the complaints. He says that it is not uncommon to hear American and other foreign inventors complain of a hostile and forbidding attitude on the part of the examiners at the German Patent Office, as though the duty of the latter were to assume that every invention presented for a patent is defective or plagiarised until the contrary is proven—in other words, to discourage rather than encourage the protection of meritorious inventions by patent. He then cites some of the difficulties under which American inventors labour, and as the same terms apply to all foreigners, it may be of interest to English inventors to bring them to light. In the first place, a foreign inventor may not deal directly with the Imperial German Patent Office. He must be represented there by a patent attorney of recognised standing, by whom the application and specifications are presented, and through whom additional details or explanations may be asked for by the examiners. There is kept at the German Patent Office a list of recognised patent attorneys who are located in Berlin and throughout the Empire. Secondly, specifications and claims for patents on American inventions, says Mr. Mason, are frequently presented in the form of translations made by persons who have only an acquired and superficial knowledge of German. Such translations, made with the aid of a dictionary, mechanically translate the words, and not the meaning, of important phrases, so that the specifications and clauses as filed are often incomprehensible. This entails additional correspondence, corrections, and frequently long delays which might have been obviated. Few persons, comparatively, are capable of translating a technical description so that it shall mean exactly the same in a foreign language as in the original, and it is this want of exact completeness that often loses a foreign patent or renders it, if gained, loose in its provisions and impaired in value. The subject is one which commands universal attention, and a clearer understanding of the requirements of the patents laws of the various countries would avert loss of time and money and avoid the possibility of friction and litigation.

Electrical Development in South Africa.—In an interesting United States consular report, Mr. Consul Snodgrass states that, although British firms have been capturing the majority of contracts in South Africa, the United States can come in for a larger share of the trade by the prosecution of an energetic campaign and by having competent men in the field. The great activity in the electrical trade, reports the consul, is not by any means confined to South Africa, for in Egypt and other northern provinces large electrical problems are under consideration. As an instance, the Soudan Government are considering the introduction of an extensive electric tramway system into Khartoum. Neither cables nor overhead wires will be used, the intention being to store the electric power in the cars. It is expected that the system will be extended to Omdurman. In South Africa, especially in the Transvaal, the demands on electrical engineers are multiplying to an enormous extent. There appears to be a feeling of optimism among the small cities as well as among the larger ones, which is bringing about a larger expenditure for utilities. Electrical hoists are being installed in nearly all the mines, electrical elevators are being placed in many of the business houses and in the tall buildings of Johannesburg, and in nearly every town of any importance some large electrical project is either in hand or in contemplation. In the city of Pretoria the citizens have been worrying along with a horse-car line, which penetrates the centre of the city, and has, perhaps, three miles of track. The Town Council are arranging to convert it into an electrical system at an outlay of several millions, it being the intention to lay 15 or more miles of track throughout the municipality, and also to connect the numerous suburbs lying within a radius of five or six miles. At Johannesburg several millions were spent in installing an electric tram system, but Mr. Snodgrass laments the fact that practically all the contracts were captured by representatives from Scotland and England.

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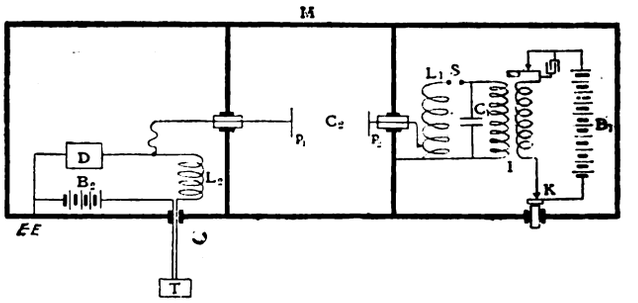
At Volksrust and Klerksdorp it has been decided to erect lamps. The report goes on to urge Americans that if they care for this trade they will have to wage a war for it against the Britishers, who are on the ground, and are in possession of the country. It concludes, however, that as America has captured the mining machinery trade on the Rand from all competitors, even under British rule, it can do likewise in the electrical field if the same amount of energy, concerted effort, and brains are expended as were laid out by the pioneers in the goldfields.

Power at the General Post Office.—Any interference with a continuous supply of power to the General Post Office would result in an inconvenient dislocation of the whole postal system of London, and the authorities at St. Martin's-le-Grand, realising this, have embarked upon a scheme for the provision of power from their own generating station. The question of cost has to some extent influenced them in their decision, for it is claimed that the change will result in a saving of 75 per cent. What the Post Office requires is practically a day and night load, because in the daytime the power plant is in full operation, and during most of the night current is required for lighting the premises. In this way they approach the central-station engineer's ideal of a very economical load factor. The present generating plants located in the various buildings will be disestablished, and, quite apart from the question of safety to the buildings themselves, there is to be considered the nuisance which is caused by the emission of steam and coal dust, so that removal should be welcomed. The new scheme provides for the supply of current for lighting and power purposes to the three Post Office buildings in St. Martin's-le-Grand, the new structure now in course of erection on the site of Christ's Hospital, and the Post Office buildings in Queen Victoria-street, but it is not contemplated to supply current to the depôt at West Kensington. The power station will be at Upper Ground-street, Blackfriars, on the river bank, which will admit of barges with coal coming alongside, and also of the use of river water for condensing purposes. A plant equal to about 3,600 h.p. will be installed, but the station is designed for indefinite extension. At the outset it is not proposed to use turbines, because for the number of units necessary to avoid the possibility of temporary stoppage, turbines would be too small to be economical, as compared with reciprocating engines. At the present time one chimney, 180ft. in height, has been completed, but the proposal is ultimately to have a second chimney as a stand-by. Buildings and plant together will cost £100,000, and this figure takes no account of the cost of the site. The power station will be within a mile of the General Post Office, which means that the cost of the cables will not be excessive. They will be duplicated throughout, and with the exception of Blackfriars Bridge, where they will cross the river, they will be laid in separate streets. This is naturally intended to avoid the risk of breakdown in the case of any accidental damage to cables. Across Blackfriars Bridge itself the cables are to be carried on opposite sides of the roadway. As regards voltage, the proposal is to generate current directly at 6,000 volts, and to transform down at the Post Office to suitable voltages for power and lighting purposes. A very considerable proportion of the current will be used for compressing air for pneumatic tube transmission. At present practically all the central London work in connection with the telegraph service is dispatched by pneumatic tubes, but proposals are under consideration for dealing with the letter work between the General Post Office and Mount Pleasant in the same way. Another of the applications of electricity in the Post Office is for working air-compressing engines for the pneumatic dispatch plant, lifts, fans, stamping machines, and a multiplicity of small appliances used for a great variety of purposes. A machine worked by an electric motor is now employed in obliterating the postage stamps on letters at a speed of 600 letters per minute, a work which in the old days was entirely done by hand at, say, 50 to 60 letters a minute. The project is being carried out entirely under the direction of Mr. J. Gavey, C.B, M.I.C.E, the engineer-in-chief to the Post Office, and Mr. Martin Roberts, M.I.C.E, the assistant engineer-in-chief.

Testing Wireless Receivers.—Mr. Greenleaf W. Pickard has conceived a new method of testing wireless receivers, which he describes in a recent number of the *Electrical World and Engineer*. Hitherto it has been the common practice among experimenters to set up miniature sending and receiving antennæ placed a short distance apart, energising the sending antenna, a simple ungrounded Hertzian oscillator, by means of a small induction coil. The method employed by Mr. Pickard utilises a closed oscillating circuit adjusted to the desired frequency, which is carefully shielded from the detector under test, but is connected thereto through a circuit of impedance so great that the resistance of the detector forms but a negligible part of the impedance. This is accomplished by inserting a variable air condenser of extremely low capacity in the circuit. Under these conditions the flow of current through the detector is governed solely by the value of the capacity, the impressed E M F., and the frequency. As the oscillating circuit, the air condenser, and the detector are separately shielded from each other and from external objects, the electrostatic capacities of these circuits are fixed quantities, with the exception of the air condenser, and movements of



the observer are, therefore, without effect. The diagram illustrates the arrangement of apparatus, circuits, and shields. M is a shield of tin or sheet zinc, forming a rectangular box with three compartments, which are fitted with metallic covers or doors giving ready access to the compartments. The compartment on the right contains the battery, key, and induction coil, together with the oscillating circuit. The induction coil, I, the spark length of which is preferably 1in. or less, charges the condenser, C_1, which discharges across the spark-gap, S, through the inductance helix, L_1, thereby setting up oscillations of a frequency depending upon the values of the capacity and inductance. One terminal of the inductance helix is connected to the shield, while from an intermediate point along the helix a lead is taken through the detector to be tested, one terminal being connected to the plate, P_2, of the variable air condenser, C_2, in the middle compartment. The other plate of this condenser is made movable, being attached to a stout wire which slides easily in the glass tube leading to the left-hand compartment. In this latter compartment is placed the detector to be tested, one terminal being connected to the plate, P_1, of the air condenser, and the other to the shield. The local circuit of the detector passes out of the shield to the telephone receiver or galvanometer, T, a suitable choke coil, L_2, being interposed on the air condenser side of the detector. With the exceedingly sensitive

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detectors now used in wireless telegraphy, the current strength required to give an observable signal is very small. By making the plates, p_1 p_2, in the form of metal discs 1cm. in diameter, and separating them several centimetres, the capacity may be reduced to less than one-hundreth of a micro-microfarad, and the current to a fraction of a micro-ampere. Mr. Pickard claims that this method also affords a source of oscillatory current suitable for testing tuned receiving circuits, giving current values comparable with those obtained in commercial wireless telegraphy over long distances. As the damping in the oscillating circuit is comparatively small, the oscillations are persistent, corresponding to those used in high-power wireless stations.

Wharf Cranes.—Facilities for transportation by land and sea have made considerable progress, but the development of the means for transferring goods from one great carrier to another has not been commensurate with the demands. Some of the greater steamship lines have very recently equipped their wharves with electric hoists, and signs are not wanting to show that both railway and steamship companies are awaking to the fact that they must make the necessary expenditure for freight-handling machinery if the work is to be done economically. About two years ago the Pennsylvania Railroad Company began to construct a new freight terminus in the New York Harbour at Greenville, N J., to be operated electrically.

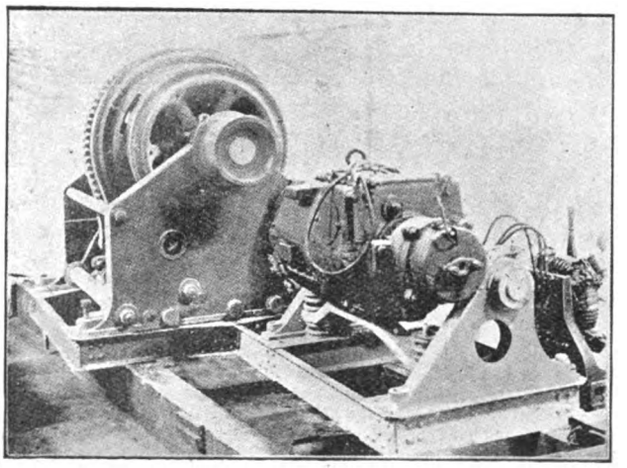

FIG 1.

Mr. John Lyle Harrington, in a paper which he contributes to the Canadian Society of Civil Engineers, describes the equipment, which he considers the most advanced type yet developed for the purpose. There are three cranes erected upon a pier 120ft. wide by about 1,000ft. long, substantially constructed of timber and especially designed to carry the cranes. Each crane in working order weighs about 125 tons, the height is about 100ft.; they are designed to handle a normal load of 10 tons of package freight and to operate a clam shell bucket of about 60 cubic feet capacity for handling the bulk freight. Each crane is carried on four four-wheel trucks running on two tracks of 14in. gauge. All the engines and the air compressor are electrically operated, and are situated in the rear of the engine-house. The operators, however, are stationed one on either side of the crane. The levers for operating the friction clutches and brakes are led to the operators' stands, where the controllers are also placed. The cranes are provided with electric lights and telephones for inter-communication or for communication with the shore. Each truck is composed of four standard chilled car wheels of the heaviest type, standard 5 × 9 journals, journal boxes and bearings, and a steel frame composd of heavy 15in. channels, substantially braced. Two trucks are provided with air brakes, and each of the other two is fitted with a 25-h.p. railway type motor and cut spur reduction gearing for operating the crane on its tracks (as shown in Fig. 1). The main hoisting engine is designed to handle either the package freight on a one, two, or three part rope, or to operate the clam shell bucket. It is fitted with a solenoid brake and with an exceptionally large and efficient load brake, which prevents the load from running down in case the current should be cut off, or accident should happen to the motor. The engine is operated by a 100-h.p. motor wound for 500 volts direct current and mounted on springs. Fig. 1 also illustrates the third auxiliary engine employed to operate the auxiliary hoist for placing slings under the loads of package freight. The hoisting rope is led directly from the engine to a sheave in the rear of the boom, thence forward to a block suspended by a slide from the underside of one part of the boom. The rope is then led around the running block in the usual manner. The slide is moved along the boom and held in position by a continuous rope running over the sheaves at both ends of the boom and operated by the winch-head on the engine. The

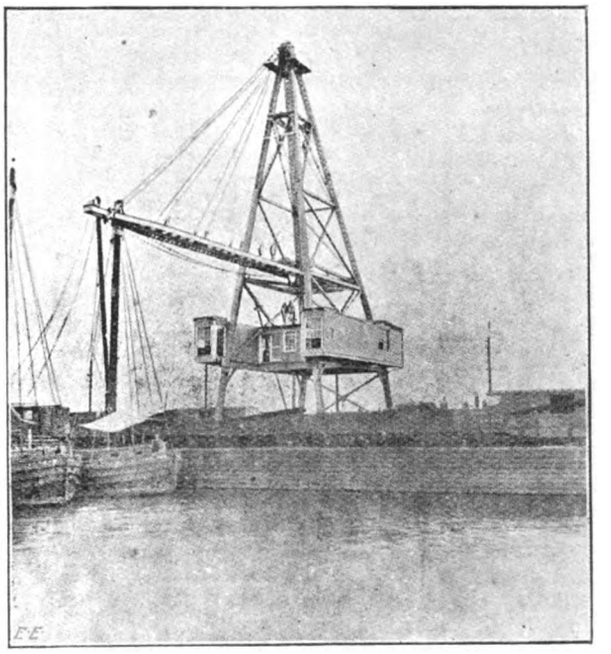

FIG. 2.

boom consists of two symmetrically disposed parts, each composed of an I beam and a channel well braced together. The truck runs on rails placed directly upon the I beams. As shown in Fig 2, the boom extends to the extreme rear of the tower, where the horizontal thrust due to the weight of the boom and the tension in the trolley ropes is carried by a heavy girder. The guy ropes always occur in pairs in order that the hoisting ropes may traverse the length of the boom between them, and they are so attached that the respective halves of the boom are balanced under load, and do not twist. A water-main is carried along the entire length of the pier just beneath the floor, and each crane is provided with universal nozzles, and connections are made so as to render each crane a veritable fire-engine. The cranes were designed to operate on their tracks at a speed of about 180ft. per minute under the greatest estimated resistance. The motors are, however, under series-parallel control, and operate together at full or half speed. The resistance is nominally far below the maximum, consequently the speed of operation is commonly much greater than 180ft. per minute. The machines are large and expensive, but, according to Mr. Harrington, they have so thoroughly demonstrated their merits while they have been in operation, that in future there is little doubt that similar machinery will be employed on all large wharves.

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THE LONDON, BRIGHTON, AND SOUTH COAST RAILWAY ELECTRIFICATION.

As was announced by us a fortnight ago, the contract for the electrification of the above railway company's line from Victoria to London Bridge has been placed with the Allgemeine Elektricitäts-Gesellschaft of Berlin. There has been an outcry in the daily papers—organised, we believe, by interested parties—against the placing of such an important contract abroad. The usual plea that English firms were capable of doing the work was put forward. This outcry, however, was quite unjustified, as nine-tenths of the work involved in the contract will be sublet to English firms. The reason why the main contract was placed with the Allgemeine Elektricitäts-

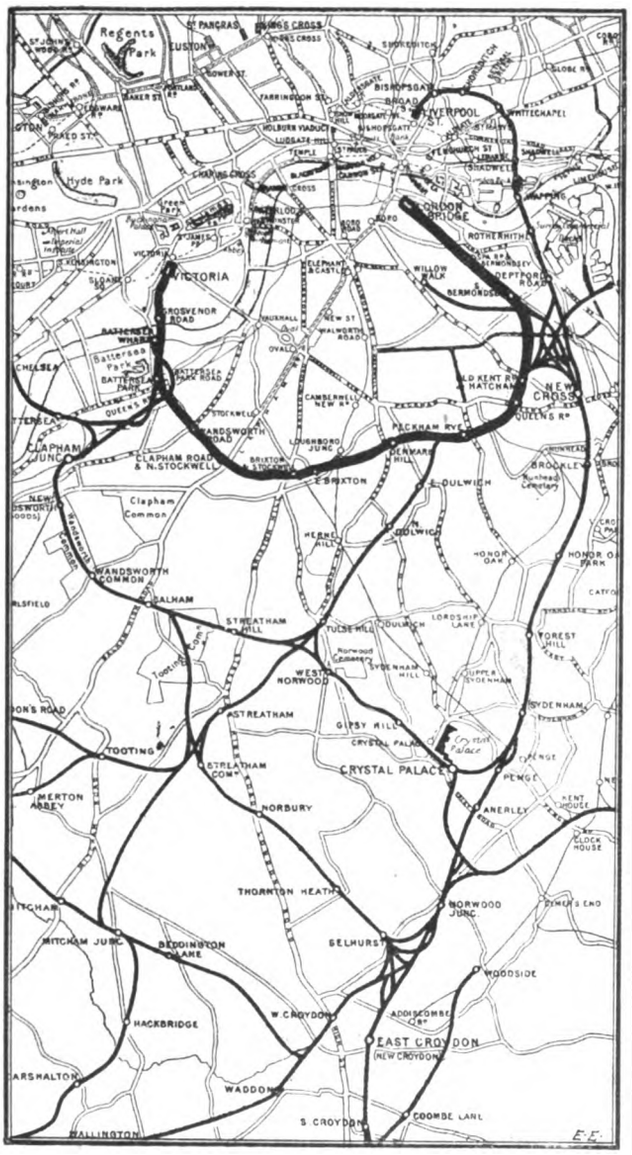

FIG. 1.—Map of the Suburban Lines of the L. B. and S. C. Railway. The portion to be electrified is indicated by the thick line.

Gesellschaft is that their tender for the Winter-Eichberg single-phase system gave more favourable results, both from a technical and commercial standpoint, than any other. This system was originated by the staff of the Union Company of Berlin, which has now been merged into the Allgemeine Elektricitäts-Gesellschaft. The Union Company was the German branch of the General Electric Company of America, which is represented in this country by the British Thomson-Houston Company. We are pleased to notice, therefore, that the British Thomson-Houston Company has a large interest in the present contract, and that all the switchgear will be manufactured at Rugby. The firm are the owners of the British patents for the Winter-Eichberg system. It has been arranged that after the first few equipments have been supplied from Germany, the rest of the motors and the controllers for the trains will be likewise manufactured in Rugby. The reason why the first equipments are to be made in Germany is that they are to be duplicates of those which have already been built and worked successfully by the Allgemeine Company. Hence they can be supplied at a much earlier date than would be possible if they had to be manufactured at Rugby. We are pleased to see that the British Thomson-Houston Company is extending its success as contractors for heavy railway electrifications. Thus they have already been responsible for the equipment of the Central London Railway, the Great Northern and City Railway, the North-Eastern Railway, and the District Railway. The company now has contracts for all the motors and control equipments for the various tube railways controlled by the Underground Electric Railways of London, Limited, and also for the Great Western and Metropolitan Railways for the equipment of the Hammersmith and certain other lines. The number of motors for this class of work which they have furnished or are under contract to furnish in England is nearly 2,000.

Coming, now, to the London, Brighton, and South Coast line from Victoria to London Bridge, we show in Fig. 1 a map of the route, which also includes a number of other lines belonging to the company which will doubtless be electrified after experience on this first route has been obtained. As evidence of this, the contractors, under the advice of their general manager, Mr. W. Forbes, have decided to equip electrically all the lines in both stations. This involves no less than 11 lines at London Bridge Station and 13 at Victoria. Thus the electrical trains will be able to run into any platform. It will also enable the

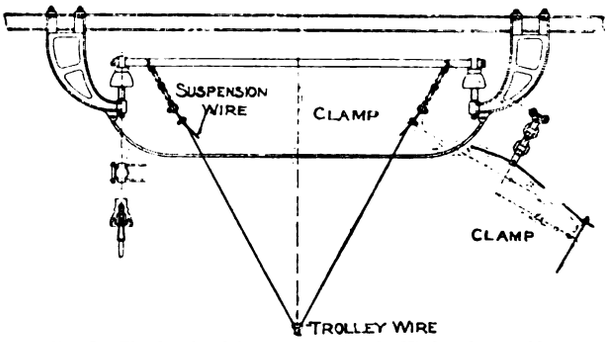

FIG. 3.—The Overhead Construction for the Niederschoneweide-Spindlersfeld Railway

overhead work, as complicated by numerous crossings, to be severely tested before dealing with the whole traffic of the stations in question. It will be seen that the line now to be equipped is one which does not go far into the suburbs, and which has suffered from the competition of the London County Council tramways. It remains to be seen how far the quicker electric service on this route will regain the traffic taken by the tramways. In our opinion the great value of the present electrification is that it is to be carried out on a system most suitable for extension not only to the suburban lines shown on the map, but also, if need be, to the main lines to Brighton and elsewhere. As far as the present route is concerned, there will be two distinct gains from the electrification. Owing to the very high acceleration which the electric motors will give, the average speed of the trains will be doubled. This is a great advantage, but a still greater gain is expected at the two end stations, London Bridge and Victoria. With the steam trains it has been proved that the time which must elapse between the train coming into the station and going out again is six minutes. A good portion of this time is spent in the shunting of locomotives, which, of course, can only be done with due consideration to other traffic on the lines. We reproduce in Fig. 2 a plan of the London Bridge Station, which shows how numerous and complicated are the crossings at the approach. With the new electric trains now proposed this six minutes' interval between the arrival and dispatch of the trains is expected to be reduced to two minutes. If this expectation is realised, it is equivalent to increasing the size of the station. In other words, the existing lines and platforms will be able to deal with two or three times the number of

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trains in the busy hours. If the value of this gain were capitalised and compared with the cost of extending the station and lines to get the same facility, the financial result would more than justify, in our opinion, the whole cost of the present conversion.

In this electrification the directors have been advised by Mr. Phillip Dawson (of the firm of Messrs. Kincaid, Waller, Manville, and Dawson), and all concerned have taken a good deal of trouble to arrive at the best system. Practically all the firms capable of undertaking work of this magnitude have tendered. They have been given a free hand to enable them to show the best results with the particular high-voltage system with which they have had experience. The examination of these tenders has hence involved a great deal of arduous labour, and the victory of the Winter-Eichberg system must be very gratifying to those firms owning the patents. We are reproducing after this article the paper presented by Mr. F. Eichberg to the International Electrical Congress in America at the end of last year.* In this will be found a full description of the essential features of the system, and a reference to a number of railways which have been equipped on the Continent. Fig. 3 shows the details of the overhead conductor on the Niederschöneweide-Spindlersfeld. The three photographs (Figs 4, 5, and 6) are of the Stubaital line near Innsbruck. They are taken from an excellent description of this line appearing in the current issue of *Elektrische Bahnen u. Betriebe*, which we hope to reproduce in full in our next issue. With this information our readers will have little difficulty in following the general principles of the system to be used on the London, Brighton, and South Coast Railway, and they will also see the details of work successfully accomplished by this system on the Continent. The conversion of this English line, however, presents novel points, and these have to be specially solved. It will be quite time to go into full details when the solution of these problems is an accomplished fact, rather than now, when approved drawings only exist. It suffices now, therefore, to give general outlines rather than actual details. The current required for this line between Victoria and London Bridge will be purchased from some supply undertaking, but no contract for this has yet been settled. The voltage on the single-phase overhead conductor will be from 6,000 to 6,500 volts, and the frequency of the alternating current will be 25 complete periods per second. The overhead construction will be of an entirely new type and remarkable for its great strength. The catenary construction is to be developed into practically a suspension bridge of sufficient strength to carry quite a number of men even midway between two supports. The sub-contract for this work has been placed with Messrs. R. W. Blackwell and Co., which will ensure that no detail will be lightly adopted or allowed to pass without most careful examination. The actual design of the overhead construction had been considered and provisionally sanctioned by the Board of Trade.

Coming now to the trains themselves, the unit in the building up of the same will be three carriages, of which two will be motorcars. There will be four motors on each of these cars, making eight motors per train, with an aggregate power of about 1,200 h.p. If need be, two or

FIG. 2.—The London Bridge Station of the L. B. and S. C. Railway, showing Approach.

* A full mathematical investigation by Mr. F. Eichberg of the relative advantages of different types of single-phase motors will be found in our issues for Feb. 26, March 11, and March 18, 1904.

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three of these units can be joined together to form longer trains. As regards the energy consumption of these trains, full guarantees have been obtained from the contractors, and we are assured that considerations of efficiency and energy consumption per train mile largely influence the decision arrived at. The average power factor was also found to be considerably higher with the Winter-Eichberg system than with any other. The decision, therefore, may be looked upon as a victory for the compensated repulsion type of single-phase motor over the plain series type.

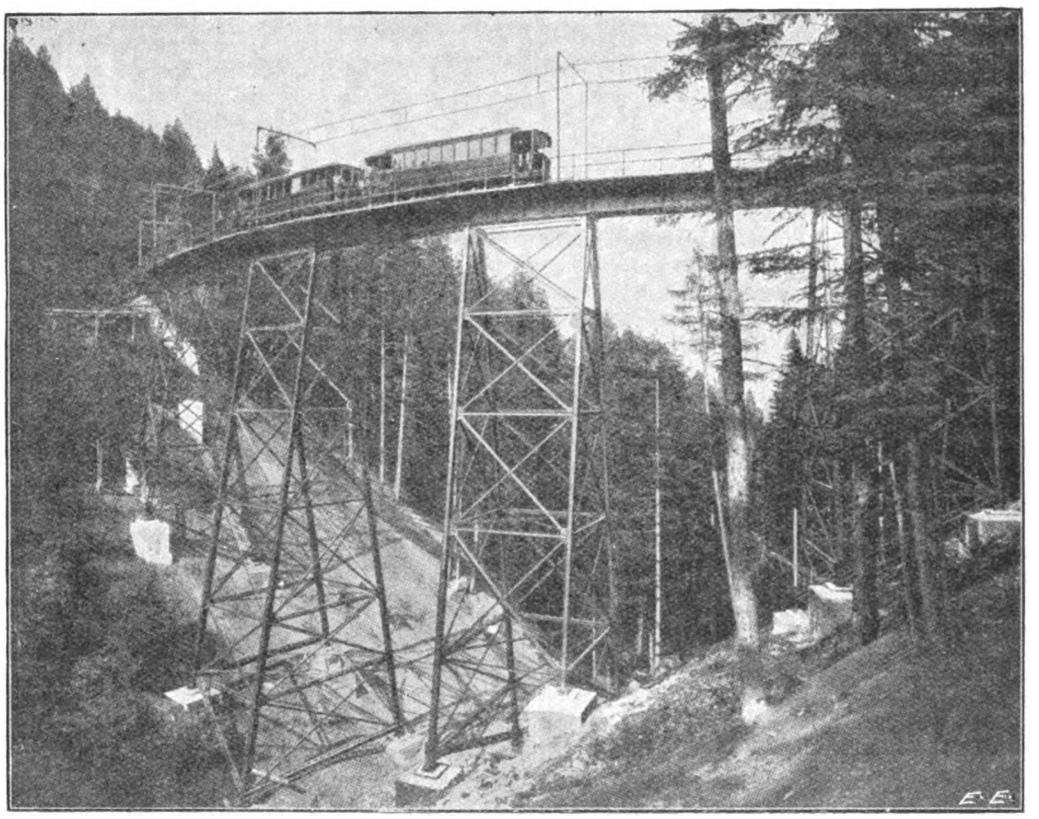

FIG. 4.—The Kreiter Viaduct with Single-Phase Equipment.

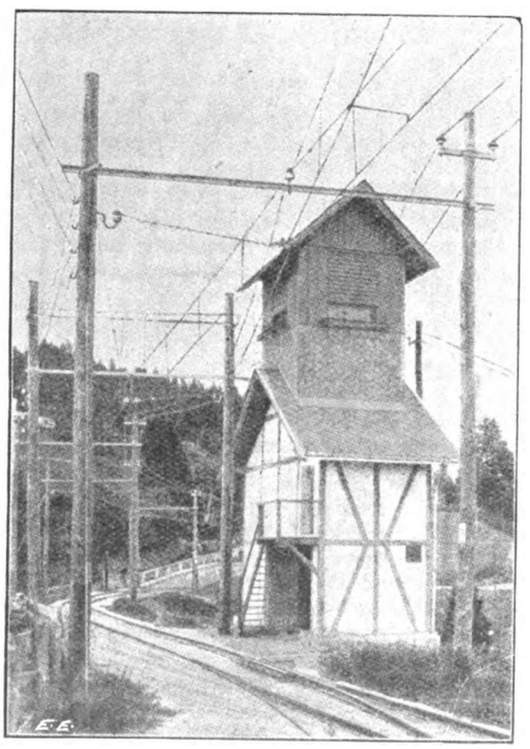

FIG. 5.—A Sub-Station on the Stubaital Railway.

In conclusion, we have to thank Mr. W. Forbes, the general manager of the railway, and Mr. Phillip Dawson, the consulting engineer, for all their courteous answers to our inquiry for information.

SINGLE-PHASE RAILWAY MOTORS.

BY FRIEDRICH EICHBERG.

The standard direct-current railway has probably been developed to its final stage. The combination of alternating current for the transmission of power, rotary converters for the conversion into direct current, and direct-current car motors is not, however, an economical solution except in rare cases. Recognising this fact, Brown and Boveri (Burgdorf-Thun) and Ganz and Co. (Valtellina line) took up the direct application of polyphase alternating currents. But even if the polyphase system has achieved practical success in special cases, it has not been proven thereby that the polyphase motor furnishes a universal

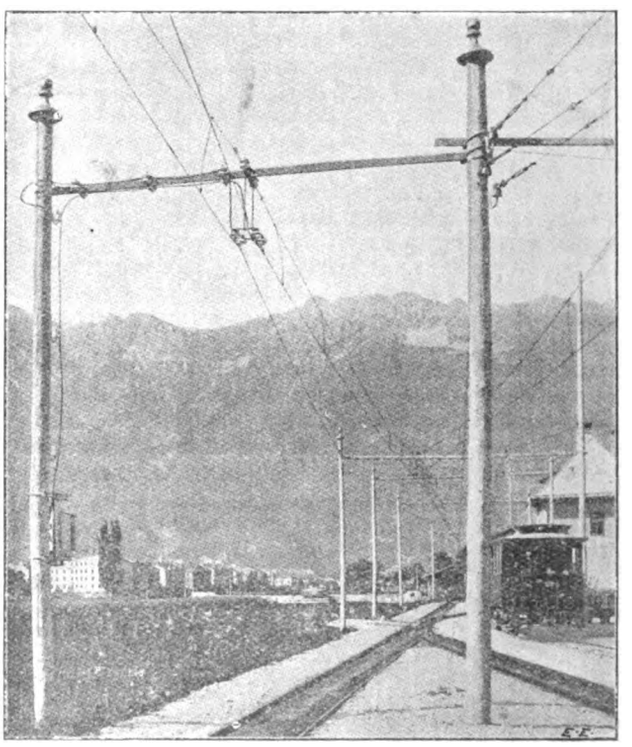

FIG. 6.—The Terminal Station at Wilton, Stubaital.

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solution of the electric railway problem. It is not necessary here to repeat all the objections that European and American engineers have brought forward in numerous discussions against the polyphase motor. The multiple trolley for the collection of current, which is unavoidable in the polyphase system, leads to complications in the overhead work and sets narrow limit to the line voltage available. For short roads (lines between neighbouring cities) the polyphase system, moreover, leads to excessive cost in the installation of the conducting system. Add to this that the polyphase motor, by reason of its characteristic speed curve, which resembles that of a shunt-wound motor, is almost or quite unfit for railway purposes. It cannot be disputed that it is possible to operate on schedule time upon special lines with a favourable profile, but this proves nothing as to the general applicability of the polyphase motor.

For two years, as is well known, efforts have been made to apply the single-phase motor to railway purposes. B. J. Arnold, with his electro-pneumatic system, and the Oerlikon Company, with the Ward-Leonard system, offered only incomplete solutions of the problem of applying single-phase current to railways. The first announcement of the direct application of single-phase motors came from Lamme, of Pittsburg, and was followed soon after by the publication of Finzi in Milan. The former used a frequency of 16 and the latter 18 cyles per second. Both have built series motors similar to the direct-current series motor. The former uses for the compensation of the armature reaction short-circuited windings, which are applied to the field-magnet coils, and whose axis coincides with that of the brushes. The latter uses slots in the poles for the diminution of the armature reaction. Later the work of G. Winter (see

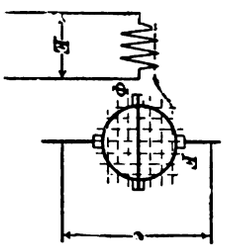
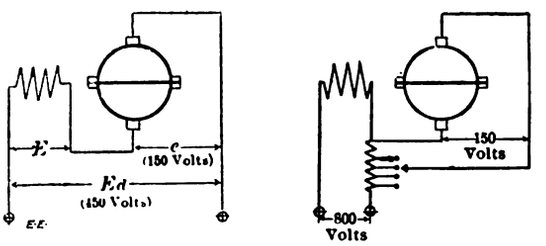


FIG. 1.—Diagram of Winter-Eichberg Motor.

Elektrotechnische Zeitschrift, 1904, No. 4), of Vienna, became known to the writer. This furnished the basis of the system worked out by the Union, and especially by the Allgemeine Elektricitäts-Gesellschaft. This system, which forms the subject of this paper, has been put into operation on the Niederschöneweide-Spindlersfeld line under the management of the Royal Prussian State Railway, and on the Stubaital line, near Innsbrück, which was opened on July 31, 1904. The first line operates with 6,000 volts and 25 cycles, and the second with 2,350 volts and 42 cycles. In perfecting this single-phase system the motor, of course, played the chief part. In a lesser degree the controlling apparatus and those devices which become necessary in the direct application of high tension to the car were also of importance.

In regard to the motor of the Winter-Eichberg system, it unites the properties of the ordinary alternating-current series motor with those of the repulsion motor. Its characteristic features are the following: In the motor, in addition to its own magnetic field, F (Fig. 1), there is developed, as in the repulsion motor, a cross field, ϕ, which at synchronism is about as strong as a magnetic field, F, from which it differs in phase by 90deg. This means that when the motor is near synchronism a complete rotary field is established, the field being less developed below or above synchronous speeds. On account of the cross field developed in the motor, the short-circuited E.M.F. under the brushes diminishes with increasing speed, becomes nearly zero at synchronism, and then increases again with increasing speed. In regard to armature voltage, these motors are essentially similar to the ordinary series motor. In both the tension per commutator segment may not exceed a certain value, and according to the size of the motor the armature voltage will, therefore, lie between 100 and 200 volts. In the ordinary series motor, in which the working voltage appears in the armature, the working voltage would, therefore, not exceed 200 volts. It is otherwise with our motor. Since the armature is short-circuited along the working axis, and the working voltage appears only in the stator field windings, the voltage supplied to the motor may be as great as desired. But even for the case where the excitation is inserted in series with the stator winding (Fig. 2), the entire working voltage, E, is in the same proportion to the armature voltage, *e*, at rest, as the entire volt-ampere input is to the volt-amperes for magnetisation at rest.

Let us suppose that the magnetising current is one-third of the armature current, which is a good practical mean; then the working voltage in the motor of our system, even with the direct introduction of the excitation, is three times as high as in the ordinary series motor. Through the insertion of a small transformer (Fig. 3) one can increase at will the proportion of the working voltage to the armature voltage without great expense (Figs. 2 and 3). The excitation, by means of the armature in combination with the cross field, yields an E.M.F. which is 90deg. ahead of the working E.M.F., and directly opposite to the E.M.F. of self-induction. This wattless counter E.M.F. gives the motor the well-known rapidly rising cos curve (see *Elektrotechnische Zeitschrift*, 1904, No. 4). Our first 100-h.p. motor had with a 3mm. air-space on each side a power factor of 0·9 even at 70 cent. of synchronism. Even more important is the fact that this good power factor is obtained with a number of ampere-turns per centimetre almost twice as great as in the ordinary alternating-current motors. From this results the possibility of building a very powerful motor for a given armature diameter and external dimensions.



FIGS. 2 AND 3.—Stator Windings.

Another characteristic property of our system is that the field can be controlled independently of the voltage in the working windings. In every alternating-current commutator motor there are magnetic losses in the coils short-circuited by the brushes. Through the possibility of adjusting the field in proportion to the stator current, one can keep these losses under the brushes within such limits as will permit the commutator and the brush-holders easily to conduct away the resulting heat. By varying the field one can, for a given working voltage, give the motor a variable characteristic. The separate characteristic curves will then be somewhat related, as the curves of a 3, 4, 5, and 6 winding motor. Control independent of this naturally is possible, and also control of the load voltage. The accompanying diagrams give examples of the control as carried out in practical cases. In Fig. 4 the primary voltage is not regulated, and only the secondary winding of the exciting transformer is altered. The absence of any primary regulation in the high-tension circuit offers the special advantage that only low-tension circuits will have to be opened or closed when the car is to start, reverse, or alter its speed. A still more complete solution is shown in Fig. 5, the stator circuit as well as the exciter circuit being regulated. This method of connection is less advantageously applied to high-tension motors, because the high-tension circuits generally cannot be readily altered in operation. The third diagram (Fig. 6A and 6B) shows the method of control, which, although not quite so complete as that of Fig. 5, is yet of value for small low-tension cars, and which will shortly be put in operation on a short Belgian road. The scheme of Fig. 5, with the modification represented in Fig. 7, was installed on the Stubaital line, near Innsbrück, now in operation, which is at times operated at 2,350 volts and at other times at 400 volts. The direct insertion of the excitation in the stator circuit (Fig. 2) in

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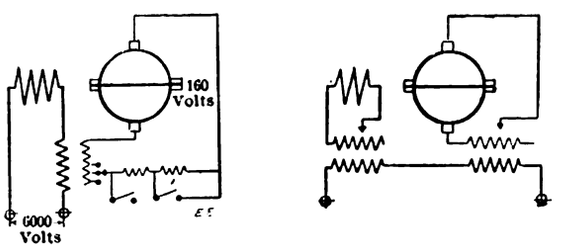
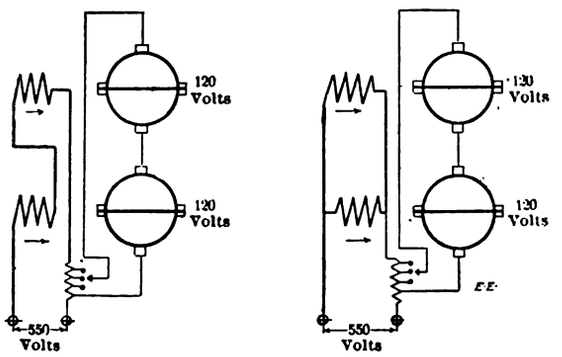
which the control is effected by ohmic or inductive resistances with the eventual application of series-parallel regulation, is possible for small cars, and hence chiefly applicable to short railway lines. In the latter case the motors can be built simply for 550 volts. Motors for 550 volts connected in this manner are already in operation, and will also run on direct-current lines (Figs. 7A and 7B).

The possibility of running an alternating-current motor with direct current is of great importance in practical application. Ordinary series commutator motors, which are built on the compensated system of Deri, can, of course, be run both on direct-current and alternating-current circuits. The voltage for the direct-current motor is one and a half to two times higher than the armature voltage with alternating current. Since, as we have shown above, the alternating-current voltage, which in our motor system can be directly applied, may be three times greater than the armature voltage, the ratio of direct-current to alternating-current voltage will be, not as in the series motor, $3 : 1\frac{1}{2}$ or $3 : 2$, but $3 : 3$ to $1\frac{1}{2}$ or 2—that is, the direct-current voltage will be about half that of the alternating-current voltage. This allows, for example, the running with direct currents with motors connected in series and with alternating current with the motors connected in series, and with alternating current with the motors connected in parallel, but in the former case at less speed. This corresponds to the case in common practice where cars which travel over interurban stretches at high speed transfer to the direct-current systems of cities, where lower speed is demanded.



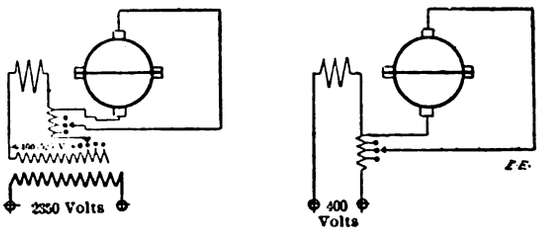
FIGS. 4 AND 5.—Diagram of Methods of Control.

There are various ways of running with the motor connected according to Fig. 1 on direct-current circuits. The method which has proved itself most practical is represented in Fig. 8. In the direction of the diameter of the exciter axis a winding is applied which counteracts and opposes the armature ampere-turns. The stator field windings then produce a magnetic field with direct current, and the exciting windings on the armature represent with direct current the working ampere windings. The field saturation in direct-current working is then somewhat greater than with alternating-current, while the density in the armature is somewhat less. These properties are extraordinarily favourable for practical operation. The auxiliary winding, *h*, is inserted only when operating with direct current. In order to make better use of the armature, the field windings of two motors can be connected in parallel in the direct-current circuit, while, in order to be able to operate at 500 to 550 volts with direct currents, the armatures can be connected in series. These conditions are represented in Fig. 9. In the alternating-current system one can operate according to the method of either Fig. 3 or Fig. 6. If operated according to plan 3, then with alternating currents the connections 2, 4, 5 are closed and 1 and 3 are open. With direct current, 1 and 3 are closed and 2, 4, and 5 are open.



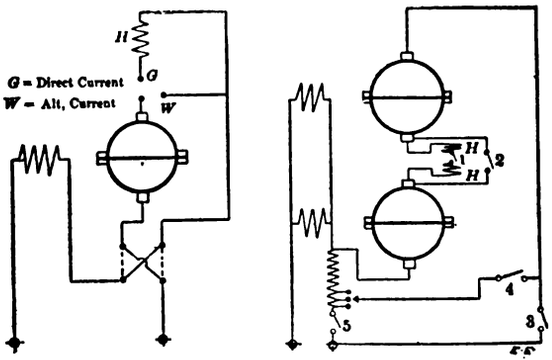
FIGS. 6A AND 6B.—Method of Control for Low Potentials.

The motor system which I have above briefly described will not be the only one in the field. I cannot, however, undertake to pass an unbiassed opinion upon the different systems possible. I can only briefly mention the reasons why, in my opinion, the alternating-current commutator motor, which has been long known in two general types—namely, the ordinary series motor and the repulsion motor—is not to be considered of equal value to the system above described. The ordinary series motor possesses, even if it is compensated, no cross field, and it has no rotary field. The short-circuit losses under the brushes do not decrease with increasing speed, and the power factor increases much slower with the speed. The maximum working voltage for which it can be built is 200 volts. When a short-circuit takes place in the field winding of the series motor, the motor becomes inoperative. Multipolar machines with series windings on the armature, if provided with the device shown in Fig. 1, can have an entire field coil short-circuited without the motor becoming inoperative. The separate field coils behave like transformers inserted in series. Any one of these can always be short-circuited, the others then receive correspondingly more voltage.



FIGS. 7A AND 7B.—Method of Control on Stubaital Line.

The repulsion motor, when contrasted with the arrangement of Fig. 1, has the disadvantage that its reversal is possible only by the application of a second field winding, or of several sets of brushes, or of reversible brushes. Its power factor is poorer, and for its control there remains only either the method of primary voltage control, the opening of short-circuits, or, finally, of brush reversal. The disadvantage of the type represented in Fig. 1, as compared with the series and repulsion motor, consists in the employment of two exciter brushes, which doubles the number of brushes in multipolar systems. These exciter brushes give rise to no difficulties with respect to short-circuit losses, as I have shown (*Elektrische Bahnen*, vol. ii., 1904). These short-circuit losses do not occur with exciter brushes. They carry, moreover, only one-third to one-fourth of the entire short-circuit current. On the other hand, the motor of Fig. 1, as compared with the compensated series motor and the repulsion motor with the double field winding, offers the constructional advantage of only one field phase, which guarantees good economy and great simplicity. In high-tension motors the increased certainty of operation in consequence of the absence of cross windings must be considered. Motors for either direct-current or alternating-current working provided with the auxiliary winding, *h*, which plays the part of the compensation winding of the compensated series motor, can, therefore, only be operated advantageously with low-tension alternating currents.



FIGS. 8 AND 9.—Motor Connections.

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The results of more than a year's operation on the 6,000-volt Niederschöneweide-Spindlersfeld line, on which during a great part of the day four 100-h.p. motors haul a 160-170-ton train, and on which daily two motors handle a 100-ton train, prove that the alternating-current motor is adapted to the heaviest traffic. Moreover, the direct application of 6,000 volts to the car has been demonstrated to be entirely safe. The Stubaital line, which has been running since July 31, 1904, at 42 cycles and 2,350 volts, has introduced an advanced practice for small roads, an advance which exceeds the boldest expectations of the year 1902. At that time it seemed as though only very low frequencies could be used. In the case of many roads running in connection with existing power stations, operating with 40 to 50 cycles, the possibility of using these frequencies limits the availability of alternating-current traction. Moreover, the possibility of operating also with direct current makes the alternating-current commutator motor in a certain sense a universal motor, and places it as regards its main features far above the direct-current commutator motor, which really represents only a special case of the alternating-current commutator motor.

THE LIMITATING FACTORS OF SYNTONIC WIRELESS TELEGRAPHY.

BY J. HETTINGER.

§ 1. The "possibility of tuning" and its "practical limitation" are two well-known facts in the practice of wireless telegraphy. The first forms the seductive incitement of the optimist; the latter increases the pessimistic view of many practitioners of this new branch of electrotechnics. The present communication has the objects (1) to show a method which permits the discussion of the practical value of syntony when the resonance curves are experimentally determined, and (2) to prove that the resonance method, as utilised nowadays, may be a *partial solution* for avoiding interference, but never can it be a *general* one.

The factors which I have to consider as determining the value and limiting the possibility of syntony are the following: (*a*) The *resonance curve* of the currents and of the E.M.F.'s of the energy induced in the receiving system; (*b*) the *transmitted energy*; and (*c*) the *relative distances* between the simultaneously working stations.

§ 2. *The Resonance Curve.*—This curve, which has to be experimentally determined, represents either the E.M.F.'s at the two ends of the detector, or the currents passing through the latter, as a function of the frequencies. Its importance consists therein that it possesses a maximum at the point where the frequency of the transmitted waves coincides with the natural frequency of the receiver, and that this maximum is supposed to be just great enough as to be equal to the working minimum of the detector. Naturally, in this case, the amplitudes corresponding to the untuned frequencies would not produce any interference. There are, however, several causes which render the maintenance of the curve maximum *at* the working minimum of the detector almost impossible, and, therefore, it is obvious that the amplitudes of the curve corresponding to the untuned frequencies may also influence the detector, and make it respond. Consequently, not only the maximum of the curve, but also its shape, is of great importance for the syntonisation, the degree of immunity being, for instance, different in the four curves of Fig. 1, which I may mention for illustration.

It is not within the scope of my present communication to show how these curves depend upon the purity of the transmitted waves, the exact adjustment of the receiving circuits to a certain natural frequency, the degree of coupling, etc., and I content myself by mentioning only their main characteristics as far as they determine the degree of immunity against interference. These characteristics are (see Fig. 1): (*a*) the difference, $E_R - E_D$, whereby E_R designates the *maximum* and E_D the *minimum* amplitude of the curve, provided m_R, corresponding to E_R, is the tuned frequency, and m_D, corresponding to E_D, the frequency whereby the curve begins to become almost a parallel line to the axis of frequency; (*b*) the differential quotient, tg. $\alpha = \frac{d\,E}{d\,m}$, and (*c*) the radius of curvature, m_m at the apex of the curve.

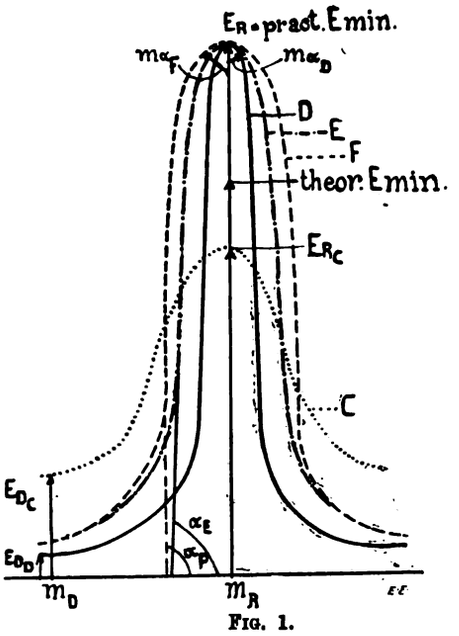

FIG. 1.

From the many hypothetical considerations which could be connected with these characteristics, I will only call special attention to the influence of the factors $\frac{L}{R}$ and $\frac{1}{R\,C}$ upon the first characteristic $E_R - E_D$. Let us, for instance, assume that the detector is controlled by the E.M.F., E_C, of a capacity, C, in parallel to it, that this capacity is in series with a resistance, R, and an inductance, L, and that the impressed E.M.F., E, is kept constant, whilst the frequencies are varied. Then, for the case of resonance—*i.e.*, when the equation $m^2\,C\,L = 1$ is fulfilled—we get (see also the vector diagram Fig. 2):

$$I = \frac{E}{R}, \quad E_L = I\,m\,L, \quad E_C = \frac{I}{m\,C},$$

and reducing R to $R_1 = \frac{R}{2}$, we get:

$$I_1 = 2\,I = \frac{E}{R_1} = \frac{2}{R}E,$$

$$E_L' = (2\,I)\,m\,L, \quad E_C = \frac{2\,I}{m\,C}.$$

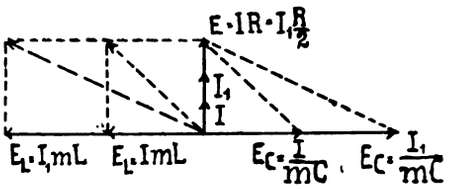

FIG. 2.

Again, doubling L, and in order not to disturb the resonance equation, reducing C to its half value, we get:

$$E = I\,R, \quad E_L = I\,m\,(2\,L), \quad E = \frac{I}{m\left(\frac{C}{2}\right)}.$$

These results mean that the resonance amplitude E_R ($= E_{C\,max.}$) is proportional to the quotients:

$$\frac{L}{R} \text{ and } \frac{1}{C\,R}.$$

Now, if the diagram corresponding to the frequency, m_D, would be considered in the same manner as has just been considered for the tuned frequency, we would find that the corresponding amplitude, E_D ($E_{min.}$), is approximately also proportional to

$$\frac{L}{R} \text{ and } \frac{1}{C\,R}$$

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As, however, $E_R = E_{cmax.}$ is much greater than $E_D = E_{cmin.}$ of the resonance curve, it follows that by increasing the quotients $\frac{L}{R}$ and $\frac{1}{C R}$, say to a double value, E_R and E_D have been respectively doubled to E_{R1} and E_{D1}, and the difference $E_{R1} - E_{D1}$ has become much greater than $E_R - E_D$ This result shows that immunity may be increased by employing great quotients $\frac{L}{R}$ and $\frac{1}{C R}$ in the receiving circuits.*

§ 3. *The Transmitted Energies and the Relative Distances between the Stations.*—The received energy, P_R, depends obviously from the transmitted energy, P_T, and the distance of transmission, D. It has been experimentally proved that the received energy is inversely proportional to the square of the distance, and the supposition that it is directly proportional to the transmitted energy is also approximately exact. Consequently, we may write the equation :

$$P_R = k \frac{P_T}{D^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

or,

$$E I \cos \phi = k \frac{P_T}{D^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

E, I, and ϕ representing respectively the E M F., the current, and the lag between both in the receiving system

(*a*) For the case of resonance, we have $\phi = 0$, $\cos \phi = 1$ and consequently the equation (2) becomes :

$$E I = k \frac{P_T}{D^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Bringing now the resistance, R, in (3), we get :

$$I^2 R = k \frac{P_T}{D^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and consequently

$$I = \frac{k}{R} \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and as R is kept constant, we may write :

$$I = C \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

(*b*) Assuming, farther, ϕ different from zero and the impressed E M F., E, of the equation (2) as constant, we get for each ϕ considered as constant the following equations

$$E_p = E \cos \phi_p = I_p R \quad . \quad . \quad . \quad . \quad (7)$$

$$E_p I_p = I_p^2 R = k_p \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad (4A)$$

$$I_p = \frac{k_p}{R} \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad (5A)$$

$$I_p = C_p \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (6A)$$

The equations (6) and (6A) mean that the current of the received energy is directly proportional to the mean roots of the transmitted energy and inversely proportional to the distance. The equation (6) refers to the resonance current, whilst (6A) is the general equation referring to the currents of untuned frequencies. For each $\phi = \phi_1, \phi_2, \phi_3, \ldots \phi_p$, we get the corresponding $C_1, C_2, C_3 \ldots C_p$ and $I_1, I_2 \ldots I_p$, and as, according to (7), E_p is smaller than E, the constants, C_p, and currents, I_p of the equation (6A) must also be smaller than C and I of the equation (6)

As any one of the E.M.F.'s (E, E_p. E_L, or E_C) is directly proportional to the currents, I_p, we may write for the E M.F. controlling the detector (in the above-mentioned example it was E_C considered as such an E M.F. controlling the detector), the following equation :

$$E_p = K_p \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

With the special forms

$$E_R = K_R \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (8A)$$

for the case of resonance, and

$$E_D = K_D \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (8B)$$

for the lowest amplitude of the curve.

I call the constants $K_p = K_1, K_2, K_3 \ldots$ the *syntonical constants*, whilst K_R and K_D may be particularly called the *constant of resonance* and *absolute disonance* respectively.

The equation (8) with its two particular values (8A) and (8B) contains the three factors which determine the limits of syntony — namely, the transmitting power, P_T, the distance, D, and the constants, K, which represent the factor of the resonance curve, and which can be easily found if the latter has been experimentally determined.

I will now proceed to show how the syntonisation becomes limited, and why, consequently, the method employed nowadays cannot be considered as a general solution of the problem of interference in wireless telegraphy.

§ 4. *First Case—The transmitted energies are of equal powers of different frequencies, and at equal distances off the receiver* (see Fig. 1)—If E_R and $E_{min.}$ represent respectively the maximum amplitude of the curve and the necessary minimum at which the detector begins to respond, it is obvious that when the equation

$$E_R = E_{min.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

is fulfilled, the signal of untuned frequencies will produce no interference with those which have been tuned.

There are, however, two practical causes which diminish the syntonical immunity—namely : (*a*) not all the detectors are constant in their working, and, therefore, the practical $E_{min.}$ must necessarily be greater than the theoretical $E_{min.}$, otherwise it might occur that some signals will fail to be detected; and (*b*) stations working with variable distances (movable ships) or variable heights of aerials (kites, balloons) also do not allow a limited $E_{min.}$

Instead of the equation (9) we get, consequently, the inequality

$$E_R = \text{practical } E_{min.} > \text{theoretical } E_{min.} \quad . \quad (10)$$

Now it will be seen from the diagram Fig. 1 that with increasing difference between the practical and theoretical $E_{min.}$, the latter approaches E_D, and signals of other frequencies begin to interfere more and more.

The difficulty of managing the detector in such a manner as to keep the practical $E_{min.}$ closed by the theoretical $E_{min.}$, may sometimes render the avoiding of interference even almost impossible. The electrolytic and magnetic detector, as well as the bolometer, possessing a higher degree of constancy than the coherer, are more suitable for syntonic purposes, and their employment may minimise the cause (*a*) The cause (*b*) may, in the further progress of wireless telegraphy, be minimised, by the receiving station being provided with such an arrangement that E_R could be automatically adjusted to $E_{min.}$ when the distance between the working stations is variable.

§ 5 *Second Case—The transmission powers of several simultaneously working stations and their relative distances are different*—I will now consider the general case, which the practice has to deal with—viz, the syntony of simultaneously working stations irrespective of the powers of transmission and the relative distances. I assume that the resonance curve of the receiver has been experimentally determined, and in order to show the impossibility of an absolute syntony by means of the method used nowadays quite clear, I will make several very favourable suppositions.

1. I assume there is existing a syntonical system which permits a perfect fulfilment of the equation $m^2 C L = 1$ for all the receiving circuits comprised between the top of the aerial and the earthing point, so that the resonance curve is very sharp, having the character of the curve D (Fig. 1)—namely, great $E_R - E_D$, great tg. α, and small m_α

2 I suppose as realised the equation

$$E_R = \text{practical } E_{min.} = \text{theoretical } E_{min.},$$

which may be attained (*a*) by constant working detectors; (*b*) by a syntonical system whereby E_R can be adjusted to

* I have considered only the case of detectors responding on potential differences, but it is quite obvious how the case of detectors responding on currents may be also discussed.

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$E_{min.}$ without disturbing the resonance obtained* ; and (*c*) by an arrangement, above referred to, whereby E_R is automatically adjusted to $E_{min.}$ when the distance varies during the working of the stations.

3. I will assume that

$$E_R - E_D = 15,$$

if E_D is considered as the unity of E M.F. This supposition is not at all interfering with the accurateness of the discussion brought in this communication, and the figure 15 may, of course, be changed for any other value which would be in accordance with the resonance curve considered; or in discussing about the further progress of the syntonisation towards a general solution, which would be proved as attainable. My supposition is deducted from the curves and data communicated by different experimenters,† although I must confess that the circumstances of their experiments are more favourable than those which the practical working stations have to deal with, and that the value of $E_R - E_D$ as deducted from these experiments are even smaller than 15.

These ideal assumptions made, let us now suppose that two pairs of stations are simultaneously working. As it is quite obvious that the currents of each transmission will flow through each of both receiving stations, let us consider how both currents will behave in the receiver.

We found above: $$E_R = K_p \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (8A)$$

and $$E_D = K_D \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (8B)$$

respectively for the case of resonance and lowest amplitude.

From $E_R - E_D = 15$ and $E_D = 1$, and from the consideration that P_T and D are supposed to be the same in (8A) and (8B), we get:

$$E_R = 16, \quad K_R = 16, \quad K_D = 1.$$

Consequently we can now write:

$$E_R = 16 \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

and $$E_D = \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (11A)$$

whilst the numerical values of the syntonical constants, K_p, of the equation

$$E_p = K_p \frac{\sqrt{P_T}}{D} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

may be easily determined from the resonance curve for each frequency intermediary between m_D and m_R.

I will now give to P_T and D of the pairs of stations under consideration certain definite values, and thus discuss by means of examples what are the effects of both transmissions upon the syntonised receiver.

Examples.—The receiving station, A, is tuned to the transmitting station, B, whilst another transmitting station, C, is simultaneously in communication with a respective receiving station.

1(*a*) Station B: transmitting power $P_T = 450$ watts.
distance from A: $D = 100$ miles.

(*b*) Station C: transmitting power $P_{T_1} = 450$ watts.
distance from A: $D_1 = 25$ miles.

We can write:

$P_T = 450$ watts = unity of power; $P_{T_1} = 1$.

$D = 100$ miles = unity of distance; $D_1 = 0{\cdot}25$ unit.

$$E_R = 16 \frac{\sqrt{1}}{1} = 16 = E_{min.}$$

$$E_D = 1 . \frac{\sqrt{1}}{0{\cdot}25} = 4.$$

As $E_D = 4$ is inferior to $E_{min.} = 16$, there are frequencies which do not produce any interference with the signals of the tuned frequency, and the limit of synteny is given by (8).

$$E_p = 16 = K_p \frac{\sqrt{1}}{0{\cdot}25}.$$

Where from $K_p = 4$.

Between the frequency for which the syntonical constant, K_p, is equal to 4 and the tuned frequency there is no possibility of avoiding interference.

2(*a*) Station B: $P_T = 450$ watts = unity of power.
$D = 100$ miles = unity of distance.

(*b*) Station C: $P_{T_1} = 1{\cdot}8$ kw. = 4 units.
$D_1 = 20$ miles = 0·2 unit.

We may write: $E_R = 16 = E_{min.}$

$$E_D = 1 . \frac{\sqrt{4}}{0{\cdot}2} = 10.$$

As $E_D = 10$ is inferior to $E_{min.} = 16$, there are frequencies which allow no interference with the tuned station, and the limit of syntony is deducted from

$$E_p = 16 = K_p \frac{\sqrt{4}}{0{\cdot}2}; \quad K_p = 10.$$

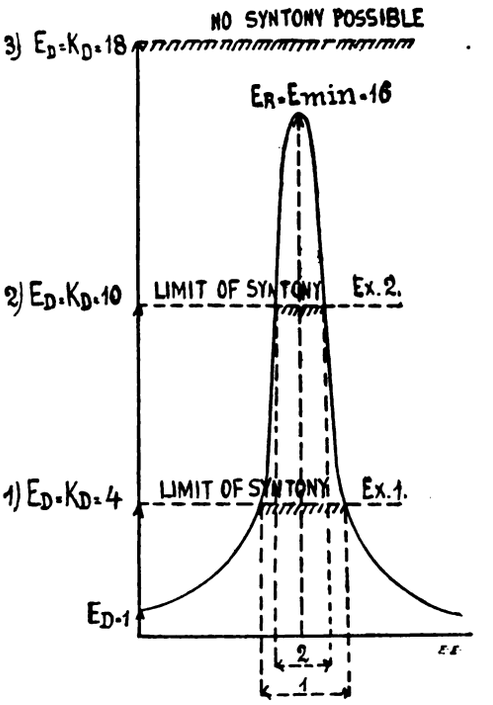

FIG. 3.

Between the tuned frequency and that one for which the syntonical constant, K_p, is equal to 10, there is no possibility of avoiding interference.

3(*a*) Station B: $P_T = 450$ watts = unity of power.
$D = 120$ miles = unity of distance.

(*b*) Station C: $P_{T_1} = 4$ kw. ~ nine units.
$D_1 = 20$ miles = 0·166 unit.
$E_R = 16 = E_{min.}$

$$E_D = \frac{\sqrt{9}}{0{\cdot}166} \sim 18.$$

As $E_D = 18$ is superior to $E_{min.} = 16$, the interference is unavoidable in a *quite absolute* manner.

I have illustrated by means of examples a series of practical cases whereby the interference is a relative or an absolute one, and I need not increase their number, as they are quite sufficient to show the true position of the problem of syntonisation, even under very favourable suppositions which I took as granted, but which practical wireless telegraphy has still to fulfil.

According to these results, I, therefore, believe that the syntonisation method as employed nowadays is only a partial, and that it never can be a general, solution of the problem of interference. The limit of syntony may, for instance, be easily found by means of the method indicated and employed in the present communication.

* An arrangement to this purpose I have described in the *Physikalische Zeitschrift*, No. 12, 1905. See also *Electrical World* of July 15, 1905.

† Dönitz, *Elektrotechnishe Zeitschrift*, Nov. 5, 1903; Tissot, *Comptes Rendus*, Nov. 23, 1903; Pierce, *Physical Review*, April, 1905.

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ELECTRICITY AS A HOME COMFORT.*

BY J. D. MACKENZIE.

(Concluded from page 839.)

But if one desires that all his friends and acquaintances shall be made fully conscious of the beauty of the ceiling, we are at no loss to please his fancy and yet get away from the hackneyed method of lighting. A sketch here will indicate one method which, while not quite idealistic in that a fitting hangs in the centre of a room, is so far good in that it still hides the source of light in such a way that it can injure no one's sensibilities; and on the score of art I think you need not call the design outrageous. In this design we have a polished and silvered metal bowl, pierced and fitted with translucent mother-pearl insertions and ornamented with hanging stars. Inside the bowl is fitted one high candle-power lamp or four or five medium candle-power ones, and the total light is reflected upwards to the ceiling, from which it is again reflected downwards. This gives a soft diffused light without any very intense shadows. One other method, and that is to have an ornamental frieze moulding round the room, above which are arranged long rows of linolite or similar system, throwing every possible ray of light on to the ceiling, and so get it again reflected downwards. But you may challenge me to produce figures and argue out the point with mathematical accuracy, and though the latter part is beyond my present scope, I'll endeavour to meet your wishes as far as possible. Appended is a table giving average results both of reflection, transmission, and absorption of light by and through various media.

	Reflection. Per cent.	Transmission. Per cent.	Absorption. Per cent.
White blotting paper	82	9·2	13·8
,, cartridge	80	11·2	12·2
,, waste	80	—	—
Tracing cloth	35	54·4	15·0
,, paper	22	76	7
Newspaper	50 to 70	—	—
Yellow wall-paper	40	—	—
Dirty deal	20	—	—
Thin opal glass	—	—	15
Thick ,,	—	—	39
Strong ,,	—	—	50 to 60
Ground glass	—	—	30 to 50
Ordinary clear glass	—	—	10 to 20
Rippled glass	—	—	20 to 25
Black cloth	1·2	—	—
,, velvet	·4	—	—
Ordinary mirrors	80	—	—
V.G.	90	—	—

Now suppose that we have five 16-c.p. lamps inside a silvered bowl, such as shown, I am quite safe in assuming that 150 per cent. of the nominal candle-power is reflected upwards—*i.e.*, $\frac{150 \times 80}{100} = 120$ c.p. reaches the ceiling. If it is whitewashed and has a reflection coefficient of 80 per cent., then the total downward light is $\frac{80 \times 120}{100} = 96$ c.p. If the height of ceiling is 12ft., then the illumination on the surface of a table 3ft. will be $\frac{96}{9 \times 9} = \frac{96{\cdot}0}{81} = 1{\cdot}18$ candle-feet, and an illumination of one candle-foot is quite ample for all ordinary purposes.

Now, so far I have dealt with lighting in the abstract; let us come more to detail. Lighting by reflection is applicable to the general lighting of any room, but it may require to be supplemented owing to special requirements. In the porch or vestibule one or more lamps placed high up with reflectors are quite sufficient unless it is of large dimensions and the ceiling finished in panelled oak, say, when a combination of both methods must be adopted—viz., some lamps to throw light directly downwards and some to throw it on to the ceiling. In the hall the same remarks apply, depending on whether the ceiling is to be plaster or wainscot. The public rooms ought to be lit by reflected light entirely, but may be supplemented somewhat as follows: dining-room—one or more sockets for table lamps, so that the most of the general lighting may be switched off, and we will have a dim, very dim, downward light combined with one or two table standard lamps deeply shaded with silk shades. In this case we are yielding a point of efficiency to gain a point in artistic effect. In the dining-room we may do the same and permit one or two tall standard lamps just to please the lady of the house. In the boudoir we must. In the bedrooms generally a reading lamp must be provided, and in that case what I generally recommend is a bracket hung from the bedrail or mounted on the bedstead, and having sufficient projection and tilt to throw the light out on to a book held in a person's hand, the lamp being covered by a very deep silvered metal conical or paraboloid reflector so arranged as to concentrate the light into a beam of comparatively small area. This will give the desired effect without being sufficiently glaring to annoy. In the dressing-room I would suggest that some such thing as a strip of linolite or similar idea be fastened to either extreme side of the pier glass; it will enable the lady of the house to see to a nicety how that new gown looks, and her lord and master to shave himself, or be shaved by his valet, in absolute comfort. Now, although I am speaking in this fashion regarding portable lamps and such like for special purposes, I must not be taken as condemning these in any way. Indeed, quite the contrary, for my aim is to point out electricity as a comfort in the home, and unless every possible contingency is forestalled and provided for, and unless every individual taste is considered, and arrangements made to suit them, this result cannot be obtained. It would be quite impossible for me to deal in this paper with every contingency and every artistic taste which may have to be studied, but the foregoing may indicate how, in my opinion, these should be met, and that is to deal with the general lighting in the most effective, economical, and unobtrusive method, and then concede the other points either to necessity or artistic taste as they arise. Now, at the start of these rambling remarks I set down a few conditions which had to be looked to, but in my enthusiasm in preaching the gospel of heterodoxy I fear they are sadly in danger of being forgotten.

The first was the purpose in view that has been dealt with and amplified as far as my time will permit, so we may look for a moment at some of the others. The ease or difficulty of carrying into effect is the next point, and is one which is often missed by architects, consulting engineers, and others responsible for the design of an electrical installation. I have before now seen cases where lights were shown in position in the middle of glazed roof lights, electroliers hung from the ceiling specified where the head room was only 6ft. 6in., and so on, these cases being where an architect designed the building and a consulting engineer the lighting, and the latter had not got sufficient data for his purpose. And while on this point I cannot understand why architects should not inform electrical contractors of the details of finishing in the various rooms, etc., in a building. We have a standard height for placing brackets, switches, pushes, and so on, but that standard is by no means as unalterable as the laws of the Medes and Persians. And yet time and again we find either that our heights do not suit the dado, or the frieze, or the picture moulding, or, in fact, the hundred and one things which go to make up the finished room, and we have painfully to search the joiner's or builder's plans to discover the internal arrangements, or still more painfully drag information out of the architect. The electrical contractor is generally, and ought to be, the last contractor to leave the job, and as he has, so to speak, to add the finishing touches to the whole, why should he not be furnished from the very start with full particulars as to how the building is going to be finished? I speak with feeling on this matter, as on more than one occasion such negligence on an architect's part has been the means of spoiling good work.

The third point—viz., accessibility for repairs—has reference more to the wiring than to the fitting, and hence consideration may be deferred until that section is reached. The fourth point was the effect of each part of the design on its immediate surroundings, and is a most important one. Because, to take one instance, it would look entirely out of place to put an Art Nouveau fitting into an old-world setting, and it looks quite as incongruous to my eyes to fit up a modernised drawing-room or dining-room with Louis candle brackets, and both of these—with many other

* Paper read before a Glasgow Engineering Society.

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variations on the same general lines—are done daily by people who aspire to gain credit for their artistic taste. Here it is that, if the room is lit by reflected light, one may give full rein to their artistic fancy. And just a case in point. I know of one entrance hall which has been beautifully designed and executed in rigid Moorish art, and the attempt was made to light that by means of lamps enclosed in handsome lanterns of pierced metal work of strictly Moorish design, and the result was, as might be expected, a ghastly failure. The gentleman who owns the house on looking about found a quasi-Moorish design, as now shown on the screen, and fitted up the hall with those. Of course, better light has been obtained, but the strictness of the art has been sacrificed, and the lighting, owing to this heavily obscured glass globe, is very inefficient. Had reflected lighting been tried, the old lanterns might have been retained with a lamp inside them for artistic effect, and the whole general lighting got quite independently and invisibly.

The fifth point—the general effect of the whole arrangement—is a difficult point to elucidate. What I mean by it is that sometimes in looking over a finished job one gets the impression that there has been no design—that, in fact, things have just happened. You know it has been said of milestones in the Highlands, that the men who set them up just carried them until they were tired and then laid down without any reference to the number of yards or feet. Something similar seems to be the case in many installations—everything seems haphazard, without rule or apparent reason, and the only way to obviate this is to study each installation separately in all its bearings and have a uniformity of purpose running through the whole scheme. I may deal with this point again under "Wiring."

So far I have dealt with the outward manifestations of electrical work, but it is quite evident that without preliminary labour we could not obtain these results, and so we must consider electric wiring and its accessories. And first as to systems of wiring. I am repeatedly asked what is the best system of wiring for all purposes, and just as repeatedly I answer, "There is none." Among all the varied and various systems there are many good ones, there are some not so good ones; but there is none which can honestly be called universally the best, just as there is none which can be in the same way termed the worst. And the reason for this is not very far to seek, for electric wiring has to be installed under such varying conditions that it is manifestly impossible that any one system should be universally applicable, and here, as well as in the matter of fittings and finishing, should each installation be considered strictly on its merits in all its bearings. Now, I know that architects are most intelligent men, brimful of knowledge on any topic under the sun, but I humbly venture to suggest that they are not so qualified to give such close and careful consideration to this matter of electrical wiring as an electrical engineer, and that even with their most careful consideration they are more liable to come to a wrong conclusion. And as the first essential of a "comfortable" installation is the quality of the wiring, I really think that architects should not arrogate to themselves the right of dictatorship on matters electrical. I could regale you for hours with errors of specification and in technical detail; and not only so, but it is just as difficult for an architect to supervise the work while in progress and to discriminate whether or not the specified material is being installed. If, for example, solid-drawn screwed tubing is specified, can he or his inspector—clever men though they be, the most of them—tell the difference between that and welded tube; if "ring" cable is specified, can he say decisively that the material being installed is of German origin; and, to come to an even more simple matter, can he tell whether the ceiling rose he is looking at has English or German porcelain? Now all these things, and many, many more, produce the difference very often between a good job and a bad one, and so I really think that architects would do well to remember that they are not electrical experts, and obtain the assistance of one to superintend the electrical portion of their work. Now in this connection I must point out that the honest contractor will do his work honestly and up to specification, aye, and even beyond specification when he detects flaws in it; but there are others. The type of man I have in my mind to-night, and whose claims I wish to impress on this craftsmen's society, is the electrical craftsman; the man who scorns such questionable methods of increasing the £ s. d. return from his work, and who endeavours to do good work for good work's sake. But there are others, men whose artistic soul can only distinguish three colours—yellow, grey, and bronze—as exemplified in sovereigns, shillings, and pence—and whose work never reaches above mediocrity. Now the principal systems in use for electric wiring are as follows, not in order of merit: (*a*) wood casing; (*b*) slip-joint tubing; (*c*) screwed steel tubing; (*d*) lead-sheathed wires; (*e*) wires carried on insulators—this latter system not being applicable to internal wiring.

Wood Casing.—This is, with the exception of wires carried on insulators, the oldest system we have, and is a most satisfactory system in many cases. Where there is little or no possibility of moisture getting at the wiring, and where the work may be exposed, there is really nothing to beat a good wood-casing job provided that the workmanship has been well carried out; and this word "workmanship," which stares us so hard in every specification and schedule that we handle, brings me back to the question of the best system. A good workman can make a satisfactory job of the worst system, and a bad workman a bad job of the best possible system—given in each case that other conditions are suitable. Hence the utter impossibility of getting good work done at ridiculously low prices. It is quite absurd to imagine that if the highest offer for a contract is, say, £1,500, and the medium offers £1,000 to £1,200, that any mortal man can do the same job and give the same material and workmanship for £543. This is a sample of actually quoted prices, and tells its own tale. But to continue my remarks on wood casing. If the work is well planned, and the casing erected by joiners who have an ideal system for dry situations, concisely put, the advantages are: (1) ease of erection; (2) the wires are separated, and to a certain extent insulated throughout their entire length; (3) the wiring is very readily accessible; and the disadvantages urged against the system are: (1) that the casing does not give much protection against nails; (2) it is not suitable for damp situations; (3) it is not fireproof. In my opinion objection No. 1 is overestimated, because very few people nowadays will attempt to drive nails through electric wires, and objection No. 3 can be overcome by using casing impregnated with fireproofing compounds. Some people urge ugliness as an objection to wood casing, but this is hardly correct, as it is quite possible to get casing moulded in all manner of styles and to use it decoratively as for panelling, say.

Slip-Joint Tubing.—Now, to me this system is an abomination; it simply stinks in my nostrils. Nevertheless, it is by no means impossible to make a good job with it, and hence I do not intend to impress you with the idea that it is the worst system. Do not misunderstand me. But it is a system of the slap-up order which lends itself so easily to unskilled labour that the tendency is to use such labour, with the result that it is so easy to make an inferior job, and hence I consider it best to dispense with the temptation to do so altogether. The principal advantages claimed for it are: (1) ease of erection: (2) cheapness of first cost; (3) it is fireproof. And the principal disadvantages are: (1) thinness of conduit, rendering it easily pierceable by nails and easily eaten away by the acid commonly found in ordinary plaster; (2) difficulty of securing through metallic continuity. I have here samples of a system worked out by Messrs. Rawlings Bros., Limited, of London, which is a variant of the slip-joint system, only they use tinned brass tube instead of enamelled steel. The system, which was originally got out to meet the requirements of a London firm of consulting engineers, can be used either as a double-wire system or for concentric wiring with only one wire inside the tube, and having the tube itself for a return. Of course, this concentric system can only be used for private plant work. In this system the advantage of the slip-joint system is maintained in the ease of erection and metallic continuity, and more skilled labour is ensured by the fact that all joints in the tubing are soldered by means of a blow-lamp flame.

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In a note which I received from Mr. Rawlings yesterday he says: "You will note that I have had the switch coupled up in a manner which I personally favour—that is, to bring both positive and negative to the switch and distribute from the switch point, and no other point. This method simplifies planning, and, in my opinion, surpasses externally the general system of wiring. Every joint in the system is of the slip-socket type, enabling bends to be easily erected, and the soldering is carried out with a blow-pipe, making a perfectly watertight conduit system. Tinned brass tube has not, so far as I can learn, ever failed either in or outside plaster work, as the one metal appears to save the other from decay. The thinness of the tube tends to reduce condensation, and in practice such a thing is unknown. Generally speaking, the price compares favourably with a steel tube screwed system. I have every confidence in this method of conduit, and consider that it will outstrip most of the others, owing to its lightness and its ease of erection due to its small size, and for the other points to which I referred." Personally, I have had no experience of the system, but considered, as it would probably be new to most of those present, that it was worth while mentioning. The system looks neat, and can be made thoroughly watertight. All switches and wall sockets are flush, and everything is metallic throughout. The only drawback I can see is the thinness of the tube and its liability to damage from nails.

Screwed Steel Tubing.—Here we can have any amount of diversity in the way of thickness, quality, etc., such as gas barrel, enamelled and unenamelled conduits, both solid drawn and welded, giving a wide range of choice. In this system we have the strongest mechanical arrangement possible, and when the conduit is free from any roughness inside likely to damage the wire when being drawn in, there are very few serious objections to urge against it for average work. The advantages are: (1) excellent mechanical protection; (2) excellent electrical continuity of sheathing; (3) if properly erected, lends itself admirably to a draw-in system. The disadvantages are: (1) the want of flexibility of the system rendering it difficult to instal in finished buildings, and making it almost impossible to make additions or alterations on the lighting; (2) in damp situations there is a tendency for moisture to condense outside the tubes.

Lead covered Wire.—Here we have wires possessing their own metallic sheathing as they come from the cable works, but the sheathing is of soft metal. The principal advantages are: (1) ease of installation; (2) sheathing is waterproof; (3) difficulty of making joints compels the use of a loop in system; (4) when properly bonded the sheathing is electrically continuous. The disadvantages urged against the system are: (1) softness of sheathing giving no mechanical protection; (2) risk of damage due to carelessness of workmen.

WEDNESBURY CORPORATION ELECTRICITY DISTRIBUTION UNDERTAKING.

The Wednesbury Corporation obtained a provisional order in 1899, an agreement having been previously entered into with the Midland Electric Power Company. In accordance with this agreement, the Corporation did not oppose the company's application for a provisional order to supply within the borough on the understanding that, in the event of the Corporation also applying subsequently for a provisional order, the company would not offer opposition, the objects of the power company being rather to supply in bulk to large consumers, such as mines, extensive engineering and other works, than to distribute electricity in detail to private consumers. The arrangement now is that the Corporation supplies electricity in detail to all consumers in Wednesbury, the company supplying the Corporation only in bulk.

The electricity is generated on the two-phase system at a pressure of 7,000 volts at the power company's station at Ocker Hill. It is then transmitted to the company's sub-station in Wednesbury, where it is transformed down to a pressure of 2,700 volts and again to 200 volts. The supply is delivered at the company's sub-station to the Corporation's "receiving mains" on the two-phase system at a pressure of 200 volts. The Corporation's sub-station contains transforming plant to convert from two-phase to continuous current. After conversion, continuous current is supplied by feeding mains laid from the Corporation's sub-station to five feeding points which supply the distributing network of mains laid in about 3½ miles of the principal streets, which are now in the form of a triangle in the centre of the borough, and from each corner radiate the main roads. Thus the Corporation's mains are complete in themselves, and are so arranged that at any future date they may be supplied from separate works should that become advisable later, whereas the two-phase supply would not be economical from a separate plant owing to the nature of the borough and the demand in Wednesbury. It may here be mentioned that both the two-phase and continuous-current systems of distribution were very carefully considered, and, after taking all circumstances into consideration, the latter was decided upon notwithstanding the additional expenditure necessitated by the transforming plant, so that full advantage could be taken of the maximum demand system of charges (for the supply in bulk) and also to give the most convenient form of supply to the consumers.

A portion of the Corporation's land has been utilised as the site of the sub-station. The buildings consist of the following: generator room and switch gallery, accumulator room, workshop, office, test-room, and stores. The three last-named are connected to the main building by a corridor. The buildings are arranged so that they may be easily extended; in the case of the office, etc., building provision has been made so that another floor can be added at any time with little or no alteration. The contractor for the main office, etc., buildings was Mr. F. J. Smith, of Wednesbury.

The transforming plant includes two motor-generators manufactured by the Phœnix Dynamo Manufacturing Company, Limited, of Bradford. These each consist of a two-phase induction motor direct coupled to a continuous-current generator capable of delivering a current of 300 amperes at a pressure of 250 volts. There are two special pillars which contain the starting gear; these pillars are fixed adjoining the machines.

The battery of accumulators consists of 117 cells, each capable of delivering 325 amperes for three hours. The containing cases are constructed entirely of lead, the crate being in the form of an antimony ⊥ section frame burnt together and lined with 6lb. sheet lead at sides, and 10lb. lead at bottom, and supported on a slate base. Each cell has 27 plates, the positive plates being of the Planté type and the negative of the pasted type. The cells have been supplied and erected on heavy pitch-pine stands by the British Accumulator Company, Limited, of Westminster. There is a charge and discharge booster of the Highfield type manufactured by the British Westinghouse Company, Limited. The booster dynamo is capable of a maximum back boost of 75 volts during charging of the battery, and is capable of keeping the pressure practically constant on charge or discharge automatically within a limit of 30 volts difference of battery and line voltage, under all conditions of load (up to 325 amperes) and battery voltage. The exciter is direct coupled to the booster, and the machine may be driven by either a continuous-current motor of 30 h.p. or a two phase motor of similar size. The continuous-current motor is connected to the booster through a clutch, and the two-phase motor is similarly connected to the continuous-current machine. These clutches enable the following arrangements of use: (1) two-phase motor driving continuous-current machine as a dynamo, booster disconnected; (2) two-phase machine driving booster through continuous-current shaft, the latter idle; (3) the same as (2), but continuous-current machine being run as a generator as well; and (4) continuous-current machine only driving booster. In addition, a portable "milking" booster has been provided, consisting of a 200 volt two-phase motor coupled direct to a shunt dynamo capable of delivering 150 amperes at six volts. This plant is mounted on a truck for convenience in moving about the accumulator room to enable one or two cells to be charged as required.

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The switchboard, which consists almost entirely of metal and marble, is arranged in a "bay" form, the central portion being reserved for the two-phase feeder gear and the continuous-current main ammeter, voltmeter, and time-piece. On the left side of the bay the continuous-current feeder panels are fixed, and on the right the machine panels. The switch gallery is raised about 1ft. from the floor level, and contains also the starting pillar of the booster. Behind the switchboard ample space has been allowed, which forms practically a separate small room, and contains, in addition to the switchboard connections, the main two-phase meters and the main continuous-current meter. The switchboard is arranged to control the following: duplicate two-phase "receiving" mains, three motors (two main and one booster), a spare panel being allowed for an additional machine, five continuous-current feeding cables, and two spare feeder panels, two main dynamos and two boosters on the continuous-current side, one spare panel being allowed for each. A system of subways leads from the switchboard to the machines, battery, etc., and to the street, for conveying the connecting cables. The switchboard was manufactured and erected by Mr. W. Sanders, of Wednesbury, the instruments being of the permanent magnet edgewise and sector types, and mostly by Nalder Bros. and Thompson.

The mains consist of two-phase twin concentric ·3, ·3, and ·45 square inch lead-covered "receiving" cables (connecting the Corporation's sub-station with the power company's sub-station), concentric lead-covered, continuous-current feeding cables, and single lead-covered cables for distributing mains. The distribution is carried out on the two wire system, the pressure of supply being 230 volts. All cables are laid on the solid system, being supported on wooden bridges in wooden troughs, filled in solid with bitumen and protected by hard-burnt tiles. Generally, where there are tramway lines and in important streets, the distributing mains are laid on both sides of the roadway under the footpaths, but in the less important streets on one side of the road only. The cables were manufactured and laid by Messrs. W. T. Glover and Co, Limited, and are of their well-known diatrine paper-insulated type.

The contract for meters, etc., was divided, the electrolytic and motor meters, maximum demand indicators, as well as the house service fuses and fuse boards, having been supplied by the Reason Manufacturing Company, Limited, and the prepayment meters by the British Thomson-Houston Company. The charges for the supply are as follows: lighting, 6d. and 2d. per unit on the maximum demand (one-hour) system; power, 3d. and 1½d. per unit, or a flat rate of 1½d. per unit in the daytime and 3d. during lighting hours.

An important point in connection with a distribution undertaking such as this is that there is no risk of excessive cost of production in the early years. The charge for electric power in bulk to the Corporation is 3d. for the first hour of maximum demand for each day and ·825d. per unit for all further supply. The losses as regards inefficiency of transformation and losses in mains appear principally in units at the lower charge, and the losses in the accumulators are entirely low-rate units. The supply of electricity to each individual consumer is on the maximum demand system, yet, owing to the diversity of the time of the maximum load, the total maximum load of the Corporation is less than the sum of each individual consumer's maximum demand during each quarter. Further, as the accumulators reduce the Corporation's maximum demand on the power company, the load is more even, or, in other words, under the system of working, if the maximum load on the Corporation's sub-station is, say, 150 kw., the demand by the Corporation on the company need only be 75 kw., so again there is a large transfer of units from the 3d. to the ·825d. rate, and the units lost in the battery are entirely at the low rate, as before mentioned. Further, in an undertaking of this nature the increase in the Corporation's capital charges as the load increases will not be heavy.

A few figures as to the results of 18 months' working may be of interest. The consumers number about 90, and the connections have reached the equivalent of 5,258 8-c.p. lamps, including 28 h.p. in motors; also 596 lamps of 8 c.p. equivalent have been applied for in addition, but have not so far been connected. Various extensions of the mains have been carried out by the staff to cope with the demand which has arisen. A noticeable point has been the even pressure which has been maintained, rendering the use of Nernst lamps very satisfactory. It would not otherwise have been possible to compete successfully with incandescent gas lighting in the borough.

The technical negotiations with the power company were carried out by Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E, of Westminster, who has acted as consulting engineer to the Corporation, and under his supervision the undertaking has been completed and operated. Mr. W. Fennell acted as assistant to the consulting engineer, and Mr. T. H. M. Swinburne as clerk of works. The undertaking has been carried on for 18 months under the instructions of the consulting engineer, and the position of resident engineer is held by Mr. W. Fennell. It is to be noted that electricity has been introduced into the following public buildings town hall, municipal offices, art gallery, public library, and public baths; the arrangements having been planned and the work supervised by the consulting engineer.

YARMOUTH ELECTRICITY ACCOUNTS.

The accounts of the Great Yarmouth electricity department for the year ended March 31, 1905, show a total expenditure on capital account to that date of £79,466. Appended are abstracts of the revenue account, balance-sheet, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
To generation of electricity	6,014	7	6
Distribution of electricity	36	13	8
Attending and repairs to public lamps	485	13	10
Rates and taxes	712	6	0
Management expenses, salaries, etc.	1,060	10	8
Special charges, insurance, etc.	91	15	6
	8,401	7	2
Amount carried to net revenue account	6,770	0	0
Balance carried to next account	25	7	1
	£15,196	14	3

Cr. Income.	£	s.	d.
By balance from last account	25	0	0
Sale of current per meter	13,252	18	7
Public lighting	1,489	0	0
Rental of meters and other apparatus	429	15	8
	£15,196	14	3

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—loans received, less repaid	64,395	0	0
Sundry creditors	1,022	19	1
Due to bank and accountant	564	4	11
Surplus account	15,230	14	11
Revenue account	4,925	14	6
	£86,138	13	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	79,466	8	7
India 3 per cent. stock	1,669	0	4
Stores on hand	1,226	9	3
Sundry debtors for current supplied	3,730	14	3
Other debtors	46	1	0
	£86,138	13	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			1,247,745
Quantity sold: Private consumers by meter	637,695		
Public lamps	117,581		
Tramways	198,918		
By contract	5,620		959,814
Quantity used on works			227,566
Total quantity accounted for			1,187,380
Quantity not accounted for			60,365
Number of public lamps			126
Total maximum supply demanded (watts)			870,000

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Headquarters will be closed from 11 p.m. on Friday, Dec. 22, 1905, until 10 a.m. on Monday, Jan. 1, 1906.

J. H. S. PHILLIPS, Captain R.E.,
for O.C. E.E.R.E. (Vols.).

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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CHRISTMAS, 1905.

We wish all our readers a happy Christmas, and trust that they will spend the time profitably. We expect that the few days' holiday will be devoted by the largest percentage of electrical engineers in this country to reading the accumulation of papers communicated to the Institution of Electrical Engineers and its various local sections. There is an old proverb which says, "You can take a horse to the water, but you cannot make him drink." We thought that this was strictly applicable to electrical engineers until we were recently supplied with an almanac by a well-known cable firm. In this firm's rules for jointing electric cable prominence is given to the first requisite, "See the jointer is well supplied with beer." The correct conclusion may be that the jointer is not an electrical engineer, or, perhaps, this is the exception which proves the truth of the above proverb as applied to our profession. In case any of our readers, after absorbing the literature above referred to, should feel too elated with the magnitude of their profession and the scientific accuracy of its members, we reproduce the following extract from the *Daily Mirror* for Oct. 4 last: "Either electricity is an exact business or it is not. Perhaps the fact is that electricity, like the white man, is 'mighty uncertain,' and needs more expert management than it gets. We wish with as much fervour as we possess that there were more certainty and less guesswork about these ohms and volts. It may be that some of the electric experts are not experts at all, but adroitly disguised farm labourers, who have taken a few weeks' course of alleged training, and adopted what looks like an easy, gentlemanly career. Offhand, from one's personal experience of the man in one's own office who keeps the electric bells in disorder and wrongly diagnoses the disease of the telephone, the conclusion is reached that there must be a great famine of men who really understand electricity. Electricity in many cases is being supplanted by gas. Electricity should drive gas out of use, one would think, if it were managed by the right persons. All this from the standpoint of the consumer. It is likely that the fault lies in the fact that there are not enough Edisons to go round, and that it takes an Edison to cope with the tremendous problem of guaranteeing that our electric bell will ring when we push the button. Ours is the lay mind, and we apologise if through ignorance we hurt the feelings of anyone, but it has always seemed to us that the electrical industry is handicapped by the enormous number of men who spend their time in pottering about with wires, doing gimcrack work improperly, and then redoing it the next day with a different sort of incorrectness." It is so unusual to have the editor of a daily paper apologising for his ignorance, that we feel the above strictures should be taken with absolute silence. Our readers will doubtless ponder over the fact that while "there must be a great famine of men who really understand electricity," the demand caused by this famine should not raise the remuneration offered to the few remaining experts.

FORTHCOMING EVENTS

Friday, Dec. 22.

Institution of Electrical Engineers (Manchester Local Section—Students' Section).—At 7.30 p.m., "The Manufacture of Electric Cables," by Mr. W. T. Massey.

Thursday, Dec. 28.

Royal Institution of Great Britain.—At 3 p.m., "Astronomy," by Prof. H. H. Turner (juvenile course).

Saturday, Dec. 30.

Royal Institution of Great Britain.—At 3 p.m., "Astronomy," by Prof. H. H. Turner (juvenile course).

Robertson Social Club.—At 7.30 p.m., dance.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRAZING CAST IRON.

SIR,—I notice in your issue of Dec. 15 the note from "J. E. H., Pretoria," and I have pleasure to convey to this gentleman through your valued medium as much information as I possess.

I am informed on good authority that the problem of mending cast iron has only recently been satisfactorily solved, and a syndicate is shortly to be registered who will work the new process. By this process brazing is entirely done away with, the repair to the cast iron being made with cast iron. I happen to have seen some repairs which have been made, and it was quite impossible to tell the repaired portion from the article itself, and on these being tested for strength it was absolutely proved that the joint was even stronger in many instances than a similar piece which had not been broken, and no shrinkage or change of form even to the slightest degree had occurred. I am not able to give any detail of the process, as I do not know it; all I know is that it is the outcome of many years of experimenting, and, so far as I could see, it will entirely revolutionise the position which cast iron takes in engineering, as the trouble connected with its brittleness is entirely overcome. I am informed that this syndicate will be prepared to grant licenses for its process very shortly.

I should be very pleased to communicate with your correspondent if he writes me, and assist him in any way in my power. I enclose my card.—Yours, etc.,

A READER OF "THE ELECTRICAL ENGINEER."

MR. PATCHELL'S INSTITUTION PAPER.

SIR,—In the *Electrician* (vol. 54, p. 573) Mr. J. S. Highfield wrote a short article dealing with certain troubles that had been met with about that time in the working of his 3,000-kw. 11,000-volt steam alternators at Willesden, for which my company were the contractors. Previous to such publication Mr. Highfield courteously communicated with the parties concerned in order to ascertain if they had objections to the publicity that would be thus given to the matter, and in view of the scientific interest attached to the questions involved, no objections whatever were raised at the time.

I do not propose to deal here with the causes that led to the troubles, or with the nature of the same, beyond remarking that there never was any doubt with regard to these points. Moreover, it soon transpired that many other makers in this country, the States, and on the Continent had met with the same phenomena from time to time and to a greater or less extent. But it is to be particularly noted that in the above-mentioned article of Mr. Highfield's it was specially pointed out that all the materials used in the construction of the armature were the best of their respective kinds, and I may add that Mr. Highfield's statement in this respect was based upon the reports of the independent specialists to whom the question of the quality of the materials employed had been specifically submitted. The reports made by these gentlemen, based upon their analyses and examinations, were absolutely conclusive on the point, and it became perfectly clear that the troubles were due to other causes and conditions, which those interested will find set forth in Mr. Highfield's article.

Notwithstanding the fact that nearly £60,000 worth of plant was involved, regarding which even the shortest stoppage meant inconvenience and loss, the Metropolitan Company and its engineering staff (recognising that the troubles were due to exceptional causes which could not have been foreseen) extended their sympathy and practical help to the contractors from the first to the last, and after the difficulties had been overcome and the contract closed an amount of £4,400 was awarded to the contractors as a bonus in respect to steam consumption, efficiency, and reduced heating.

The publication of Mr. Highfield's article naturally gave wide publicity to the matter, and, as a result, much comment has been made in many quarters in regard to the same. Throughout, and from everyone—particularly from competitors—I have received much sympathy and evidences of goodwill, and in some cases considerable help, in the shape of data and particulars of similar insulation troubles with other high-pressure plants.

It remains for Mr. W. H. Patchell, in his recent Institution paper, to be the first, as far as I know, to bring up and treat this matter in an altogether different manner. Referring to Mr. Highfield's discovery of nitric acid in the windings of the Willesden alternators, he says: "It appears to the author, therefore, that probably the acid is due to impurity of the insulating materials rather than the destruction of pure material by ozone."

In other words, Mr. Patchell, knowing little or nothing of the facts of the case, and in face of Mr. Highfield's explicit statement to the contrary, goes out of his way to do my company and the manufacturer of the alternators a grave injury by deliberately making the wholly incorrect assertion that the troubles were due to the use of *bad materials*.

I feel compelled in the interests of the manufacturers of the alternators to protest against Mr. Patchell's action, and in doing so have little doubt but that I shall have the support of all those who like to see fair play. It may be that Mr. Patchell, when making the comments in question, did not realise that he was doing an injustice and an injury to others, and if this was the case I have no doubt that he will think it well to withdraw or amend the statements referred to above.—Yours, etc., A. C. EBORALL.

[We understand that Mr. Highfield has already contradicted Mr. Patchell's statement in the discussion on the paper. Mr. Patchell will, therefore, have to refer to the matter in his reply next month.—ED. *E.E.*]

THE PRODUCTION OF A DISINFECTANT (HYPOCHLORITE OF SODIUM) BY ELECTROLYSIS.

BY C. V. BIGGS.

It is possible that, even in scientific circles, not everyone is aware that we have, in a solution of chloride of sodium treated electrically so as to convert a certain proportion of the salt into hypochlorite, a deodoriser of considerable value, and a disinfectant and even steriliser of approved quality. Various attempts have been made to bring this substance within the scope of commercial applicability, but hitherto with but meagre success. This may be attributed in some cases to the use of too weak a solution tending to bring the substance into disrepute, to difficulties in its production, or to its lack of stability, or the quality of keeping its strength. A recent paper by Mr. Pollard Digby, read before the Faraday Society, deals with this latter most important question. From this it is apparent that, after the solution has reached a certain strength, the deterioration which goes on in the same solution is so considerable that a large proportion of the energy used in conversion is consumed merely to supply the waste—*i.e.*, to keep the solution at a constant strength in the tank. Temperature of the solution during working is also of vital importance. It will thus be seen that it is necessary to maintain a low resistance of the liquid by increasing the quantity of sodium chloride in the tank, otherwise the action of the current at an increased voltage will tend to be a heating one. These factors, depreciation, temperature, and efficiency, exercise the control over the manufacture of the liquid, as at present practised. Practical experiment goes to show that for commercial purposes a solution of 2 grm. or 3 grm. per litre is about what is to be aimed at. Prof. Kanthack's report on the Maidenhead experiments (1898) gives sufficient evidence of the sterilising properties of such a solution when used in the proportion of 2 gallons per 1,000 gallons of sewage effluent, whereas we have Sir H. Roscoe's report on the Hermite system at Guildford to show that a solution of 1 grm. per litre is liable to rapid deterioration, and has no value as a steriliser, though it constitutes an excellent deodoriser. To produce a solution of this strength an expenditure in energy of some 10 kilo-

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watt-hours per 1 000 litres will be needed, according to the data at present available.

An important feature of the case, however, is brought forward by Mr. Digby's paper, before alluded to, which is that at the end of a run, or period of conversion, a large proportion of the salt in the tank still remains in its original condition, and must, therefore, be taken into account in any calculations of efficiency. Quotation is made from a collection of records of experiments made by Herr Victor Engelhardt, and from these a table has been compiled relating to this point. This table gives four instances of runs to attain solutions of from 3 grm. to 15 grm. per litre of available chlorine, the voltage being kept constant at 5·5, and salt being added to keep the solution in a good state of conductivity. The highest percentage of salt converted shown on this table is 13·6, which was attained for an 8·2 grm per litre strength. In fact, the average conversion appears to be about 10 per cent. of the total quantity of NaCl in the solution. As this residuum (about 90 per cent.) of salt will probably be waste on account of the action of the water, we have here a very marked source of inefficiency in the production of the hypochlorite solution. It appears, however, to be difficult to carry on the process, as at present practised, without this large preponderance of salt present in the solution which cannot be converted.

The question of the manufacture of this fluid would seem to depend, not so much on actual cheapness of the process (we have evidence from Dr. Alexander's report for Poplar and Dr. Robinson's for Maidenhead, that the liquid can be produced for about 1d. per gallon), but on the possibility of producing a really stable solution. From a curve given in Mr. Digby's paper it is evident that the higher in grammes per litre of available chlorine the solution can be made to go, consistent with the time available, the better will be the lasting qualities of the liquid. For instance, a solution of 6·5 grm. per litre had, in 43 hours, deteriorated to 5·2 grm. per litre, while a solution of 8·8 only dropped to 8·2 In another diagram it is shown that the effect of deterioration of the solution under conversion is appreciable when the strength has risen to 4·18 grm. per litre, and that at a strength of 8 grm. per litre the yield per kilowatt-hour is adversely influenced by over 60 per cent. It would appear from this and other data on the subject that after the solution has been worked up to about 4 grm. per gallon strength, the resistance of the liquid rising causes the process to become inefficient in conversion of salt, or in consumption of power, or both.

As the interest in this steriliser appears to be reviving at the present time, and the load for the purpose of electrolysing would be a very welcome one to any generating station in whose neighbourhood an electrolysing plant might be installed, it is to be hoped that the difficulties in the matter of stability and waste of salt may be so far overcome as to render the process a commercially successful one.

BRIGHTON ELECTRICITY UNDERTAKING.

Local Government Board Inquiry into an Application for a Loan.

A great deal of public interest was centred upon the proceedings of the Local Government Board's inquiry into the application of the Town Council for sanction to borrow £38,500 for electricity purposes and £5 909 for the purchase of the Star Foundry site and the erection thereon of buildings in connection with their electricity undertaking The inquiry, to which we called attention last week, was opened on the 12th inst., and lasted two days. It was conducted by Mr. H R Hooper, M A, M.I.C.E The town clerk (Mr. Hugo Talbot) appeared in support of the application on behalf of the Corporation, and Mr. Elvy Robb represented a committee of ratepayers who opposed the application of £5,909, while Mr. J F. Blacker watched the proceedings on behalf of the Ratepayers' Federation. The town clerk at the outset furnished the inspector with details of the borough's indebtedness, which was £2,607,232. included in that being £482,798 for electricity and £268,286 for tramways. Turning to the present application, he explained that the period of repayment asked for in respect of the £38 500 was 25 years, and for the £5,909 40 years. With regard to the former amount, he was instructed to withdraw an item for some of the proposed fitting mains, which would reduce the sum by £2 650. The balance, £35,850, was made up in this way: 900 house service connections at £10 each, £9,000; one new feeder, £2,000; 1 000 meters at £4 each, £4,000; motors for hiring purposes, £4,000 These motors were purchased by the Corporation and let out for the convenience of customers, and also as additional means of encouraging the consumption of electricity. The revenue produced was amply sufficient to cover all the charges, and also to derive profit on that part of the business. Additions to the switchboard and accessories would cost £1,350. The 900 house services represented the system of requirements for the next three years, and was based upon the actual demand during the four preceding years, that average being 344 a year. Much time was then spent in discussing the methods of keeping accounts relating to loans, the inspector desiring to be informed whether it had not been the practice in seeking sanction for a loan for a specific purpose to apply it to another purpose The town clerk replied that such a question had never been raised during the 15 years of the undertaking, and he was not, therefore, prepared to answer it at once, but he contended that so long as the amount sanctioned was not exceeded the matter was immaterial. The first witness called was the engineer, Mr. John Christie, who explained in detail how the estimates had been made up, and upon each item he was carefully examined by the inspector. Regarding the cost of services at £10 each plus £4 each for the meter, he attributed the increased cost to the fact that the Corporation were now taking a class of consumer whose house had a long front garden, and therefore the cost of laying on the service to these houses was higher. But a further examination elicited a statement that the cost had been overestimated, and this was eventually reduced to £6. 10s. Mr. Christie admitted that he had not made comparisons with other towns in England, and was, therefore, not in a position to say whether in Brighton they were doing work cheaper or whether it was costing them more. Other towns, he said, had different conditions, but he averred that in Brighton the work was being done economically. Mr. Christie was then examined at great length on the question of £4,000 for meters. Here, again, the established precedent was departed from, inasmuch as the inspector entered into details upon which he could not receive enlightenment because the necessary information had not been prepared. It was stated that during the last 14 years £37 800 had been expended for meters and only £1,000 had been written off. Mr. Christie could not say whether they had exceeded the amount sanctioned, as it occurred before his time, but on the second day of the inquiry it was brought to light that the sum had been exceeded by £2,500. The town clerk promised to advise the Council to repay the money out of the reserve fund. With regard to the £5 909 for the Star Foundry site, the town clerk urged that there was a necessity for the additional accommodation, which would not be a burden on the undertaking. The old North-road station would be retained as a generating station. Mr. Christie explained that the steam plant would be retained in order to take the "load" during the three darkest months. The Southwick station when in full work would supply two-thirds of the maximum demand, and the North-road plant would be run to meet the "peak," which would be more economical than scrapping the whole of the existing plant at North-road and buying new plant to instal at Southwick. For nine months in the year the North-road station would be practically closed down as a generating station. During the other three months they would run on one shift of men. The inspector thought that the steam-engines at the station were not up to date, and the station would have to be kept open because it would not pay the Corporation to scrap the machinery.

The examination of the chairman of the Lighting Committee, Mr. Butt-Thompson, related chiefly to the allocation of loans and methods of keeping accounts. Mr. Arthur

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Wright, consulting engineer to the Corporation, stated that he recommended the expenditure of £437,000 on the new works, and so far they had expended £330,000 including what they had rendered themselves liable to. At present there were three foundations out of nine occupied by the 5,600 kw. of engines. The maximum that could be put into the station was nine times 1,800—that is, about 16,000 kw.—and the maximum load last Christmas was only about 5,000. Asked by the inspector when he expected the station to be filled with plant, he answered that it would depend on the development of the business. He denied the suggestion of Mr. Robb that the station was designed solely to supply the needs of the neighbouring districts. A great deal of the cross-examination of witnesses by the solicitors for the opposing parties was altogether outside the scope of the inquiry, and the proceedings were on that account greatly protracted. Much of the criticism was based on surmise, and although it seemed formidable, there was in point of fact nothing relevant in it which had not previously been touched upon by the inspector, whose searching investigations revealed several points which deserve attention. Mr. Elvy Robb contributed much amusement to the inquiry, which it is doubtful if even this was worth the time wasted by him and by Mr. Blacker.

THE COMMERCIAL TESTING OF SMALL MOTORS UP TO 15 B.H.P.*

BY THOMAS CARTER, A.M.I.E.E.

(Concluded from page 842.)

As a rule, however, the power-house does not give the exact voltage required for 3, and then 1 and 2 are also belted together to run as a motor-generator set. The armature of 1 is coupled to the power-house, while 2 must have an armature which will generate the volts required for 3. Then 2 and 3 are electrically coupled together, and the shunt of 3 is in this case excited from T_3. The process of putting load on 3 is exactly as before: 3 and 4 are belted together, and 4 can be put in parallel either with 2 to assist it in driving 3, or with the power-house as before, to assist it in driving 1, according to the voltage of the armature that happens to be in 4. During the temperature run all the resistance in the shunt circuit of 3 is, of course, cut out; it is only inserted when tests for speed regulation are being made. All adjustment of volts, etc., is made through the resistances in connection with 1, 2, and 4. Since the motor on test is always—except in a special case to be referred to afterwards—loaded by running 4 in parallel with another generator, no external resistances are required for taking up waste power, and, therefore, the apparatus, just as it has been described, complies perfectly with the requisite of flexibility at both ends, as it has been shown how, by a suitable arrangement of pulleys, stock armatures, and field strengths, practically any desired voltage for testing can be obtained from a source of power at the same or any other voltage.

In actual practice 1, 2, 3, and 4 are mounted on a wooden bench 11ft. long, 2ft. 6in. wide, and 2ft. 6in. high. It has four legs on each side, 3ft. apart lengthwise, so that one pair of legs comes under each machine; and the whole is fixed down to the floor—cement in this case—as firmly as possible. A row of slide rails is fixed along each long side of the top, and four pairs of cross-rails sliding on these, and capable of being bolted down to them, carrying the four machines. An idea of the appearance of this bench with the machines on it, as well as of the other apparatus, is given in Fig. 2, for the opportunity of obtaining the original of which thanks are due to Messrs. J. H. Holmes and Co. The frame of resistance coils standing at the end of the bench is for a special purpose yet to be mentioned, and is shown, not as part of the regular apparatus, but simply because it is occasionally used in certain tests. All the switches, instruments, and terminals already described are mounted on a switchboard which stands at the end of the bench. In Fig. 2 one of these boards is seen complete, and part of another belonging to the bench, on which are seen the pulley ends of 1 and 2 belted together. The terminals, T and T_2, on the switchboard are connected for convenience to corresponding terminals, mounted on the under side of the bench top, and visible in the photograph, to avoid having loose wires lying over the floor between the board and the bench. Thus 1, 2, and 4 being for all practical purposes permanently coupled up, all that is necessary to get a motor running for test is to connect it to two pairs of terminals, armature and field respectively, which terminals are in practice all ready provided with wires for fixing at once to the motor terminals. The rest is all done at the switchboard. It is not necessary to go into much detail about the arrangement of the apparatus on the switchboard, since this is simply a matter of setting out a certain number of articles in what each designer considers to be the prettiest possible way. The over-all sizes of the two slate bases, positive and negative, is in this case 2ft. 10in. wide by 4ft. 11in. high, and they are mounted, as shown in the figure, on angle irons, so that the top is 6ft. 6in. from the floor. As the switchboards happen to be near a wall, all the starting and regulating resistances, as well as the ammeter shunts, are mounted on the wall, which leaves the back of the board quite clear. They could, of course, be mounted on iron brackets and supports carried from the vertical angle irons, but this is more

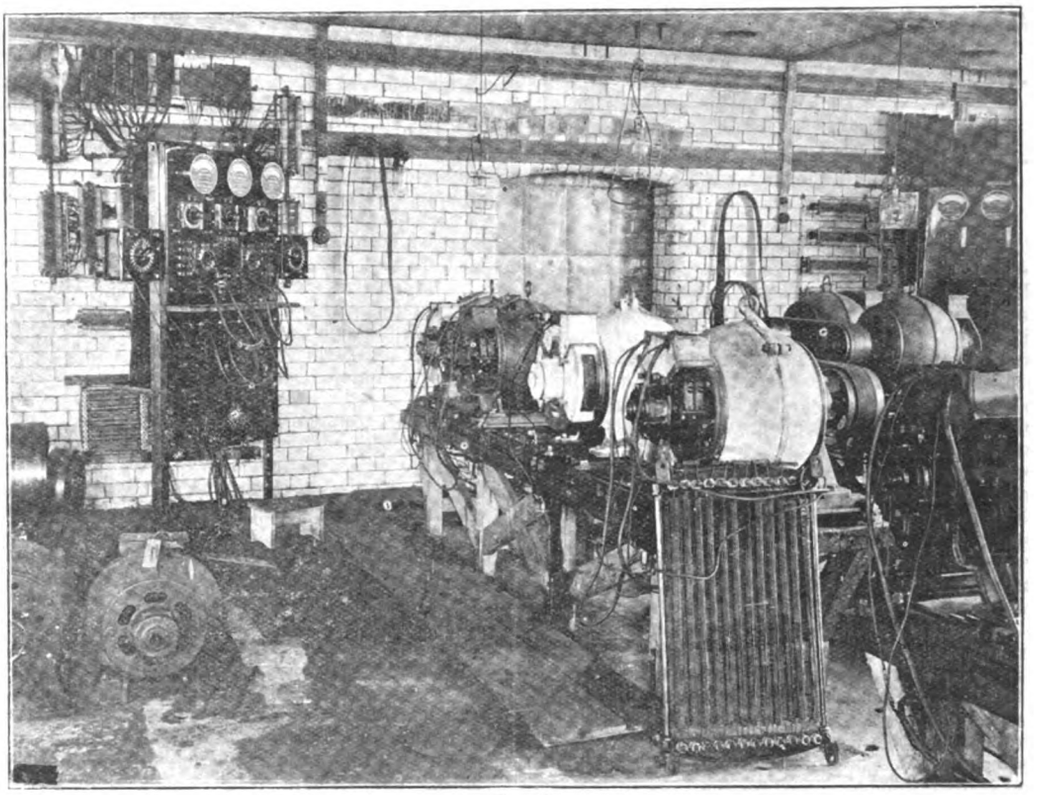

FIG. 2.

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Dec. 11.

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likely to cover up the back of the board with wires, which is a great evil, to be avoided studiously. It is, perhaps, unnecessary to mention that there are not actually five voltmeters, five ammeters A, and four ammeters A_1. There is one voltmeter only, reading 0-150 volts direct, with resistance to give 0-300, 0-450, and 0-600 volts, and a five-way double-pole switch couples it up, through a fine double-pole fuse on each circuit, to any one of the five V points of Fig. 1, which thus represent simply five places where volts may be measured. Similarly, the five points, A, are five separate shunts, connected, however, through a 10-way double-pole switch to the instrument, which has a small switch between the double-pole switch and its terminals so that it can be cut out of circuit in changing over the double-pole switch, in case of an overdose of current. The reason for the 10 ways is that each point A is actually two shunts in series, one giving full deflection with 15 amperes, the other with 150 amperes, so that the ammeter has two ranges. Similarly the four A_1 points are coupled through an eight-way switch to their instrument, and each A_1 has a 5-ampere and a 0·5-ampere shunt giving again two ranges on the ammeter according to the position of the double-pole selecting switch. These instruments are checked about once a month against a standard. As has already been suggested about the setting of carbon brushes, so also about all electrical instruments used by a number of different people in ordinary testing work, one must be in a perpetual state of scepticism, sometimes even of terror, lest they be inaccurate. Instruments of even the so-called "best make" will, especially when new, drop off in strength of field sometimes very rapidly, and by letting some go too long without checking they have been known to get as much as 10 per cent. out. It is a most useful piece of advice that one should never believe any single reading of any instrument in constant use. Only when one gets into a state of out-and-out unbelief like that does one take sufficiently vigorous steps to have the matter looked into with thorough regularity. This applies, of course, to supply companies as well as to manufacturers: there was once a time when the voltmeter of a certain company—shall it be said it was within a hundred miles of St. Nicholas's Cathedral, or shall that not be specified?—was found to be about eight volts low, and that same company declared that a monthly check of its instruments was taken regularly. This, therefore, is a matter equally important to us all.

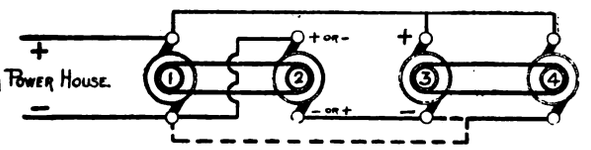

FIG. 3.

It may be said here that the cost of one complete set of apparatus as above described will probably be from £60 to £90—including everything but the armatures for 1, 2, and 4—according to the way the switchboard is fitted up and the type of instruments used, as well as the amount of wiring required and other possible variables dependent on individual circumstances. The number of tests per bench per day generally works out at about 1½ on the average under the conditions as to length of run already mentioned. As there are four benches, it is possible, as a rule, to keep each one for a given voltage, and to put each motor as it comes on the bench whose number 2 armature suits the case best. This involves less changing of armatures, but even if this has to be done, it is a very simple and short matter to accomplish.

In cases where the power-house voltage is only a few volts different from that of the motor to be tested, it is convenient sometimes to generate from 2 only the difference in volts and put this in series with the power-house voltage, thus increasing or diminishing it by the necessary amount. The connection would be as in Fig. 3, which shows only the armatures. The shunt of 3 must be excited from T_1 on the positive side and T_3 on the negative side in this case, and 4 can run, as shown by the full and dotted lines on the negative side, in parallel either with the power-house—that is, with 1—or with 3 as usual. This method saves transforming all the power required from one voltage to another, and is consequently a little more economical. It is interesting to see how well standard full-speed armatures work in for this in 2. For low-voltage motors the maximum difference between 1 and 3 will be 15 volts, as the possible range of working voltages is from 100 to 115: for medium voltages the maximum difference would be 60 volts—range 200 to 260 volts: while for high voltages the maximum difference would be 150 volts—range 400 to 550 volts. Thus for all cases a low-voltage armature is run in 2, and a high-voltage armature in 1, because if 1 is working at low volts it will run about quarter normal speed, and if the pulleys on 1 and 2 are in the ratio of about 1 : 2 in diameter, 2 will run at about one-eighth of normal speed, and will thus give out a maximum voltage of about 110/4 or 14 volts. Smaller differences could be got by weakening the field of 2. Similarly, for medium voltage, 1 will run at half speed, and equal pulleys on 1 and 2 will give half volts—about 55—from 2, which can be reduced, if necessary, by field regulation. For high volts, 1 will run at full speed, and by weakening the field of 1, and thus getting a higher speed, or by having a smaller pulley on 2 than on 1, 2 will give out 150 volts if required. This example is quoted at length, as it is useful for showing the great flexibility of the system.

It is a very simple matter to measure armature and series resistances on these benches. It is only necessary to disconnect the shunt of 3 and prevent the armature from turning, and then to send a current through the armature and series, if any, of 3 from 2, running at a reduced voltage. The drop of volts recorded on a low-reading voltmeter at once allows the required resistance to be calculated, the current giving this drop of volts being read on the ammeter A in circuit with B.

In ordinary tests the standard 10-b.h.p. frames are evidently large enough to test up to 15-b.h.p. motors, which is about the limit of weight that can be dealt with in this particular shop. If 4 runs in parallel with 3, and if 3 is a 15-b.h.p. motor with an efficiency of, say, 90 per cent., while the efficiency of 4 is, say, 88 per cent., then 4 will generate—neglecting belt losses, which with Hendry belts are very small—about ·88 of 15 b.h.p., or 13·2 h.p., which can easily be got out of this frame as a generator, while 3 will require to drive it about $\frac{1}{\cdot 9}$ of 15 h.p. Hence, since all that 4 generates is used for driving 3, 2 has to generate and supply to 3,

$$\left(\frac{1}{\cdot 9} - \cdot 88\right) \text{ of } 15 \text{ h.p.}$$

Assuming an efficiency of about 80 per cent. for 2, since, as will be seen, it is not working at full load, there will be required to drive 2, in order to get the above from it,

$$\frac{1}{\cdot 8}\left(\frac{1}{\cdot 9} - \cdot 88\right) \text{ of } 15 \text{ h.p.}$$

or, roughly, 4·4 h.p., which means that 1 must deliver 4·4 h.p. to 2, and will consequently, with an efficiency of about 80 per cent. also, take from the power-house about $\frac{4 \cdot 4}{\cdot 8}$, or 5·5 h.p., to drive the whole combination when 3 is a 15-b.h.p. motor. This is a much more economical method of running than when 4 is put in parallel with the power-house, as the latter has in that case to supply the losses between 1 and 4 which are due to a double transformation, and amount to nearly half as much again as the 5·5 h.p. mentioned above. Besides this, the load on 1 and 2 is now increased to 19 h.p. and 16·7 h.p. respectively, since 2 is no longer directly helped by 4, and this overload would probably overheat their armatures. Hence it is always better to run 4 and 3 in parallel if possible, but, because there may be cases where 4 has an armature of unsuitable winding and no other is available, 1, 2, and 4 are all chosen alike, of the standard 10-h.p. size. This has the further advantage of allowing all the armatures to be interchangeable.

For brake tests on the larger sizes of motors, 1 is not capable of developing enough power to drive the combination, as there is no longer any opportunity of running in parallel when 3 is loaded by a brake instead of by being belted to 4. In such a case, 1 and 2 on another bench must be used in addition, and the two 2 armatures put in parallel, unless it can be arranged to get the necessary voltage direct from the power-house.

In testing series-wound motors, the only difficulty is in starting up, as sufficient torque must be kept on the motor all the time to prevent it running away. This is accomplished by keeping the volts of 2 very low at first, and by putting 4 in parallel with 2 at the very start, and continually adjusting the field while raising the speed by means of increasing the volts of 2 so as to keep enough current in 3 to avoid a dangerous speed. Otherwise the procedure is just the same.

In testing small dynamos, the simplest method is to bring 4 along to the place of 3 on the bench and run it as a motor, while the dynamo on test is coupled up to the mains of 4. This avoids all changing over of ammeter flexibles which would be necessary if the dynamo were put in place of 3, everything being coupled up to suit the testing of a motor normally. Load is put on the dynamo 4 by putting it in parallel with the motor 3, and then, keeping the speed right by adjusting the field of 3—in doing which a tachometer belted to the dynamo or driven by a pin in the end of the shaft saves repeatedly counting the revolutions—the current from 4 is adjusted by altering its field in turn. Dynamos of very low voltage, such as milking boosters or plating dynamos, are most simply loaded by wasting the energy in a resistance, such as is shown in Fig. 2 at the end of the bench. This is the only case in which an external heavy current resistance is necessary, except in a few special cases where it is desired to test a motor specially for starting under full torque. In this case the resistance is put across the terminals of 4, which is then loaded as soon as it begins to rotate, being separately excited, and consequently puts load on 3 at once, instead of, as usual, having to be run up to the correct volts for putting it in parallel with 1 or 3, which

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means that 3 would start light, as it does, of course, in all the usual tests. This resistance, then, is really a special movable piece of apparatus, only used in a few tests, and is not at all necessary in normal cases, which are dealt with, as has been seen, by an entirely permanent arrangement.

These benches have not as yet been actually used for alternating-current motors, but it is proposed to do so by replacing 1 and 2 by an alternating-current transformer fed from mains quite independently of the continuous-current board. The motor on test would be coupled up to the secondary of this transformer through a starting switch, which would probably be mounted on the transformer. The load would be put on the motor by belting it to 4 as before and

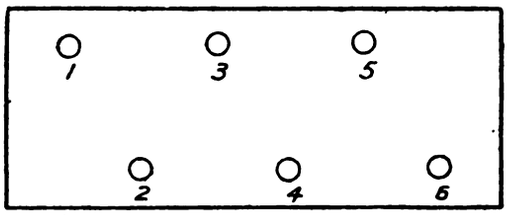

FIG. 4.—Blank.

running 4 in parallel with the power-house, the connection to which would always be available through the terminals on the continuous-current board. Thus the power given out by the motor, while it could not be used to help to drive itself, would help to drive continuous-current motors on other benches, and so cause them to take less from the power-house than would otherwise be necessary. The transformer would need to be specially designed with arrangements for varying the ratio of the primary and secondary turns through a large range. As regards instruments, while it would be possible to adapt the connections of the continuous-current board so as to use in the ammeters and voltmeter mounted on it, it is not proposed to do this, but rather to mount an ammeter, voltmeter, and wattmeter, with the necessary change-over switches for three-phase

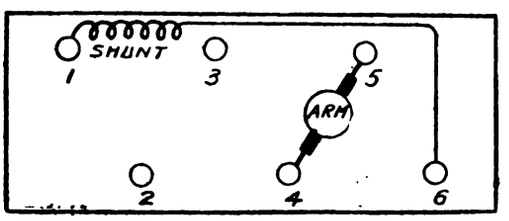

FIG. 5.—Shunt.

motors, on a light portable table, which could be placed by the side of the bench as required. The saving in time as compared with the necessary alteration in connections to use the continuous-current board instruments each time the motor on test was changed from continuous to alternating current would quite compensate for the necessity of providing an extra ammeter and voltmeter. The wattmeter would, of ocurse, be needed in any case for power factor measurements.

It may be interesting to mention, in conclusion, a terminal base for motors recently designed by the writer, and now used on the motors tested on these benches. It consists simply of a flat slab of porcelain held in the terminal box of the motor by a screw at each end (the holes for which are not shown in the illustrations), and provided with six holes, numbered

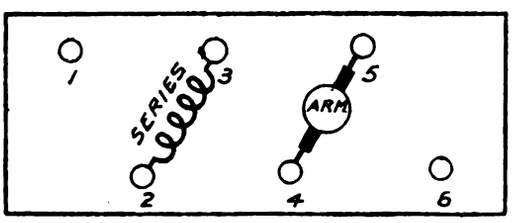

FIG. 6.—Series.

1 to 6, and so spaced that all the distances, 1-3, 3-5, 2-4, 4-6, 1-2, 2-3, 3-4, 4-5, and 5-6 are equal. Brass studs are fitted in as many holes as are required, and are provided with cable sockets for external mains in the proper places. The same block, as illustrated in Fig. 4, is used for shunt, series, and compound wound motors, such holes as are not required being simply left blank. The armature is in every case connected between 4 and 5, while the shunt is between 1 and 6, and the series between 2 and 3. The three types are shown in Figs. 5, 6, and 7. All the connections from the inside of the motor to the terminal base are brought to the under side of it, while on the upper side the external mains are connected up, and copper links, with holes at each end, distant by the amount of the pitch of the holes in the base from each other, are used to connect together pairs of studs as required by simply dropping them over the studs and clamping them down between two nuts. The advantage, which is great, is that no internal connections of the motor need to be altered if the direction of rotation has to be permanently or temporarily reversed; everything is done on the upper side of the terminal base by simply changing the links, and, in some cases, the position of the external mains. The variety of ways in which motors may have to be coupled up makes it impossible to describe all the possible combinations—as one example, however, is shown, in Fig. 8, the connections for a compound-wound motor with shunt and series regulation. To reverse the direction of rotation, all that is necessary is to change the link from 3-4, shown full, to 3-5, shown dotted, and

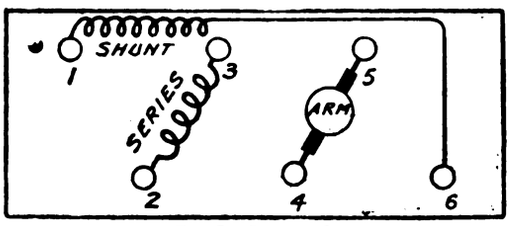

FIG. 7.—Compound.

to change one external main from 5 to 4, indicated by full and dotted lines. All the other wires remain exactly as before. The distance 3-4 being equal to 3-5, the same link serves in each case, as in fact it would for any other pair of studs on which the type of motor field winding and the way in which the motor was to be used required it to be placed. Two or more links may be used as required, and it is possible to use this base for absolutely every conceivable type of coupling up either a dynamo or a motor. A card sent out with each machine shows the proper place for links and mains for each direction of rotation, so that even the country-house gardener could not err, except deliberately.

There is much more that might be said on this subject and its side issues, but so long a paper must already have tended to

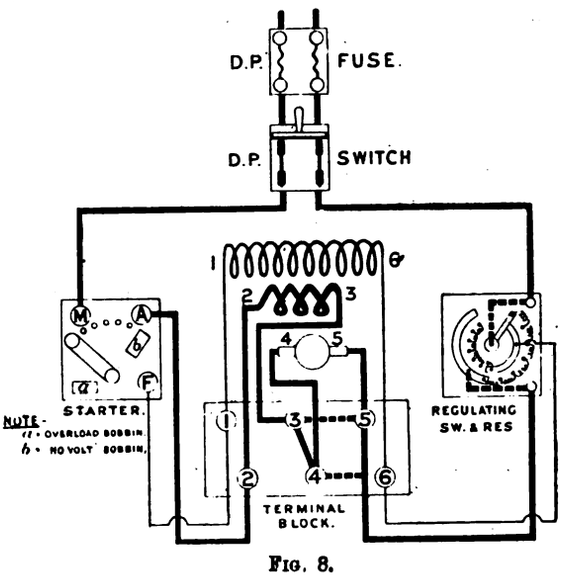

FIG. 8.

become wearisome, and must, therefore, now draw to a close with a renewed expression of the hope that some at least of what has been said may contain something which will prove not altogether uninteresting and unserviceable to some fellow-workers in this or some other province of the vast and ever-increasing domain of electrical engineering.

APPOINTMENTS VACANT.

Electrical Engineer, Pontypridd Urban District Council. Salary £91 per annum. Applications to the Clerk by Dec. 27.

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THE WIRING OF BALOR CASTLE: A MYSTERY.

[The following story has been sent us by a friend of the narrator's, whose manuscript he has slightly edited in order to improve the deficiencies of literary style. The story is one of that class that calls for the investigation of the Society for Psychical Research.—ED. *E. E.*]

My chief wireman burst into the office with a face as white as a sheet and collapsed on to a chair.

"Good heavens! Tom," I cried, "whatever is the matter?"

"I've seen it, sir," he whispered, clutching hold of the table and shaking all over like one with the ague. "It—he—O Lord——." He had fainted.

Two or three of the others were at the door, looking over each others' shoulders with scared faces. "What is all this about?" I asked, loosening Tom's scarf and applying my whisky flask to his lips. No one spoke. At last Mike the labourer came forward. "Shure, sorr, an' he's seen th' pooka," he said, crossing himself.

"The wha-at?" I cried.

"He means the ghost, yer honour," said another; "the one Mr. Murphy told ye of."

Murphy was the bailiff. Well, here was a pretty fix.

When I was asked by my employers to take charge of the work in connection with the electrical installation at Balor Castle, the seat of Lord ———, in the North of Ireland, I concluded that this would prove an important episode in my business career, and I accepted the offer with alacrity. Had I guessed at the time what the nature of the episode was to be, and the manner in which it would affect my prospects, I should not have been quite so eager. I am now out of a job, and writing this story in the hopes of getting something to eat—— But I am anticipating.

I took two good wiremen (of whom Tom Joyce was foreman) and two carpenters from London, and engaged the remainder of my staff, in the shape of a pipefitter, a wireman, and three labourers at Belfast. The family were away for the whole winter, and our comforts were attended to by Murphy, the bailiff. The men were found lodgings amongst the tenantry and I was given a bedroom and an "office" in the castle, where the housekeeper and one or two servants were in charge. No architect or consulting engineer had planned out the job (thank goodness), which was to be executed on a basis of cost. All that we knew was the schedule of lights and the positions had been fixed by his lordship in consultation with the bailiff. The plant was to come along afterwards, but for the present there was a good two months' wiring to do, and I was to draw on supply houses at Belfast and Dublin for the material. The castle was a very peculiar building. I should think it had been added to bit by bit every century since its original foundations were laid, but when that remote work was carried out even Murphy did not know. "Some folk say that this was originally the castle of Fin mac Coul," he told me when I first came, "but, anyway, his lordship knows more about it than I do, and he's got some pretty grim stones tacked on to the family, which, as you know, is descended from some of the Irish kings." I did not know, but I had heard that very few of these ancestors had died a natural death. "I suppose the castle is said to be haunted," I asked jestingly.

The bailiff looked hard at me. "I should advise you to leave that subject alone when speaking to those superstitious Irishmen you've got," he said, "or they'll vanish like a shot. There are various tales about, but I've never seen anything myself, nor known anyone who has. It is said that one of the kings of Ulster flayed his brother alive in this castle for attempting to run off with the queen, and that he had her majesty's throne covered with the skin, in order to remind her whenever she sat down that she was in the arms of her lover. The brother is reputed to haunt the old part of the castle, so, perhaps, you may see him." With that he left me, and we did not revert to the subject until the present incident occurred.

When I had brought Tom round, I questioned him and all the other men. It seems that one of the carpenters had overheard the bailiff's conversation with me and had promptly told his mates, who had no doubt all put themselves into a receptive mood for anything uncanny by discussing the matter over their grog with their respective landlords. I could not get Tom to give any coherent account of his adventure; all I could gather was that, having strayed for a moment into the older part of the edifice to plan out where a "run" was to come through, he had chipped some brickwork away, and had then seen (or thought he had seen) something horrible.

"Now look here, men," I said, "we are living in the twentieth century, and there is nothing that cannot be explained by scientific methods—no ghosts, or pookas, as you call them here, or anything." They all looked dubiously at Tom. "It is evident, too," I went on, "that Tom is not well, a touch of influenza, perhaps, and his disordered mind has conjured up a vision. (Tom shook his head.) So go to your work again, and I'll be around in a minute." I took Tom to his lodgings and made him lie down. Afterwards I returned to the castle, walked round the works, made the men accompany me to the place of Tom's fright, and, having reassured everybody, went back to my plans. I mentioned the matter to Murphy, who shook his head and said I had better have left that old brickwork alone.

Next day Tom was very ill, and I sent for a doctor, who pronounced him to be suffering from pneumonia. I telegraphed for another wireman, but in the meantime poor Tom died. Curious as it may seem, I was able to use this event as an argument to prove to his mates that Tom must have been delirious at the time when he had his alleged experience, and that put matters right again.

The new wireman arrived and things went on smoothly for a week or so. On the day when we started to work in earnest at the older part of the castle, I was assisting one of the carpenters in the long hall, when a terrible hubbub arose in another part. The door at the end was burst open, and one of the Irish labourers, named Mike, came through, followed by the two wiremen, the other carpenter, and Fergus, the second labourer. Mike rushed past me, calling loudly, "Ochone, yer honour, I've seen a bloody hand all covered wid blood, an' I'm not stoppin' f'r me money," and he fled along the corridor, fell at the top of some stairs, rolled to the bottom, and was picked up dead. Well, I had more trouble this time. The others had not seen what Mike thought he saw, but they followed him in his wild flight, from which it was clear that they were all more or less in a state of nerves and ready to believe anything. The death of Mike, although he smelled somewhat of drink, quite neutralised my argument about Tom; in fact, the two deaths were at once associated with the alleged apparition, and I pointed out in vain that Mike must have been drunk to go without his money. However, the pipefitter, a fat man with a red nose, who had been to sea, laughed at the whole thing, and by dint of some influence he had over his mate Tim succeeded in reassuring him and making him stick to the job. As for the others, it was only after I had promised to be on the works with them continually that they agreed not to lay down their tools. Such is the influence of a sceptic amongst a company of the superstitious.

After this the work went on without any further event for quite a fortnight, and we were beginning to forget all about our unhappy mates. In fact, I had gradually weaned myself away from the works in order to attend to my correspondence and plans when necessary. Suddenly our whole company was thrown into a fresh state of consternation. It happened in this way. One day the Belfast wireman, who was called O'Reilly, had not been seen for some time, so I sent Fergus, the remaining labourer (Tim was at the forge) to look for him. Hearing a loud yell, or rather shriek, we all rushed in the direction of the noise. Bursting into the turret room, an extraordinary sight presented itself. Fergus was leaning against the wall and pointing to the further door, whilst O'Reilly was lying at the foot of a trestle, mixed up with yards of 3/20 wire, apparently quite dead, and with a drawn look of intense horror on his face. Fergus found his voice when he saw us. "I saw th' pooka go through th' dure," he cried, "th' momint me mate fell, an' if it wasn't him, thin it was his shadder, be jabers."

"Come," I said, "you're a silly fellow if you have been frightened at shadows. Your mate here got twisted up with a wire and fell off the trestle whilst you were mooning." We made a most exhaustive search, and, as I expected, did not see or find anything, nor was there any evidence to show that anyone had been near the room. But nothing would pacify Fergus, who insisted on going back to Belfast at once. The result of all this was a great deal of unpleasantness. A second inquest was necessitated, and although "accidental death" was the only possible verdict, the local jury at first wanted to suggest that O'Reilly had seen something of the nature of which there was no evidence.

I sent a long report to my firm, who, however, only replied that the work must be got on with more quickly than had lately been the case. The bailiff was also rather distant; he would not discuss the matter, merely grumbling that everything had been all right until the infernal electricians came on the spot. Naturally the servants were somewhat disturbed, although they slept in quite a separate new wing from where we were working. Personally, I began to get uneasy. I was as sure as ever that here was one of those curious chains of circumstances or coincidences that all combined to point to a wrong conclusion. Nevertheless, the uncanny surroundings and the three deaths so quickly in succession had got on my nerves.

After this I made up my mind that I would have no more native labourers, and I determined to push on with the work as rapidly as possible, so as to get on to the newer part of the castle. Being short-handed, and also to inspire confidence, I myself took up the position of leading wireman. The work

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went on again uneventfully for a couple of days, when a fresh incident occurred to disturb our equanimity. The pipefitter came to me one morning looking rather pale.

"If ye plase, sorr," he said, touching his cap, "I'll be afther taking my money an' goin' home."

"Whatever for?" I asked rather angrily.

"I name no raisons, sorr," he said, "but I cannot sthop at all."

Argument, abuse, entreaty, all were of no avail, and so I paid him off.

"Stop a minute, though," said I, as he was going. "Where's Tim?"

He grinned in rather a sickly way. "Tim's taken his hook!"

"Confound you all for a lot of cowards!" I cried. "What's to become of the work?"

The pipefitter approached me in a mysterious manner. "Look ye, sorr, I've been a bit about th' wur-ruld an' seen many grously sights. My advice to ye is, give over wid th' wur-ruk." And with that he went.

"Never!" I cried. "I'll see this infernal mystery through if I die for it!" As I uttered this exclamation my heart gave a jump. Did I, or did I not, see a reddish shadow at the window, between me and the light? I pulled myself together quickly, remembering that the man who had just gone out must have passed the window. My mind was evidently disordered. Taking a gulp of whisky, I called the four remaining men into the office. They were the two London wiremen and carpenters. At least I could rely on these.

"Now, mates," I said, "you see that Joe and his labourer have gone for no reason. With the exception of poor Tom, who died of pneumonia, all concerned in these desertions and accidents are Irishmen. Are we, five Englishmen, to be beaten by a supposed ghost, when we know such things don't exist? What do you say? Are we to go home and say that we failed to wire a castle because there was a ghost in it? What would your mates at home say? Shall we see this job through together, we five, and lay the ghost?"

After considerable discussion, from which it was clear that the men thought there must be something, but that it was capable of a solution, we decided that we would in future all work together, doing one room at a time; also that we would all sleep together in the turret room where O'Reilly fell, so that if anyone attempted to play any trick on us—an idea I encouraged—we should know how to deal with him.

The bailiff grumbled at the new arrangement, but I took no notice of his moods. That night we all moved into this room, and made up some shakedowns on the floor. It was arranged that if any person were to intrude we should all, without further ado, throw ourselves on him so as to allow of no chance of escape. For this purpose our beds were fixed at intervals all round the room. I had obtained the loan of a pack of cards and a box of dominoes from Murphy, and thus with our pipes and some good Irish whisky the evening passed away. At about midnight we retired. At first no one slept, but to our surprise we all awoke in the morning and agreed, with feelings of relief, that nothing had happened.

The next evening passed in a similar manner, and we retired at the same time, and woke up less surprised than the day before. But the third night—ah, well, I will tell you. I woke up with a feeling of uneasiness, and found the moonlight streaming into the room. Not feeling comfortable, I turned my head on the pillow, and saw—God! shall I ever forget it?—a man standing in the centre of the room, looking at me. I say looking at me, because his face was turned that way; but the eyeballs were sightless, and the man was—raw. *He had no skin on.* For what seemed an eternity my tongue was glued to my mouth and my blood froze. Then with a superhuman effort I screamed, "Help, mates! There, in the middle of the room!"

The men woke up instantaneously and with one bound we all jumped into the centre of the room and fell to the floor, grappling each other. How long we fought I cannot say, but someone got separated and struck a match. The silence that followed when we saw that there was no one to hold was broken by a low whining noise, which might have been the wind, and then the match went out.

"For heaven's sake light up again," cried one of the men, and we then lighted the candles, and so, with shattered nerves, waited for the day.

Now, the extraordinary part of the affair was that, when we talked the matter over, the other men all agreed that they had seen absolutely nothing themselves, but being woken up suddenly with a command, had done what they had been told. I thought it wisest, therefore, to maintain a silence regarding what I had seen, and tried to make myself and them believe it was a dream. The incident had, however, so thoroughly upset them, coming on the top of all the previous events, that one and all asked to be paid off and refused to stop another hour in the place. Personally, I felt too ill to argue the point, and I wired to my employers that I was coming straight back with the four men, and we left that very afternoon.

I mention here incidentally that when I got to Belfast I saw in a paper that my pipefitter had fallen between a train and the platform, and had been killed; whilst a labourer, in whom I recognised Fergus, had been found drowned in the docks.

When I returned home my firm would have nothing to do with me, and gave me my discharge. Since then it has fared ill with me. Business is bad, and the one or two jobs I might have got were refused me because I could not show a satisfactory reference from my last employers.

This morning, when looking at a paper in the free library (where I went to consult the "situations vacant" advertisements), I read that my pipefitter's labourer, Tim, had been killed at Belfast by the snapping of a hawser.

And so, although everyone of the alleged appearances at Balor Castle might be explained away, is it not a curious fact that all those who saw (or thought they saw) something have since died? All, that is, except myself, who must have had a nightmare, I am beginning to think.

And, as I said before, I am writing this account of my extraordinary experiences in the hopes of getting something to eat, but——

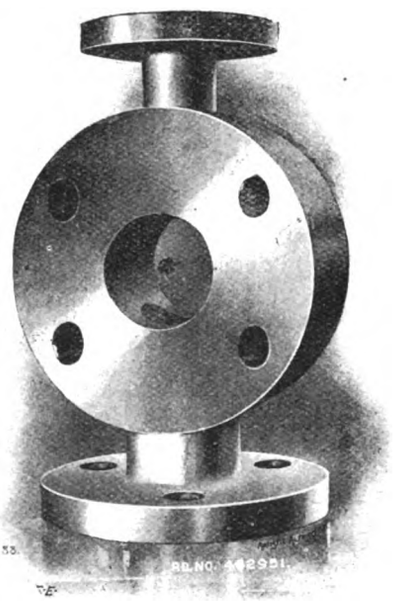
* * * * *

[The story ends here. Our correspondent who sent it says that he found his poor friend sitting at his writing, quite dead.—Ed. *E. E.*]

TRADE NOTICES AND NOVELTIES

Wrought Tees.

A tee of the special form recently introduced by Messrs. Meldrum Bros., Limited, of Timperley, near Manchester, is shown in the accompanying illustration. The distinguishing feature of this tee is that it



Meldrum's Wrought Tee.

is of wrought, not cast metal. It takes up much less space than the ordinary pattern, it is claimed, and, being machined from solid mild steel, is absolutely reliable—a fact which should alone recommend it especially for high pressures.

Catalogues, etc.

Knife Switches.—We have received from Messrs. Ferranti Limited a catalogue of their double-pole, double-throw, quick-break knife switches.

Artistic Fittings, etc.—From Messrs. O. C. Hawkes, Limited, Globe Works, Birmingham, we have a well-illustrated catalogue of their artistic fittings and heating stoves. The latter include some charming designs, and will appeal strongly to those who have a leaning towards art furniture.

Boardman's Arc Lamps.—Arc lamps for photographic, photo-process, stage, and medical purposes, etc., of the single-pair and multi-carbon types are dealt with in a list recently issued by the Boardman Electrical Patents Company, Limited, 10, Southwark Bridge-road, London, S.E. Some of these lamps have as many as four pairs of carbons in series, and yield up to 10,800 c.p.

Prometheus Heaters.—The British Prometheus Company, Limited, Kingston-on-Thames, have sent us a copy of their new catalogue of electric heaters, in which 56 different patterns of convectors, eight radiators, and one combined convector and radiator are described. The antique finish copper convectors are especially noteworthy. These are made of the finest hand-beaten metal, the workmanship employed being of the highest quality.

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HEATING AND COOKING APPARATUS, ETC.—The General Electric Company, Limited, have just issued a new edition of their catalogue section "H" of heating and cooking apparatus, radiators, etc. The articles listed cover a wide range of usefulness. Special mention may be made of the auto service water-heaters and hot-water jugs (pp. 813-814), and of the new designs of glow radiators shown on p. 821. Electric irons, glue-pots, sealing-wax heaters, furnaces, etc., are included in great variety.

THE "O. AND I." ELECTRIC DRILLING MACHINE.—The United States Metallic Packing Company, Limited, Soho Works, Bradford, have sent us a copy of a booklet dealing with their "O. and I." portable electric drilling machine, which has already been largely adopted by the principal engineering firms in the United Kingdom. Illustrations showing the ready adaptability of the machine for the most awkward positions are included. It is especially suitable for use in connection with bridge-building and general constructional iron-work, shipbuilding and ship repair work, locomotive and stationary engine building, tramway trackwork, colliery work, and general engineering of all descriptions.

LABOUR-SAVING DEVICES.—A catalogue, which we have received from Messrs. Neville Bros., 7-9, James-street, Liverpool, illustrates a large variety of labour-saving machines and tools for use in electrical engineering works, etc. Among the contents we notice: vacuum drying and impregnating chambers for dynamo and motor armatures, coils, covered wire, etc.; automatic coil-winding machines; slot broaching and slitting machines for assembled stator and rotor stampings of induction motors; automatic tissue-papering machines for papering sheet iron for armature discs; armature disc varnishing machine; armature coil taping machines; armature disc, segment, and ring, automatic notching and dividing machines; hydraulic presses, and a large range of other useful machines to meet the requirements of the electrical manufacturing industry.

THE BATES-PEARD ANNEALING PROCESS.—We are indebted to the British Insulated and Helsby Cables, Limited, Prescot, Lancs., for an interesting description of the Bates-Peard patent automatic process of annealing non-ferrous metals. This process, which has already been widely adopted, provides not only for the annealing of metals absolutely free from oxides or scale, but has an automatic mechanical means of loading and unloading the furnace—reducing the labour cost to an irreducible minimum. It also has the advantage that only the article requiring to be annealed is heated up and cooled again, thus reducing the fuel used to a minimum also. The furnaces are at present in operation for annealing copper wire for the electrical trade's use, copper sheets, fillets, and tubes, brass tubes, nickel tubes, gold and silver articles for jewellers' use, fine brass, copper, and phosphor-bronze wires for weaving purposes. Needless to say, they are made in several types to meet these special requirements.

PERSONAL.

The Municipality of Johannesburg have appointed Mr. J. Foster as car-shed superintendent.

The Chichester Town Council have decided to increase the salary of the surveyor from £150 to £200 per annum.

The Radcliffe District Council have appointed Mr. Henry Wilkinson, of Radcliffe, electrical engineer to the Council at a salary of £150 per annum.

Mr. G. C. Milnes, of the Sandycroft Foundry Co., has been appointed switchboard attendant at the Lancaster Corporation electricity works.

Mr. Sydney Buxton, Postmaster-General, has appointed the Hon. Richard D. Denman to be his principal private secretary and Mr. H. F. McClintock as his assistant private secretary.

We are informed that Mr. G. H. Oswald Strick is leaving the Westinghouse Co.'s publishing department to take up the position of publicity manager with Messrs. Davidson and Co., of Belfast, the manufacturers of the well-known Sirocco fan.

The third annual dinner and smoking concert of the staff of the Salford Corporation electricity department was held last week. Mr. C. D. Taite (electrical engineer) presided over a large attendance, and was supported by Councillor Hodgson (chairman of the Salford Electricity Committee) and Councillor Barratt, J.P. (deputy-chairman).

The Aberdeen Tramways Committee have decided that the tramway manager shall be paid a salary of £300, and that he shall have charge of the undertaking, without the electrical equipment and track. The electrical work is to be under the charge of the electrical engineer, and the repair of the track in the hands of the burgh surveyor—as at present.

At the invitation of the chairman (Mr. F. J. Ferguson) of the Whitchurch and Pangbourne Electric Supply Co., a farewell dinner was given last week to Mr. A. T. Cooper, the managing director of the company, who is leaving on the 23rd of this month for Bombay, where he is to take up the management of a large electrical power and light undertaking for the authorities at Bombay.

The following increases of salaries have been made in the Electric Lighting and Tramways Committee of the East Ham Borough Council: Mr. T. Owen, traffic superintendent, from £200 to £210; Mr. W. G. Newton, outdoor assistant, £200 to £210; Mr. W. R. Elliott, station superintendent, £180 to £190; Mr. T. Aitken, mechanical engineer, £180 to £190; Mr. E. C. Baker, chief clerk, £140 to £150; Mr. A. H. W. Slaughter, clerk, £85 to £95; Mr. M. Deitchman, junior shift engineer, 30s. to 35s. per week; Mr. W. S. Westbury, car-shed foreman, 56s. to 58s. per week.

LEGAL INTELLIGENCE.

UNDERGROUND ELECTRIC RAILWAYS CO.

Appeal as to Stamp Duty.

In the House of Lords, Lords Halsbury, Robertson, and Lindley gave judgment on the 15th inst. in the case of the Underground Electric Railways Co. of London *v.* Commissioners of Inland Revenue.

This was an appeal by the company from a judgment of the Court of Appeal reversing a decision of Mr. Justice Channell upon a case stated by the Commissioners of Inland Revenue under the Stamp Act, 1891. The question was the amount of stamp duty payable on a sale by what may be called the old company to the new company. The consideration for the sale was a certain definite sum of money, and a further consideration was the payment of such a sum of money as should be equal to a dividend of 3 per cent. for each year on the amount for the time being paid up on such of the original ordinary share capital of five millions sterling in the new company as should for the time being have been issued by the new company. At the date of the agreement the whole of the ordinary share capital of £5,000,000 in the new company had been issued—viz., 500,000 shares of £10 each and on 100,000 of such shares £5 per share had been paid up, and on the remaining 400,000 shares £2 per share had been paid up, such payments amounting altogether to £1,300,000. Upon this sum a 3 per cent. dividend would amount to £39,000. The Commissioners were of opinion that this £39,000 was contingently payable according to the terms of the agreement either in perpetuity or for an indefinite period within the meaning of Section 56 (2) of the Stamp Act, 1891, and that in respect of this part of the consideration the stamp duty amounted to £3,900. That figure was arrived by multiplying the annual sum by 20 in accordance with the provisions of the Act and treating the capital sum so found as liable to a duty of 10s. per cent. The question was whether this sum of £3,900 was rightly included in assessing the stamp duty the agreement was liable to bear. Mr. Justice Channell gave judgment for the company, the Court of Appeal reversed the decision, and the company now appealed.

Their Lordships upheld the judgment of the Court of Appeal, and accordingly dismissed the appeal, with costs.

SWANSEA TELEPHONES.

The hearing was resumed on the 14th inst., before Lords Justices Vaughan-Williams, Stirling, and Ozcens-Hardy, on the appeal of the National Telephone Co. from a judgment of Mr. Justice Buckley, who in an action brought by the Corporation of Swansea against the company to enforce the giving of "reasonable facilities for intercommunication" for their telephonic subscribers, held that the facilities offered by the company amounted to a refusal to give any facilities at all within the meaning of the New Telegraph Act, 1899.

During the course of the reply of Mr. Astbury, K.C., on behalf of the Telephone Co., Lord Justice Stirling suggested the appointment of an expert to define what were reasonable facilities.

Mr. ASTBURY said he supposed that the greatest expert apart from themselves would be one from the Post Office, which was the next biggest system to that of the Telephone Co. They were opponents of the company and their rivals in London, but he had not the slightest objection to their Lordships asking the principal engineer of the Post Office system in London to go down to Swansea to look at the systems and state what in his opinion was the best way of affording facilities.

Mr. R. J. PARKER, on behalf of the Corporation, said he would rather that the matter should not be referred to the chief engineer of the Post Office, but left entirely in the hands of their Lordships.

Lord Justice VAUGHAN-WILLIAMS said that any expert appointed by the Court would have to have inspection of the company's works at Swansea.

Mr. DANCKWERTS, K.C., on behalf of the company, said there would be no difficulty about that.

Lord Justice VAUGHAN-WILLIAMS: It is obvious that our judgment must stand over for the present.

A MANCHESTER TRAMWAY ARBITRATION.

In the House of Lords on the 16th inst. Lords Macnaghten, Robertson, and Lindley gave judgment on an arbitration between the Manchester Carriage and Tramway Co. and the Swinton and Pendlebury Urban District Council. The appellant was the liquidator of the tramway company, and the difficulty of the case arose, to some extent, from the fact that the arbitrator whose award was under consideration (Sir Frederick Bramwell) had since died, and therefore it was impossible to refer the matter back to him to clear up a question of doubt that had arisen as to the exact meaning of a part of the award. The local authority decided to purchase the company's undertaking. The question was whether a depôt situated outside the Council's district, but suitable to and used for the purposes of such part of the undertaking as was within such district, was to be taken and paid for by the Council. The arbitrator found that the value of the tramway was £24,689, the value of the land and buildings constituting the depôt in dispute, known as the Church-street depôt, was £24,000, and the value of the fixtures and fittings at the depôt £308, making altogether a total of £49,006. Should the Court be of opinion that the Council was not compellable to purchase the Church-street depôt, then the items of £24,009 and £308 must be deducted from the above total, and in such event he awarded the £24,689 only. The special case came before Mr. Justice Channell, who held that the Council were bound to pay for the Church-street depôt. The District Council appealed, and the Court of Appeal came to the conclusion that

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as the finding of the arbitrator was ambiguous as to whether the depôt was suitable to and used for the purposes of the undertaking the tramway company could not compel the local authority to purchase the depôt. The tramway company thereupon carried the matter to their Lordships' House.

Their Lordships held that the local authority was liable to take and pay for the Church-street depôt, and accordingly allowed the appeal with costs.

WATER RIGHTS.

The Llanrwst Electricity Supply Co v. the Llanrwst Urban District Council and the Geirionydd Rural District Council

This action was heard before Mr. Justice Warrington in the Chancery Court, and was brought to restrain an alleged interference by the defendants with the plaintiffs' water rights. In pronouncing judgment, his Lordship said the plaintiffs claimed to be entitled to certain water rights in respect of a mountain stream running past their works from Llyn Crafnant down to the River Conway; the particular right they now insisted upon was to have a flow of water from Llyn Crafnant through two 7in. pipes at all times necessary for the working of the power demised to them for the purposes of their business, which in the present case meant to have a full flow of water during the night. In other words, the plaintiffs asserted a right to have a full flow of water during such hours as they might themselves select for their own convenience. The water rights in question were obtained from a natural stream falling rapidly down on its way from the lake above, and from the evidence it appeared that this flow had been regulated for many years for the common benefit of all their tenants by the owners of the lake or their licensees by artificial means which had been erected in and prior to the year 1874. On these facts the plaintiffs, therefore, were not entitled to the natural rights of ordinary riparian owners, but their rights, if any, were contractual, and the onus was on them to make out from the documents in the case that they were entitled to have a full flow of water at certain hours of the day or night to be selected by them. In other words, the plaintiffs' rights depended upon contract, for his Lordship found as a fact that but for the control of the flow from the lake exercised by means of the sluice in 1874, and after that by the valves put up by the defendants, the stream could not have been used for all the purposes to which it had been put throughout the whole year. Having stated the facts and examined in detail the leases, his Lordship said what he had to determine was whether on the construction of these documents the plaintiffs had made out their right to the particular claim they now made, and his Lordship came to the conclusion that they had not made out their right to such a claim. All that they appeared to have was an undefined right to use the water flowing down this stream. The defendants were the lessees of the lake and the embankment, and the lease of 1884 did not contain any stipulations which bound the then owner of the lake and embankment to use the valves in these pipes in any particular way. The right set up by the plaintiffs in their statement of claim had not been established, and there must, therefore, be judgment for the defendants, with costs.

OVERHEAD v. UNDERGROUND TELEGRAPH WIRES.

County Court Action.

A case of considerable interest to local authorities and others came before his Honour Judge Emden at Bromley County Court on the 15th inst. It was a case in which application was made under the Telegraph Act of 1878 by the Postmaster-General for the hearing and determination of a difference which has arisen between himself and the Foots Cray Urban District Council in respect of the placing of a telegraph line consisting of posts and the wires and apparatus connected therewith in, upon, over, along, or across Station-road, Sidcup, which is in the district of the respondents. Formal notice was served upon the respondents on Aug. 3 last applying for their consent to the proposal, which they failed to give, and as a result the applicant claimed an award by the learned judge consenting to the erection of the proposed line.

The basis of the refusal was that Station-road was too narrow for the erection of the proposed line, and the reply of the appellant was that this was a good wide road. As to the suggestion that the wires should be laid underground, the contention of the appellants was that the excavating would be too expensive. It would cost about three three times as much compared with the estimated cost of the erection of overhead wires, and it was their opinion that they would not be justified in incurring such expense. The submission was that the Foots Cray Council were not justified in refusing this specific application, and the Postmaster-General therefore applied to his Honour for his consent to his proposal to provide telegraphic facilities in the road in question.

Mr. MARTIN FENN ROBERTS, an assistant engineer-in-chief to the Post Office, said the cost of carrying the wires underground would be £145. 6s. 9d., but if erected overhead, as they proposed, the cost would amount to only £50. 3s. 2d. He had prepared plans showing the width of Station-road at two points. The minimum width of the road was 35ft., and of the footpath 6ft. 8in. In some places, however, the road was 40ft. and the footpath 7ft. 3in. in width—in some places, in fact, he believed the path was 8ft. in width. Witness also gave the dimensions of the posts it is proposed to erect, and produced photographs of the same.

On behalf of the Urban Council it was stated that they were anxious and willing to assist the Postmaster-General in giving the utmost telegraphic and telephonic facilities in the district of Foots Cray. They, however, thought he had two alternatives to the proposal to erect overhead wires. The Council offered to pay the expenses of excavating the trenches for the pipes, filling in the ground, and making good the surface with all speed.

HIS HONOUR, in giving his award in favour of underground wires, said that it was subject to the Council's agreeing to excavate and make good the surface with all convenient speed, and the Postmaster-General, through his representative in court, consenting to put the wires underground.

COMPENSATION CLAIM AGAINST TRAMWAY ENGINEERS.

Sheriff Sym in Perth Sheriff Court on the 15th inst. closed the record in an action at the instance of John Dickson, Perth, against Robert W. Blackwell and Co., engineers, Perth, for payment of the sum of £300 at common law, or £178 under the Employers' Liability Act, 1880. Pursuer in his condescendence states that on May 22 last he was in the employment of the defenders, and was engaged, along with other workmen, lifting tramway rails on to a lorry at the Shore. While the pursuer, along with four workmen, was lifting one of the rails on the instructions of Robert Myers, the foreman, it canted, fell, and injured the pursuer. It is contended that if a sufficient number of workmen had been provided and appointed they would have been able to prevent the falling of the rail, and no injury would have been sustained. By the falling of the rail the pursuer's left hand was badly crushed, and the middle and right fingers had to be amputated. The pursuer also received a severe fracture of the large toe of the left foot. These injuries had caused pursuer great pain, and he would be unable to do any work for a considerable time, and would be permanently and seriously affected through the loss of his fingers in following his usual occupation. At the time of the accident pursuer was earning 23s. a week.

The defenders plead that the number of men provided to lift the rail in question was ample for the purpose, and in point of fact large quantities of the rails had been safely and satisfactorily loaded by four or five men for some months prior to the accident. They further plead that the action is irrelevant, and that the pursuer's injuries, being due to the fault of persons engaged in a common employment with him, he is not entitled to claim compensation from a common employer in respect thereof. In any case the damages claimed are excessive.

ACTIONS AGAINST TRAMWAY CONTRACTORS.

Two claims were recently heard in the Record Court in Ireland before the Lord Chief Baron for damages arising out of personal injuries received owing to the excavations on the roadway necessary for the purpose of relaying tramways. The defendants in both cases were Messrs. J. G. White and Co., and in the first action the jury found that the obstruction was not reasonably lighted, and returned a verdict for plaintiffs, with assessed damages at £17.

In the second case, plaintiff claimed that defendants wrongfully raised portion of a public footpath on Woodstock-road, in Belfast, and left it in such a condition as to be a danger to the public, whereby the plaintiff, when lawfully using the footpath, caught his foot, hurt his kneecap, and was unable to attend to his duties.

The jury again found in favour of plaintiff, and assessed damages at £300.

TRAMCAR ACCIDENT.

The action Williams *v.* the Salford Corporation, heard before Judge Shee, K.C., at the Court of Record last week, was a claim for damages sustained owing to the carelessness of a tramcar driver in the employ of the Corporation.

The jury returned a verdict for plaintiff, and awarded her £225 damages.

SEQUEL TO ELECTRICAL FRAUDS CASE.

At the Wandsworth Bankruptcy Court, before Mr. Registrar Willoughby, George Webber, formerly an ironmonger, Putney, who was recently convicted with William Leslie and Alice Cheeseman at the Central Criminal Court of complicity in the electrical appliance frauds, was brought up in custody from Brixton Prison to undergo his public examination. According to his statement of affairs, his gross liabilities amount to £30,000, and he attributed his insolvency to the orders which Leslie induced him to sign.

The trustee asked for an extension of three months in which to consider the numerous proofs, which the registrar granted, and the examination was adjourned.

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL TRAMWAYS.

The annual meetings of the Blackpool, St. Annes, and Lytham Tramways Co. and the Blackpool Electric Tramways (South) were held consecutively at Blackpool on the 18th inst., shareholders in the latter Company being privileged to be present at both meetings.

Opening the meeting of the former Company, Mr. THOMAS BLANE (chairman) pointed out that the receipts of the past year had been slightly better, but the full advantage of the arrangement to run into Blackpool would not be felt until next year, when he expected that the gross receipts would be materially increased.

Mr. MARSDEN HARGREAVE criticised the balance-sheet, pointing out that the working expenses of the tramway were over 70 per cent.

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of the gross takings, which with management expenses made the net expenses nearly 80 per cent. Unless these items could be materially reduced, he held out little hope for the debenture holders receiving full interest, and absolutely no hope for the shareholders. He dissected management expenses, drawing attention to the fact that the receivers were getting £539.

Mr. Smith, retiring director, was re-elected.

At the close of the meeting, the meeting of the Blackpool Electric Tramways Co. (South) was held.

Mr. GUTHRIE (the chairman) spoke at length regarding the relative position of the two companies, and regretted the debenture holders' action in opposing the winding-up of the company and a division of the assets, consisting entirely of shares in the Blackpool, St. Annes, and Lytham Co., amongst the shareholders.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The sixth annual general meeting of this Company was held on the 18th inst., Mr. William I. Buchanan presiding.

The CHAIRMAN, in moving the adoption of the report and accounts for the year ending July 31 last (a copy of which appeared in our issue last week), said the year had been one of disappointment to the Board. The controlling factor which guided those who created this large industrial undertaking was not the immediate present, but the future industrial development that must follow the constantly increasing uses to which electric power was being put—a feature yet in its childhood in this country. Certainly the moment had not been reached when either the capacity or the potential ability of their immense plant had had an opportunity to justify the faith and belief of almost every competent person in touch with the development of electrical traction and power undertakings in this country. The difficulties met with centred chiefly around the keen competition the Company had to meet in the sale of their product as a result of a very light demand. These had brought constantly lowering prices with them, with the invariable result—namely, abnormally reduced trading profits. The number of orders received during the year was nearly double that for the previous year, and three times that for the year 1903, while the total value, even in the absence of any large orders, had remained approximately that of the previous year. Another encouraging feature was the fact that the business being done by the Company in the Colonies was increasing. The competition which the Company had to meet at home was still disadvantageously affected by Continental companies, and he saw little likelihood of any immediate change in this vital matter. The chairman referred to the experimental application of single-phase electrical traction to one of our prominent railway lines, the order for which was given to a Continental company. The work in question was awarded this Continental company under terms heretofore unknown. It was not alone a matter of the price at which the given case would be taken that was involved, but, more important, the pernicious effect exercised on prices as a whole by the constant presence of such a competition. So long, however, as the public policy of a country encouraged competition within its own borders from its strongest and most active rival, just so long would that country's industrial undertakings be powerless to do other than try to meet it by following down prices to the point of factory costs, or, in many cases, see work they urgently required for their own shops go abroad to help reduce the shop costs of their foreign competitors, who themselves enjoyed freedom from outside interference within their own country through economic legislation. He was, therefore, unable to hold out any strong encouragement for the shareholders to look for a marked change during the present year, either in an advance in prices or in an increase in the volume of their output.

Mr. J. H. LUKACH seconded the motion.

Dr. DAVID BROWNE declared that the chairman's statement left him almost without hope, and complained that the undertaking had been worked with great extravagance. The retirement of Sir Joseph Lawrence, M.P., and the accession to the Board of Mr. Newcomb Carlton, a vice-president of the Westinghouse Electric and Manufacturing Co. of America, he thought, indicated a desire on the part of the American company to squeeze them out. He moved as an amendment that the report be not adopted.

Mr. MACKENZIE supported the amendment, and contrasted the condition of the concern with the prosperous state of the American company, while another shareholder referred to the fact that the Canadian company also was able to pay a dividend.

The CHAIRMAN explained that Mr. Westinghouse was unable to be present, as he desired, owing to engagements in America, and he (Mr. Buchanan) had taken the responsibility for not postponing the meeting further. The suggestion that there was some ulterior purpose in the relations of the American and British companies was untenable to any man who considered the fact that the interests of the American Westinghouse Co. in this Company had been constantly increasing. The holdings of the American company and Mr. Westinghouse himself in the preference shares had increased by more than 6,000 shares within the past year. Not one had been sold; not one would be sold. These gentlemen would not put their money into the concern in preference shares if they did not believe in it.

Sir JOSEPH LAWRENCE, M.P., repudiated the suggestion that his retirement was due to any want of confidence in this undertaking. It was due to a desire cherished for some considerable time to lessen his cares and responsibilities. He bore testimony to the great difficulties which the directors had experienced in meeting foreign competition, and said it was absolutely impossible for electrical companies in this country to conduct their business with ultimate benefit to themselves by reason of this competition. Foreign companies, like the Berlin Electrical Co., came into this country backed by enormous capital and buttressed by the cartel arrangements, one feature of which was that a combination of electrical manufacturers in Germany guaranteed to those of their members who competed outside Germany the difference between the low prices they had to take in Great Britain and the prices they could get in Germany. As to the Brighton Railway contract, he said the terms of it were impossible. One of the conditions was that they were to wait 18 months for their money. No business could succeed that was tied down by such uncommercial conditions.

After some further discussion the amendment was withdrawn, and the report declared unanimously carried.

MANX ELECTRIC RAILWAY.

The report of the Manx Co. for the year ended Sept. 30, 1905, to be submitted at the meeting on the 3rd prox., shows gross receipts £32,638 and gross expenditure £15,349, leaving net earnings £17 289. After deducting debenture interest, £9,054. and adding balance brought forward, £780, there is a credit balance of £9,015. After payment of dividend due on the preference shares there remains a balance of £2,205, which the directors propose should be carried forward. During the year a further capital expenditure has taken place of £5,995, from which the Company has not yet reaped the full benefit; whilst preference shares for £6,325 and debenture stock for £2,500 have been issued. A considerable amount has again been spent out of revenue in maintenance and renewals, and the whole line is kept in good repair. The summer season in the Isle of Man has shown considerable improvement over the previous year. Visitors have been a good deal more numerous, and passengers carried during the past 12 months totalled 501,696, as compared with 472,556 carried during the previous 12 months.

PROVINCIAL TRAMWAYS.

The report of this Company for the year ended Sept. 30 last states that net revenue received from the local companies has been £24,050, against £24,095 last year. To this must be added amount brought forward (£3,496) and transfer fees (£19), together £27,565. There has been set aside for depreciation £7,000, and the directors now recommend a dividend on the ordinary shares of 4s. per share, making 7s. per share for the year. The balance to be carried forward will be £2,752. Through unforeseen difficulties in connection with the construction of the track and overhead work, and also in consequence of delay in the completion of the power station plant, the directors regret that their expectations that their undertaking would have been completed and working by electric traction in the spring of this year, have not been realised; the lines are, however, now completed, and the machinery has been running for some short time with satisfactory results. The Board of Trade inspections will be held at an early date, and upon the receipt of the certificate the line will be at once worked by electric traction. The Bill in Parliament for an extension to Privett Station and for power to supply electric energy to a local railway duly passed and received the Royal assent. In June last the directors issued a circular to the shareholders in order to elicit their views as to the desirability of writing off lost capital by reducing the nominal value of the ordinary shares of the Company. The result was out of 870 shareholders, 230, representing about 31 per cent. of the ordinary capital, signified their assent; 105 shareholders, representing abont 14 per cent., signified their dissent; and 535, representing about 55 per cent., did not reply. The circular stated that those shareholders who did not reply would be assumed to assent. The directors, therefore, conclude that a considerable majority of the shareholders are in favour of the reduction. The matter is somewhat complex, and requires that all the details shall be carefully worked out as, if it were duly approved by the shareholders, it would afterwards have to be submitted to the Court for confirmation. The directors do not, therefore, propose to submit the matter upon the present occasion, but they have the scheme under careful consideration.

COSTA RICA ELECTRIC LIGHT AND TRACTION.

The report of this Company for the year ended June 30 last states that the net earnings in Costa Rica amount to £10,159, as against £9,155 the previous year. Since the accounts now presented were made up, returns from Costa Rica for the four succeeding months indicate an average profit of £1,040 per month, or at the rate of over £12 000 per annum. A further issue of debentures to the amount of £5,000 was made during the year in accordance with the authority given at the general meetings of November, 1902, in repayment of the balance of Mr. Keith's advances on capital account. The lighting concession under which the Company is working in San José was dated to run out on Dec. 31 next. A new concession of 50 years from Jan. 1, 1906, both for lighting and tramway, has been granted to the Company by the municipality on equitable terms, subject to confirmation by the President of the Republic. The small plant at Cartago, from which a very insignificant revenue was derived, has been disposed of to a local enterprise, and the proceeds are being devoted to improvements in the San José plant. A storage reservoir increasing the capacity of the Maria Aguilar River by 3,000 8-c.p. lamps was completed in June last. The tramway sub-station at Torres and the workshops have been removed to the head office in San José, thereby facilitating supervision and effecting economies both in time and labour. As practically all the power at present at the Company's disposal has been taken up, and the management is compelled to refuse new customers, it has become necessary to develop further water power and to instal further machinery. Surveys have been made and estimates obtained showing that for a sum of £8,000 to £9,000 the lighting capacity on the Tiribi River can be increased from 15,000 as at present to 36,000 8-c.p. lamps. The directors propose to make an early issue of deben-

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tures for this purpose, and the stock and debenture holders will be given an opportunity of subscribing to the issue. During the year the gold premium has remained steady at about 110 per cent. The general manager certifies that all buildings, machinery, plant, and permanent way have been kept in good working order.

NEW COMPANIES REGISTERED.

Kamm's Zerograph Syndicate (1905), Limited. — Capital, £24,000. Object: to acquire the business of manufacturers of telegraphic and other instruments and typewriters carried on at 27, Powell-street, Goswell-road, E.C., as Kamm's Zerograph Syndicate, Limited, to adopt an agreement with the said company and H. B. Harvey, the liquidator thereof, etc. Registered office: 27, Powell-street, Goswell-road, E.C.

Automatic Electric Block Signalling Co., Limited.—Capital, £1,000. Object: to adopt an agreement with the Electric Railway Signalling Syndicate, Limited, to acquire any patents and inventions, and to carry on the business of electricians, engineers, suppliers of electricity and electrical installations and machinery for light, signalling, heat, motive power and other purposes, manufacturers of electrical apparatus, etc. Registered office: 302, Finsbury-pavement, E.C.

Macclesfield Tramways Syndicate, Limited.—Capital, £5,000. Object: to acquire, construct, equip, maintain, and work railways, tramways, or light railways in the United Kingdom, whether worked by electricity or other power, and to carry on the business of railway and tramway proprietors, carriers of passengers and goods, suppliers of electricity for power or otherwise, engineers, etc. No initial public issue. The first directors (to number not less than three nor more than seven) are to be appointed by the signatories. Qualification, £100.

Liens Registered.

Carbonite and Arborite Syndicate, Limited, London, E.C.—Lien registered Dec. 6 for £500 4½ per cent. debentures, part of £2,500 authorised. No trustees. Charged on all the property, including the uncalled capital.

Guildford Electricity Supply Co., Limited. — Twenty-five thousand pound debentures created Nov. 21 and dated Nov. 30, 1905, have been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

Electolytic Alkali Co., Limited (Middlewich).—Issue on Nov. 30 of £300 4½ per cent. first mortgage debentures, part of a series created July 9, 1905, to secure £50,000. Charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., Limited, 6, Castle-street, Liverpool. Total amount previously issued of same series, £20,850.

Perth Electric Tramways, Limited —Issue on Nov. 15 of £600 debentures, part of a series created Dec. 22, 1903, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to £200,000 first debenture stock. Trustees: Lord Arthur Butler, 7, Portman-square, W., and J. S. Austen, 68, Dashwood House, E.C. Total amount previously issued of same series, £39,000.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Calcutta.—The Corporation propose to remove their conservancy refuse by means of electric motor wagons.

Pontypridd.—The Urban District Council invite tenders for cable conduits. Tenders to the Clerk by Jan. 1.

Cardiff —The Parks Committee invite tenders for an electric launch for Roath Lake, not exceeding 30ft. in length, to carry 40 persons.

St. Marylebone.—The Electricity Supply Committee invite tenders for house service fuse-boxes. Tenders by Jan. 10. See advertisement.

St. Marylebone.—The Electricity Supply Committee invite tenders for various stores. Tender by Jan. 10. Full particulars in advertisement columns.

Puente Genil (Cordoba, Spain).—The Municipality require tenders for provision and maintenance of electric lighting for 16 years. Tenders by Jan. 5.

St. Pancras.—Tenders are invited for supplying (Section A) arc lamp columns and cradles; (B) open-type arc lamps. Tenders by noon on Jan. 9. See advertisement.

Grimsby.—The Corporation require tenders for contracts contained in Specifications No. 35 39 and 43-45, for electrical plant, cables, and buildings. Tenders by Jan. 5, 1906.

Paris.—The Post and Telegraph Department, 13, Rue de Grenelle, require tenders for four lots of rubber-insulated cables and six lots of copper wire and copper junction boxes. Tenders by Dec. 23.

Leyton (Essex).—The Urban District Council invite tenders for the construction of nine miles of double tramway track, and for all materials connected therewith. Tenders by 7 p.m. on Jan. 8.

Croydon.—The Guardians invite tenders for the installation of electric fire-alarms at the infirmary. Tenders to Mr. H. List, clerk, Union Offices, Mayday-road, Thornton Heath, by 4 p.m. on Jan. 8.

Madrid.—The Public Works Department require tenders for a concession to construct and work an electric tramway between Santander and Astillero. Guarantee, 8,195 pesetas. Tenders by Jan. 30, 1906.

Gravesend.—The engineer has been authorised to forward specifications to a number of firms asking for tenders for economisers to be submitted to the town clerk so as to be available for committee during January next.

Manchester.—Tenders are invited for laying underground telephone pipes, with other appurtenant works. Tenders to the Chairman of the Special Committee re Telephones, City Surveyor's Office, by 10 a.m. on Jan. 2.

Launceston (Tasmania).—Tenders are invited for the supply of 500 or more electric meters and for maximum demand indicators. Tenders to Mr. C. W. Rocher, town clerk, Town Hall, Launceston, Tasmania, by 12 noon on Jan. 15.

Sofia (Bulgaria).—Tenders are invited for the electric lighting of the Government Cadet School. Tenders by Jan. 19. Offers must be addressed in the Bulgarian language and be accompanied by a deposit of 5 per cent. of the amount of the tender.

Spain.—The *Gaceta de Madrid* contains a notice inviting tenders, which will be opened at noon on Jan. 30 at the Directorate-General of Public Works, Madrid, for the concession of an electric tramway between Santander and Astillero. A deposit of about £208 is required to qualify any tender.

Brussels.—Tenders are required for the electric lighting of the marine hospital. Conditions may be obtained from the Secrétaire général de l'administration des hospices et secours de la ville de Bruxelles, Boulevard du Jardin botanique, hôpital St. Jean, Brussels. Tenders by Jan. 5, 1906.

Castlerea.—The Rural District Council invite tenders for the construction of works for lighting the town of Ballaghaderreen: (1) builders' work; (2) hydraulic turbine plant; (3) electrical work. Specifications and particulars may be had from Mr. C. Mulvany, M.I.C.E., Engineer's Office, Athlone, on payment of £1 as a deposit, returnable after receipt of bona fide tender. Tenders by Dec. 23.

Southport.—Tenders are to be obtained by the Town Council for the supply of a battery of accumulators and a booster to be worked in connection with the traction sets; a shaping machine is to be purchased for the workshop; and the electrical engineer has been instructed to rewind the field magnets of three alternators as soon as convenient, and to provide an atmospheric exhaust to the No. 3 traction set.

RESULTS OF TENDERS.

Croydon.—The Council have accepted the tender of the British Thomson-Houston Company, at £1,450, for a three-machine motor-generator.

Weston-Super-Mare.—The Urban District Council have agreed to let the National Telephone Co. install certain fire-alarms on a seven years' agreement, at £42 per annum.

Howrah.—The Agent of the E.I.R. has accepted the tender of T. E. Thompson and Co., of Calcutta, for the supply of the electrical equipment of Howrah new station with fans and lights at a cost of about Rs 20,000.—*Indian Engineering.*

Condensing Plant.—The Haste Pump Co., Crown-buildings, Old Broad-street, London, E.C., have received orders from the War Office for three sets of surface-condensing plant of the counter current type, including Edwards patent air-pumps; also separate contract for a large direct-acting steam pumping engine.

London.—The London County Council have received the following tenders for supply, delivery, and erection of steelwork required in connection with the second portion of the Greenwich electricity generating station:

E. C. and J. C. Keay, Birmingham*	£46,490	7	10
Clayton, Son, and Co., Leeds	47,725	11	2
J. Westwood and Co., London	49,451	5	6
Braithwaite and Kirk, West Bromwich	50,275	1	10
Thames Ironworks, Shipbuilding, and Engineering Co., London	53,139	5	7
Redpath, Brown, and Co., London	54,660	4	8
Head, Wrightson, and Co., Thornaby-on-Tees	54,918	6	2
J. Butler and Co.'s Trustees, Leeds	57,897	7	7

* Recommended for acceptance.

The offer of J. Mowlem and Co. to execute for a sum of £20,872 the roadwork and platelaying in connection with the reconstruction of the existing tramways in Vauxhall Bridge road, between Victoria Station and Vauxhall Bridge, for the underground conduit system of electric traction, has been accepted. The British Westinghouse Electric and Manufacturing Co. will be allowed to sublet to the undermentioned firms (or to such other persons or firms as may be approved by the Council's chief officer of tramways) the following portions of the work included in the company's contract for the supply of 34 tramcar trucks and electrical equipments—namely: (1) the manufacture of the trucks to Mountain and Gibson, of Bury, and (2) to A. Reyrolle and Co., of Hebburn-on-Tyne, for the manufacture of the plugs for car ploughs.

Lowestoft.—The Town Council have adopted the recommendation of the Joint Tramways and Electric Committee respecting the charge made for current supplied to the tramways undertaking, which was to the effect that the Electric Lighting Committee should return the equivalent of ¼d. per unit for all electricity used for tramway purposes for the year ended Sept. 30, 1905, and for the year ending Sept. 30, 1906, current for tramway purposes should be charged at 2¼d. per unit.

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BUSINESS NOTES.

TRACTION.

Dumbarton.—The Town Council have formally agreed to petition against the Dumbarton Tramways Order.

Mansfield.—The Board of Trade inspection of the new route from Mansfield to Sutton-in-Ashfield was fixed for the 19th inst.

Luton.—At the next meeting of the Council the report of the Tramways Committee with regard to the trams will be presented.

Lambeth.—A town's meeting, recently held, passed a resolution in favour of the London County Council providing tramway services over the bridges.

Torquay.—The first section of the tramlines, over a mile in length, is almost completed. No more roadway will be opened until after the Christmas holidays.

Bexley.—The District Council are about to confer with the Dartford Urban District Council in respect of granting the latter running powers over part of the Bexley system.

Folkestone.—The resolution of the General Purposes Committee that the Tramways Sub-Committee be limited to nine members has been confirmed by the Council.

Kingston-on-Thames.—The Board of Guardians have agreed to give up 4ft. of their workhouse frontage, about 600ft. in length, to enable the tramway company to widen their track.

Liverpool.—A deputation has waited upon the Council urging them to provide a line of trams along Edge-lane. As an alternative proposal the deputation urged the inauguration of a service of motor 'buses.

Wembley.—The question of the Middlesex County Council's tramway scheme was again considered by the Council at their meeting last week, but discussion was postponed pending the receipt of further information.

Hampton (Surrey).—The Council have resolved to appoint a deputation to confer with the London United Tramways Co. and the Board of Trade relative to the proposed widening of High-street for tramway purposes.

Glasgow.—The Town Council had before them at their last meeting a proposal for the increase in distances of ½d. fares. In opposition to the proposal it was pointed out that to do so would cost about £129,000. The proposal was defeated.

Stalybridge.—At the monthly meeting of the Town Council last week allusion was made to the faulty ventilation of the Joint Board's electric cars. The chairman of the committee undertook to bring the matter before the notice of the Board.

Leicester.—The annual supper and concert in connection with the Corporation Tramways Employés' Sick Benefit Society was held last week, and was attended by the tramways manager (Mr. A. F. Lucas) and prominent members of the Tramways Committee.

Poole.—The Railways Committee report that plans were prepared and approved by them for the extension of railway through Parkstone. Various street widenings have been proposed with a view to improving the service, and a new tramway shelter will be erected.

Newport.—The Electricity and Tramways Committee have decided to make a little improvement in the position of men who are partially employed as drivers on the trams or in the car-sheds, and they will present a recommendation to that effect to the Corporation.

Rotterdam.—Electricity as a motive power for tramcars was used for the first time in Rotterdam on Sept. 19, when the motive power of the tramline Honingerdyk-Parklaan was changed. The line runs through Rotterdam from east to west, and is 3·22 miles long.

Metropolitan Railway.—The extension of the Baker-street Station necessitated the demolition of a house once occupied by Mrs. Siddons. The railway company have allowed a commemoration tablet to be placed by the London County Council on their new building.

Norwich.—The General Purposes Committee have reported that the conveyance to the Corporation of the site at Orford-place in connection with the trams has been completed, and recommended that it be referred to the City Committee to devise a scheme for the utilisation of the site. The recommendation was adopted by the Council.

Grangemouth.—It was reported by the Law and Parliamentary Committee at the Town Council meeting that they had had a conference with representatives of the tramways company to discuss various questions arising out of the proposed construction of tramways. The company have promised to forward an advance copy of the draft order.

Rochdale.—A meeting of the Rochdale Tramways Committee was held last week to consider the agreement between the Rochdale and Heywood Town Councils in connection with the running of the tramways. A sub-committee of three was appointed with power to settle the matter. When the agreement is signed, Rochdale will have running powers to Heywood.

St. Marylebone.—The Council have passed a resolution in favour of the proposed extension of the London County Council South London tramway system over the Thames and along the Thames Embankment as a help towards the improvement of the traffic of London, subject to the widening of Blackfriars Bridge or the erection of a new bridge, as required by the House of Commons.

West Ham.—The chairman of the Electric Light and Tramways Committee of the West Ham Corporation replies in the local Press to some criticisms made at a public meeting respecting the finance of the tramways. He denies that the £7,000 grant to the rates was derivable entirely from horse cars, and points out that the summer receipts for 1905 were a distinct improvement on the satisfactory receipts for the summer of 1904.

Johnstone.—Representations have been repeatedly made by the Council to induce the tramway company to continue the tramway line from the present terminus to the boundary of the burgh, which is at least half a mile in length. The officials have expressed their desire to meet the wishes of the Council as far as possible, and we understand they were quite willing to construct a single line from the Cross at Johnstone to the burgh boundary.

Camberwell.—The London County Council have informed the Borough Council that, as it does not appear that it will be practicable to use any portion of the London, Camberwell, and Dulwich tramway lines, the Highways Committee propose to recommend the formal abandonment of the lines, but before doing so they ask whether the Borough Council will be prepared to carry out the work of removal subject to the Borough Council retaining all the materials removed.

Hythe.—The Town Council have held another meeting for the purpose of interviewing representatives of the two companies competing for the privilege of securing the rights to run the trams between Folkestone and Hythe. After a lengthy deliberation the matter was deferred. A public meeting of the ratepayers favoured the National Electric Construction Co.'s scheme, which took its lines through the High-street, and another line along the sea-front. Mr. Sellon in his scheme opened up a new route through Hythe on to Dymchurch and Romney.

Oxford.—The amended Bill to enable the Corporation of Oxford to work and construct tramways was considered by the Council last week, and the seal affixed thereto. The Town Clerk explained that the important financial clause had now the figures inserted in it which were not in the draft Bill, as follows: (*a*) for and in respect of the reconstruction and construction of tramways as authorised by the Act, the sum of £76,228; (*b*) for and in respect of the purposes of electric equipment and other incidental expenses in connection with the tramways, the sum of £39,357; (*c*) for lands authorised to be purchased and buildings to be erected, the sum of £17,250—making altogether £132,835. Various other minor alterations were made.

Plymouth.—The new section to Pennycomequick has resulted in a failure. For the four weeks ended Dec. 9 the receipts per car mile averaged 4·13d., or about half the cost of working. It has been decided to withdraw the large cars in use to Pennycomequick and substitute demi cars. Being much smaller than the ordinary cars, the demi cars consume less current and are worked by one man, who acts both as driver and conductor. The Tramways Committee have decided to recommend the Corporation to discontinue the Union-street service. In connection with the proposed electrification of the West Hoe section, the committee are of opinion that the present was not an opportune time to incur so large a capital expenditure as would be involved, and have decided to make no change for the present.

Light Railway.—The order made by the Light Railway Commissioners, and modified and confirmed by the Board of Trade, authorising the construction of a light railway from Hope Station (Midland Railway Co.'s Dore and Chinley branch) to Bradwell and Castleton, has been issued. The line is to be nearly three miles in length, and is to be constructed on a gauge of 4ft. 8½in., the motive power being steam, electricity, or such other as the Board of Trade may approve. If the railway is not completed within five years, the powers granted to the company will lapse, except as to the part then completed. The speed is not to be more than 25 miles an hour, and at certain points 10 miles an hour. The maximum charges for passenger traffic are to be 3d., 2d., and 1d. per mile for first, second, and third classes respectively.

Paris.—The navvies and labourers who are employed on the Metropolitan Underground Railway are up in arms against the contractors and engineers of the underground line, whom they openly accuse of purposely botching or of inadequately completing the tunnels, thereby endangering the public safety. They tried to force their way into the chamber where the municipal councillors were holding a meeting the other day. The councillors have adopted a motion calling on the Prefect of the Seine to see that all the specifications and conditions of the contract for the construction of the underground line were strictly carried out. Furthermore, the prefect is to be pressed to establish responsibilities for any shortcomings in the work of the underground line, and to deal rigorously with persons not carrying out in a proper manner the conditions of the contract.

Portsmouth.—At the last meeting of the Town Council, a report was presented by the Tramways Committee recommending the provision of additional plant for working the tramways. In consequence of the increase of car mileage run, the reserve plant has had to be utilised for daily operation of the system. The committee recommend the immediate installation of sufficient plant to act as proper reserve. Sixteen extra cars are required to be operated on the existing lines to deal with the summer traffic. The additional plant will be capable of operating an additional 25 cars should any extension be decided upon by the Council. The estimated cost of the work is as follows: engine, generator, boiler, feed pumps, economiser, condensing plant, alterations and additions to switchboard, sinking well, laying negative return feeder, and providing 16 double-decked cars, £29,800. The proposals were adopted by the Council.

Dundee.—The Board of Trade inspection of the Dundee and Monifieth route was carried out last week, and everything worked smoothly and to the satisfaction of the inspector. The question of extending the lines down Union-street to Tay Bridge Station was introduced at the last meeting of the Tramways Committee. Further improvements on the system, the desirableness of which was urged, were the doubling of the line at various points, notably at Cherryfield and at Tay-street. The committee deferred consideration till a future meeting. Concerning the proposed extension along Arbroath-road to the city boundary, it was suggested that the work should be carried on by Corporation employés. The borough engineer and the tramways manager were instructed to prepare specifications for the work of the permanent way, and the electrical engineer concerning the overhead

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equipment. The manager was authorised to put additional cars on the Constitution-road and Perth-road sections to meet the requirements of an increased service.

Bury.—A special meeting of the Town Council was recently held, at which a motion was carried authorising the promotion of a Bill in the next session of Parliament. The Bill provides for an extension of the system along various sections. It was urged by Colonel Hall, the proposer of the motion, that the earnings would amount to 9½d. per car mile, which was sufficient to meet all expenses. It was also stated that the tramways undertaking was improving, and it was hoped that the Council would be able to go in for powers to link up with Bolton. Referring to the proposed extension of the car-shed, Colonel Hall remarked that whether they extended the car-shed or not they would have to provide a series of workrooms in which to carry out repairs and do other work. The cost for that would be £4,400. If they extended the car-shed over about one-third of the vacant land they now had, they would provide accommodation for 27 small cars and 18 large ones, and the inclusive cost of that and the workshops would be about £8,451. As to the workshops, the committee had decided to provide those.

Ilford.—We have received a statement of accounts of the tramways fund of the Urban District Council for year ended March 31, 1905, from which we see that the gross revenue amounted to about £23,574 (or 10·09d. per car mile), against a total expenditure of £14,288 (or 6·12d. per car mile), leaving a balance of £9,286, which is equivalent to an average of 3·97d. per car mile. The bulk of the income (about £22,719) was derived from the sale of car tickets, while the chief items of expenditure were made up as follows: traffic expenses, £6,892; general expenses, £1,888; maintenance, £1,825; power expenses, £3,629. Interest on mortgage debt to the extent of £4,419 was paid during the year, together with £3,098 as instalments of principal of money borrowed. The total track mileage is over 11 miles; the number of car miles covered during the year was 560,971, over which 5,584,901 passengers were carried at an expense of 530,605 units, which, per car mile, was 1·03 units. The number of cars in stock is 22, and the average in use per 14½-hour day was 14. The average fare per car mile was ·74d., and that per passenger ·99d. The number of passengers per car mile averaged 9·95, and the number of journeys per head of the population was 3·93.

Huddersfield.—The motormen and conductors of the Huddersfield tramways have handed in their notices to cease work unless certain alleged grievances of which they complain are remedied. The chief of these appear to be suspensions and dismissals without sufficient cause. Further, the men state that for six months they have been trying to get alterations made in the rules relating to the use of the brakes, but have not been able to get an interview with the committee. A strike was, however, averted, and representatives of the men's union have been asked to meet representatives of the Council. The Corporation on Wednesday considered recommendations of the Tramways Committee to agree to transfer to the National Electric Construction Co. the powers of the Corporation to construct so much of the tramway from Halifax to Huddersfield as lies without the borough of Huddersfield, or such of those powers as are necessary for the promoters. The following conditions govern the transfer: the company to pay the Corporation the costs (£855. 6s.) incurred in obtaining the powers for the Brighouse and Rastrick line, to satisfy the Corporation of their intention to construct the tramway within a reasonable time after the company obtain powers, and to execute an agreement accordingly. The General Purposes Committee, having considered these resolutions, recommend that the Corporation agree (subject to approval of the Board of Trade and all necessary authorities) to grant running powers to the promoters, on terms satisfactory to the Corporation, over the line of the Corporation between Ashbrow and the centre of the town. The Tramways Committee had previously decided that they could not see their way to agree to grant running powers.

Wandsworth.—On the subject of the proposed continuation of the tramway from the present terminus in Streatham High-road to the county boundary at Norbury, the Improvements Committee of the London County Council state that, after careful review of all the facts, they adhere to the opinion that the scheme now suggested for widening the thoroughfare is preferable to the one proposed in 1902, and that they do not see their way to advise the County Council to depart from its decision. They asked that the matter may be again considered by the Council with the view to its agreeing to consent to the construction of the proposed tramway, and to contribute one-third of the net cost of the improvement shown on the plan accompanying the letter from the County Council on July 31 last. The General Purposes Committee, however, recommend the Borough Council to adhere to its resolution objecting to the scheme of the London County Council. The Streatham Tradesmen's Association have forwarded a letter to the Borough Council expressing a hope that they will persist in their objection to the London County Council's proposed diversion. In connection with the London County Council's proposed construction of a tramway from Clapham to Lavender-hill, the Highways Committee of the Borough Council have recommended that the County Council be informed that they would be prepared to consent to the introduction of the proposed Bill upon the conditions that the London County Council pave with wood the whole width of the carriageway of the part of North-side, Clapham Common, in which the tramway would be laid; that they construct a surface-water sewer along Long-road, of which the Borough Council would pay one-third of the cost; and that they reconstruct as a double line and electrify the existing tramways from the junction of Cedars-road and Lavender-hill to East-Hill, Wandsworth, as soon as possible.

London County Council.—The Highways Committee recommend that the tender, amounting to £46,490, of Messrs. E. C. and G. Keay for the erection of steelwork for the second portion of the Greenwich generating station be accepted. The Highways Committee ask for a vote of £3,560 with which to commence the tramway subway service, beginning with a four-minute service of cars. The same committee recommended that the offer of J. Mowlem and Co. to execute for a sum of £20 872 the roadwork and platelaying in connection with the reconstruction of the existing tramways in Vauxhall Bridge-road, between Victoria Station and Vauxhall Bridge, for the underground conduit system of electric traction, be accepted. The committee further recommended that the British Westinghouse Electric and Manufacturing Co. be allowed to sublet to the undermentioned firms (or to such other persons or firms as may be approved by the Council's chief officer of tramways) the following portions of the work included in the company's contract for the supply of 34 tramcar trucks and electrical equipments—namely: (1) the manufacture of the trucks to Messrs. Mountain and Gibson, of Bury, and (2) to Messrs. A. Reyrolle and Co., of Hebburn-on-Tyne, for the manufacture of the plugs for car ploughs. The Council have adopted the recommendation of the Highways Committee for the expenditure of capital sums of £186,000 to cover the cost of the erection of the second portion of the Greenwich electricity generating station and sub-station, and of £250,500 for the provision of the plant, machinery, and other equipment of the station. Colonel Yorke, on behalf of the Board of Trade, has inspected the length of tramway which has been constructed from the Highgate Archway to the Archway Tavern, to link up the systems of the Middlesex and London County Councils. Sir Francis Cory-Wright, chairman of the Highways Committee of the first-mentioned, was also present. This short length has been made by the latter on the overhead electric system, but, until their own lines have been electrified, will be leased to the Metropolitan Electric Company, and worked by them in continuation of the route from Whetstone to the Archway, which they already lease from Middlesex. The new line opens for public traffic this morning. At Greenwich on Wednesday, R. Craker, a London County Council tramcar driver, was summoned for exceeding the speed of 12 miles an hour between Canal Bridge and the Greenwich borough boundary. The defendant said he had been driving only a fortnight and did not know the speed at which he was travelling. The magistrate said the rate of speed was dangerous, and fined the defendant £5 and 2s. costs.

LIGHTING AND GENERAL.

Street.—Plans for the proposed telephone poles, etc., in the district have been approved.

Rathdown.—The Guardians have decided to light the workhouse, etc., by electricity at a cost of £2,800.

Lewisham.—The Postmaster-General has obtained permission to lay underground telegraph lines along Stanstead-road.

Llanelly.—An inquiry is to be held into the application of the Town Council for a loan in connection with the electric lighting.

Worthing.—The Council have now decided to raise a loan for electricity extensions, sanction to which has already been obtained.

Pontypridd.—Tenders are required for the construction of a reservoir for the purpose of condensing works for the electric generating station.

Salford.—We understand that the Corporation's offer for lighting a number of streets in Prestwich is being favourably considered by the Urban District Council.

Glasgow.—We noted last week the proposal to borrow £240,000 for electric plant, and it is estimated that an additional £35,000 will be required for mains and buildings.

Christmas Cards.—We are pleased to acknowledge receipt of illustrated greetings from the engineer and staff of the electricity department of the Leek Urban District Council.

Brent.—The Parish Council have unanimously agreed to accept the Postmaster-General's terms to establish a call office at Brent Post Office in connection with the trunk telephone system.

Beverley.—The application of the Town Council to the Board of Trade for permission to let the electric lighting order stand good until some *bona fide* application was made for its revocation has been refused.

Whitehaven.—The Lowca Engineering Co. are contemplating an extension of plant which might include a scheme for the lighting of Parton by electricity. The matter has been referred to the Parochial Committee.

Calcutta Electric Supply Co.—The number of units delivered to consumers during the four weeks ended Nov. 24, 1905, were 263,852 compared with 176,897 units in the corresponding four weeks of the preceding year.

Portsmouth.—The construction of an inlet in the sea-wall at the tidal basin of Portsmouth Dockyard for the pipes that are to convey the sea-water to the condensers at the new electric power station has been completed.

National Electrical Manufacturers' Association.—At a meeting of conduit tube manufacturers on Dec. 18 it was decided, owing to the rise in the price of raw material, to raise prices 5 per cent. on the net as from Dec. 20.

Chichester.—We understand that the provisional order for electric light has been transferred to Mr. Boot, electrical engineer of Tunbridge Wells, who is to pay the Council £500 for the transfer, and to proceed with the formation of a company at once.

London County Council.—On Tuesday it was agreed to lend the Fulham Council £25,000 for electric lighting purposes. Sanction was also given to the borrowing by the Stoke Newington Borough Council of £18,020 and £5,800 for provision of a dust destructor.

South Metropolitan Electric Light and Power Co.—The final instalment upon the ordinary and preference shares and debenture stock, issued under the circular dated June 23, 1905, falls due on the 1st prox., and the notices have been sent to the shareholders.

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Bridgend.—Arc lamps are coming into use here for the lighting of shop fronts, the current for which will be charged at the rate of 3½d. per unit. A reduction is being made to all consumers from 4½d. to 4¼d. per unit and 4d. per unit to all consumers of over 200 units per quarter.

On the Telephone.—Messrs. Johnson and Phillips, Old Charlton, inform us that they have arranged a new telephone system with the General Post Office to their works at Old Charlton. The telephone number is "75 Central," and they have three direct lines from the London exchange.

Christmas Souvenir.—W. T. Glover and Co., Trafford Park, are issuing a novel pipe cleaner, with wings inscribed "Glover's Cables," and they draw attention to the fact by a card inscribed as follows: "We trust that (with pipe free from nicotine stings) you'll notice the message displayed on the wings."

Methyen.—The National Telephone Co. are about to open a telephone office here. It is understood that communication will be given through an exchange office with Crieff, Perth, Scone, Bridge of Earn, etc., and that a further extension will be made to Glenalmond College, Logiealmond, and Kipney through the Glen of Dumtochty.

Stoke-on-Trent.—The electrical engineer in his monthly report states that at the end of last month the works were supplying 158 consumers, representing a total of 10,558 8 c.p. lamps. The negotiations between the electrical engineer and Mr. Tabbinor for a supply of electricity to houses in Shelton New-road have been completed.

Blackpool.—The Electricity Committee recommend that application be made for sanction to the borrowing of £4 000, repayable in 30 years, for cables, transformers, and other materials for extensions of the electricity mains in Raikes-road, Whitegate-drive, Raikes-parade, Palatine-road, Bloomfield-road, and for main extensions for new prospective consumers.

Newcastle.—The Watch Committee have issued their report upon the proposal that certain streets in the city be lighted by electricity. The committee, after considering the merits of gas v. electricity, recommend that the City Council apply for a loan of £4 500 to defray the necessary capital expenditure for lighting the proposed streets by 180 electric lamps of 700 c.p. each.

Coventry.—Application is to be made for sanction to the borrowing of a further £5,000 for the purchase of electric motors to be let out on hire. Alderman West, chairman of the Electric Light Committee, on Tuesday showed that a previous investment of £7,000 for similar purposes is earning about 12 per cent. interest by the hire of the motors, while the interest and sinking fund expenses represented a charge of only 6 per cent.

Telephones to the Continent.—The Chambers of Commerce Association, recently addressed a letter to the Postmaster-General on the subject of telephonic communication with the Continent. A reply has been received stating that no definite information was available as to the limits of distance by sea and land over which telephonic conversation could take place, and that the limit had to be determined by practical experiment in each case.

Grimsby.—At the last meeting of the Grimsby Chamber of Commerce and Shipping it was resolved to again approach the Postmaster-General to endeavour to obtain an all-day and all-night telegraph service for Grimsby. The secretary was instructed to inquire into the telephone service at Grimsby, and to urge that an extra trunk line should be put on to Hull, as members find the line so occupied that a great deal of time is lost in endeavouring to get through to Hull.

Brighton.—At Friday's meeting the Telephone Committee received a report from their engineer and manager stating that the whole of the authorised capital of the department had been expended, and recommending that application be made for sanction to borrow a sum of £2 000 for connecting new subscribers on to existing spare plant, pending the settlement of the negotiations now in progress with the Post Office. The committee agreed to recommend that the Council should apply for the loan.

St. Pancras.—The Borough Council propose to apply to the London County Council for sanction to a loan of £12,150 for electric lighting purposes as follows: for purchase of leasehold interests in 108 and 112, Great College-street, £1,700; for extensions of mains, services, etc., from April 1 to Sept. 30, 1905, £6,124; for extensions of mains, services, etc., from Oct. 1 to Nov. 30, 1905, £1,783; for further extensions of mains and services, feeding and supply mains in Cumberland Market district, etc., £2 543.

Hipperholme.—A circular is being posted throughout the district calling upon all ratepayers willing to take the electric light to give notice thereof at the Council offices as early as possible. Mr. T. J. Constantine, in proposing the adoption of the minutes of the committee, said they wanted to hear the voice of the ratepayers on the question of introducing electricity. It would mean an expenditure of £3 000, and to meet that outlay it would be necessary to sell 19,000 units at 5d. per unit, which worked out at £200 for interest, etc.

Removal.—The Private Wire and Telephone Installation Co. have acquired premises at 78, Queen-street, Cheapside E.C., where they have extensive showrooms well equipped with every kind of electric fittings, and facilities for charging and repairing accumulators, which will be appreciated by many motoring men who daily go to the city. It is now close on 12 years since this company commenced its operations, and owing to the increase in its business it has been compelled to remove to the City from Palmer-street, Westminster, where its offices have been for so long.

Walsall.—The last report states that the total number of consumers supplied on Nov. 30 last was 441. During the past month the total units generated at the station was 174,679. The total output from the main generators was 169,171 units. The total units from the transformers was 131,782 (estimated). The total units registered on the meters was 122 655. The machinery was run for 715 hours. The wages paid amounted to £132. A request of the Tramways Committee that the charge for current supplied for tramway purposes should be reduced from 1½d. to 1¼d. per unit has been declined.

Beckenham.—The Urban District Council have adopted the recommendation of the Electric Lighting and Tramway Committee to the effect that Mr. Angell be asked to continue his honorary services as advising engineer for a period of six months dating from Nov. 22 last, but that Mr. Tapper, the resident engineer, be directly responsible to the Council for the running and condition of the station and undertaking. The following subjects will come under the consideration of the committee at an early date—viz: free wiring to new houses, hire of motors, arc lamps, etc., differential system of charge.

London Gazette.—The partnership between G. H. Scriven and H. G. King, carrying on business as electrical and consulting engineers and dealers in patents at Craven House, Kingsway, Holborn, London, has been dissolved by mutual consent. A first and final dividend of 2s. 8¾d. in the £ has been declared in the estate of F. Shaw, electrical contractor, Hessle-road, Kingston-on-Hull. A receiving order has been made out on debtor's petition in the estate of J. R. Charnock, electrical engineer, etc., Stonegate-road, Leeds. The first meeting will be held at the official receiver's offices, 22, Park-row, Leeds, at 12.30 p.m., Dec. 29.

Paddington.—The Finance Committee of the Borough Council are of opinion that the following figures, at which the undermentioned municipal electric undertakings were assessed for rateable purposes in the recent quinquennial valuation, are inadequate: Bermondsey, £1,796; Fulham, £2,432; Hackney, £5 430; Hammersmith, £6,500; Hampstead, £13 000; Islington, £4,666; Poplar, £3,760; St. Pancras, £6 621; Shoreditch, £4.628; Stepney, £4,233; and Woolwich, £2 620. The committee recommend that the London County Council's attention be directed to these valuations of electric mains and generating stations, "with a view to such assessments being made more in accordance with the real values."

Lowestoft.—The resident engineer in his last report states that during the month two new consumers had been connected to the mains, representing 252 8-c.p. lamps. There are now connected to the mains 650 consumers, representing 32,668 8 c.p. lamps. At a recent joint meeting of the Tramways and Electric Lighting Committees the question of the charge made for current supplied to the tramways undertaking was considered, and it was resolved that, in the opinion of this joint committee, the Electric Lighting Committee should return the equivalent of ½d. per unit for all electricity used for tramway purposes for the year ending Sept. 30, 1905, and that for the year ending Sept. 30, 1906, current for tramway purposes should be charged at 2¼d. per unit. The Electric Lighting Committee have agreed to the proposal.

Cardiff.—The National Telephone Co. have asked for consent to place their wires underground. They are prepared to take the work in hand at once, and when completed the city would derive an income of about £450 per annum. A special committee has been appointed to deal with the matter. Mr. Arthur Ellis, the electrical engineer, in his last monthly report to the Electrical and Lighting Committee stated that there were 1 209 consumers connected, with a total equivalent of 144,383 lamps of 8 c.p. The total at the corresponding period of last year was 118,930, showing an increase of 21 per cent. in the total connections. The estimated revenue for the month was £664 revenue for street-lighting and £3,161 private supply, making a total of £3,826. The estimated revenue for the corresponding month of last year was £3,354, showing an increase of 18 per cent.

Awards.—We are informed that the highest award for mechanical stokers for industrial boilers, consisting of the only silver medal, has been accorded to Ed. Bennis and Co., Little Hulton, Bolton, by the Smoke Abatement Society for their mechanical stoker and self-cleaning compressed air furnace, which has obtained such splendid results over hand firing, and also over every other type of machine stoker in leading boiler-houses all over the country. Messrs. Bennis obtained at the above-mentioned exhibition a bronze medal for their new chain grate (Bennis-Miller-Bennett patent), of which a very fine model was shown, the feature of the light load damper distinguishing the chain grate evoking special interest on the part of the judges. To carry off the two highest awards for two distinct types of stokers is an honour in the receipt of which Messrs. Ed. Bennis and Co. may well feel gratified.

York.—We learn from the *Yorkshire Herald* that a serious accident has occurred at the Corporation Electricity Works, Foss Islands, York, whereby an engine driving one of the two principal dynamos for supplying electric light and power to the city was considerably damaged. There are at the works eight dynamos—four small, two medium, and two large. The last-named have been recently erected, and are very powerful. Owing to a small drain pipe of the engine driving one of the newest dynamos becoming blocked, water accumulated in the low-pressure cylinder. The engine was being started for the purpose of lighting the city, but the strain caused by the obstruction was such that the cylinder was much damaged, and the dynamo was thus put out of action. The lighting of the city was, however, not much interfered with, for ample provision had been made for stand-by plant. The other large dynamo was set in motion in a short time, and there is no reason to fear that the supply of electric light in the city will be affected. The great strain of the sudden stoppage dislocated portions of the machinery, and some parts which fell smashed some of the iron steps attached to the machinery. Fortunately, no person was near at the time. The makers of the machinery have been communicated with, and meantime some repairs have been carried out, but the dynamo is not yet in use, and will not be ready for some time. The members of the Electricity Committee have inspected the damage, which, it is feared, is considerable.

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Rostrevor.—At a recent meeting of the ratepayers, Mr. J. A. Fearon (hon. secretary) read the report of the committee appointed by the ratepayers recommending that the public streets and roads leading into the village (for a distance of one-half or one-third of a mile from centre of village) be lighted with electric light—namely, one arc lamp of 1,000 c.p. in the village square, and about 18 smaller lamps on the different roads and streets leading into the village, and that the ratepayers should select a solicitor who would draw up agreements to protect the ratepayers' interests and guard against any increase being made on the rates at any future time for electric light. The meeting approved the scheme, and decided that the charge should not be more than 2d. in the £, and that this extra rate not to be extended further than the townland of Rostrevor.

Gelligaer.—The District Council have adopted a report of Messrs. Mathieson and Lloyd on the scheme for which the Council are now seeking a provisional order. Mr. Lloyd said it was questionable whether the current could be purchased from the South Wales Distribution Co. as proposed, for their mains did not run to the Gelligaer district, and it was also doubtful whether the company would run their mains to supply the Council alone. The collieries in the Council's district had their own electrical plant. In the absence of getting the current from the company there was the question as to whether they could obtain light from neighbouring collieries, and failing that, it was suggested by the engineers that a generating station be constructed at Bargoed to supply that town and Gilfach, at a cost in plant of £10,000. A provisional order and a loan of £11,000 will be applied for.

King's Lynn.—The engineer in his last report states that since the last monthly meeting applications had been received from three additional consumers for a supply of 527 additional lamps of 8 c.p., or equivalent, making a total of 22,766 from private consumers. He also reported that the walls of the engine-room were showing signs of giving way at several places, and his proposal to fix two stay-rods from end to end of the room has been approved. The following statement of figures are available: units generated, October, 1905, 49,162 (1904, 49 388); total units sold to private consumers (light and power), 25 346 (29,340); units sold at lighting rates, 17,497 (17,483); units sold at power rates, 7,849 (11,857); cost of fuel, stores, repairs, and wages at station, £131. 0s. 2d. (£142. 1s.); cost per unit generated, 0·6395d. (0 6902d.); wages of lamplighters and outside staff, £23. 18s. 11d. (£27. 11s. 10d.).

Luton.—The last report of the Electric Light and Power Committee states that since Oct. 6 last 113,256 units had been generated, an equivalent of 1,358 8 c.p. lamps and two motors of 7 h.p. connected, making a total of 286 consumers with 17,561 lamps and 100 motors of 495 h.p.; that the number of units generated showed an increase of 100 per cent. over the number generated during the corresponding period of last year; and that at the present time applications were in for over 700 additional lamps and 55 h.p. in motors. The electrical engineer has been instructed to carry out extensions of cables at an estimated expenditure of £744. It has also been resolved that the following shall be the reduced charges from March 31, 1906: lighting—6d. per unit for the first 70 hours of the minimum demand per quarter, 2d. per unit after such 70 hours, or a uniform rate of 4½. per unit; power—2d. per unit for the first 1,000 units per quarter, 1½d. per unit for the second 1,000, 1d. per unit for any amount over 2,000 units per quarter.

Glasgow Exchange Fire.—A fire occurred on the premises of the National Telephone Co., Royal Exchange-buildings, last Saturday night. The outbreak occurred in the test-room, which is situated near the roof at the south-east corner of the structure, where all the cables converge. Standing as the building does in the centre of a comparatively large square, there was little chance, owing to the slight wind which prevailed, of the flames being bodily carried to adjoining property. The one dangerous means of communication was over the numerous wires which radiate from the exchange in every direction, but the brigade effectually performed their task, and only the test-room and the wires were damaged. As soon as the exchange officials were apprised of the outbreak, emergency gangs of electricians and telephone workers were summoned from all over Scotland, England, and Ireland, even as far south as London. These men set to work immediately the flames subsided, and will be engaged without a break until the damage is repaired. It is expected, however, that communication will not be fully restored for two or three days.

Gravesend.—The Western Electric Co. have advised the Council that owing to the present abnormal prices of copper and lead they could not supply cables at existing schedule rates, but they were prepared to supply subject to an addition or deduction depending upon the market prices of copper and lead at time of ordering. A patent reversible booster is to be purchased, and the engineer is to visit two or three power stations to which reversible boosters have recently been supplied. He is also trying to ascertain by experiment if sufficient water for the new condensers is available from a shallow subsoil well. The Windmill-street type of lantern fitted with tantalum lamps on wall brackets is to be used for West-street lighting. The engineer has been directed to report at the next meeting *re* wiring. The lighting of Upper Wrotham-road from Woodlands to Cross-lane by electric light will come before the next meeting of the Town Council. The chairman of the Electric Committee and the engineer are to attend the annual conference of the Incorporated Municipal Electrical Association, and the Local Government Board will be asked to allow the expenses of delegates attending those conferences in the same way as are the expenses of delegates attending the meetings of the Urban District Councils' Association.

Stepney.—The Council propose to obtain a *locus standi* for the purpose of opposing the preambles of all Electricity Supply Bills in the ensuing session of Parliament which affect the borough, and for the purpose of obtaining the insertion of such clauses therein as the Council may consider necessary for safeguarding the interests of the ratepayers. Mains in Tenter-street South are to be extended. It is proposed that the resolution passed by the Council on May 25, 1904—namely: "That the charge for lighting, as and from June 1 next, at the rate of 8d. per unit for the first 30 hours' use of the maximum demand during each of the six months ending March, and for the first 20 hours' use during each of the six months ending September, and 1d. per unit for all further consumption in each month, any resolution or other act of the Council or their predecessors to the contrary notwithstanding"—be (as and from Oct. 1, 1905) modified to the following extent—namely: "(*a*) That to any consumer whose total accounts, calculated on the undermentioned rates for any half-year ending June 30 and Dec. 31, reach £60 or over, or who is willing to guarantee this amount as a minimum payment for each such period, the charge for current for lighting purposes shall be 6d. per unit for the first 30 hours' use of the maximum demand during each of the six months ending March, and for the first 20 hours' use during each of the six months ending September, and ·9d. per unit for all further consumption in each month; and (*b*) that in calculating the total amount of a consumer's half-yearly bill for the purpose of arriving at the minimum mentioned in (*a*), the accounts for lighting, power, and other purposes on the same or different premises be added together." This is subject to the provision that where the accounts of various premises are so added together the average half-yearly account per service shall not be less than £15.

Bury.—The Bury and District Chamber of Commerce, having called the attention of the Postmaster-General to the charge for trunk calls between Bury and Bradford (Yorks) as compared with those between Rawtenstall and Bradford, and also to a statement that the charge for a call between Bury and Whitefield was 6d., a reply has been received containing the following statement: "The charges are calculated upon the distance by direct measurement between the towns into which trunk wires lead. The scale of charges, which under the regulations have received statutory authority, is as follows: 25 miles or under 3d. for three minutes, 50 miles 6d., 75 miles 9d., 100 miles 1s. For every additional 40 miles or fraction of 40 miles 6d. The Chamber of Commerce are doubtless aware that certain areas have been assigned to the National Telephone Co. for their local exchange system, and that trunk wires provided by the Post Office connect these areas. Rawtenstall is on the company's exchange system, of which Bacup is the trunk centre, and as Bacup is less than 25 miles from Bradford, the charge for a trunk call between Bradford and any place in the Bacup area, which includes Rawtenstall, is 3d. Bury, on the other hand, is more than 25 miles from Bradford, and the proper charge for a call between the two places is 6d. Whitefield is in the Telephone Company's Manchester exchange area, and the trunk fee for a call between Whitefield and Bury is 3d. only. In stating that the fee is 6d., possibly the Chamber of Commerce have in mind the charge made to a caller at a call office on the company's system, as it is understood that in addition to the trunk charge due to the Post Office the company charge 3d. for the use of their call office in making the trunk call. The Postmaster-General does not think the prescribed charges are excessive, and fears he cannot hold out any hope of their reduction. He is also, of course, unable to grant a special reduction in the cost of calls between Bury and Bradford." It has been decided to point out that no charge is made to subscribers for calls between Bury and Radcliffe or Ramsbottom, that Whitefield is as near to Bury as each of these places, and suggesting that Whitefield should be included in the Bury area.

Bermondsey.—When the auditor of the Local Government Board, Mr. H. Carton Roberts, attended at the town hall on Tuesday to audit the accounts of the Electric Lighting Committee for the year ended March 31, 1905, there was considerable opposition by the Bermondsey Municipal Association on behalf of the ratepayers. The discussion centred largely upon the fact that the electric generating station and the dust destructor are under the management of the same committee, and essentially connected with each other in running the electric light scheme. The recent committee of inquiry held that it would be manifestly unfair to charge against the electric lighting the cost of dealing with the dust and refuse or any losses connected with the destructor machinery. As, however, the destructor was installed in conjunction with the electric generating station, and is used to supply steam to it, the Municipal Association maintain that the charges for the destructor, after making allowance for any saving which it may bring about, should be considered jointly with the electric lighting undertaking. The cost of working and maintenance of the destructor for the year proved to be £5,675. The revenue, which included £500 credited to the destructor for electricity on account of its steam supply, amounted in all to nearly £887. The actual cost of the destructor for the year was, therefore, £4,788 odd. Some 13,027 tons of refuse were dealt with, which, if carried away by barges in the old way, would have cost £1,302. The realised loss for the year on the destructor was, therefore, £3 486. In the matter of disposal of refuse, the cost per ton with the destructor thus works out to 7s. 4d. per ton. The Municipal Association also objected to electric lighting debits being transferred to another account, whereby the electricity undertaking was made to appear in an unduly favourable light. It was pointed out that the accounts showed a surplus of £1,000, which the Municipal Association contended was brought about by charging to other accounts expenses which really ought to be borne by the electric lighting undertaking. They contended that the sale of current to private consumers resulted in a loss of £308. The declared profit of £1,000 was brought about by the following means: During the year 387,480 Board of Trade units were generated for municipal purposes. The cost of producing this amount of current was £3,591. 10s. 9d., while the ratepayers paid £5,039. 4s. 6½d. for it as follows: for lighting municipal institutions, £1,535. 11s. 0½d.; and for public lighting, £3,505. 13s. 6d. Deducting the loss on sale to private consumers of £308. 3s. and other items amount-

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ing to £139. 10s. 9½d., the profit of £1,000 is left—that is, the profit in question has been made by placing an undue charge upon the undertakings which are maintained by the rates, or, in other words, imposing an excessive charge on the ratepayers so as to show a surplus on the year's working. The auditor will give his decision in the course of the next two or three weeks.

Dundee—Mr. Harry Richardson, the city electrical engineer, has presented to the City Council a report in which he deals with the present position and prospects of the electricity undertaking, and with the outlines of the scheme for a new generating station at Stannergate, the estimated cost of which is £75,000, exclusive of the price of land. Mr. Richardson says that the question of extending the undertaking is not debatable, as they had a maximum load of about 2,500 kw., while the capacity of the present plant under favourable conditions did not exceed 2,700 kw. He suggests that one of the two following courses be taken: (1) putting down more plant in the present station and more low-tension feeders over the present area; (2) putting down a new station and generating three-phase alternating current at a high pressure, and distributing with but little loss to small sub-stations in the different districts, and from these sub-stations supplying the surrounding districts at low-pressure current, as at present distributed, thereby not affecting the consumers by any change of their conditions, except that they get a more satisfactory supply. The following is an approximate estimate of the cost of extending the present station: engine and dynamos, £11,000; boilers, £3,500; mains, £5,800; three complete sets of superheaters, £650; three sets of mechanical stokers, £680; one complete condenser, £700; air-pumps, £500; circulating pumps, £120; two sets of feed pumps, £400; feed-water purifier, £400; feed-water heater, £320; new cooling tower, £900; batteries, etc., £900—total, £25,770. Mr. Richardson considers it almost impossible to put anything else on the present site than a turbine, owing to the very limited space and the power required. Experience pointed to the fact that there was trouble in generating continuous current with a high-speed turbine, while there was none in generating alternating current with the same means. Boiler space might be found, but the chimney and main flue were not large enough by any means for the present station. The cables were overloaded also, and in spite of the careful rearrangement of distribution with a view to saving the loss between the station and the consumers, this still amounted to 17 per cent. In other words, the low-tension system of distribution in towns or areas having above a certain demand gave a very poor elasticity of extension with reasonable expenditure. Mr. Richardson does not recommend the adoption of the extension scheme, but is in favour of the building of a new station and of starting a new policy of distributing at high pressure. He quotes figures showing that Dundee, which received from its consumers only 2·17d. per unit, had spent considerably less per head of population than many other towns on their electricity undertaking. The ratio of Dundee is £1, as compared with £1. 4s. in Aberdeen. He mentions that the cost to the town of the present station, exclusive of cables, was as follows: buildings, lands, and works, £19,913; machinery and dynamos, £63,677; batteries, £2,882; electrical instruments, £1,747; general apparatus, £1,026; office furnishings and fittings, £524—total, £89,769.

PROVISIONAL PATENTS, 1905.

DEC. 11.

14889A. Improvements in the method of insulating electric wires or cables. Paolo Coridori, 31, Bedford-street, Strand, London. (Date applied for under Rule 5 of the Patents Rules, 1905, July 19, 1905.) (Complete specification.)

25684. Improvements in electrical conduit fittings. William Winstanley Strode and Horace Foster Richens, 48, Osnaburgh-street, London.

25687. Improvements in conduits for electric conductors, pipes, and the like. John Henry Harradine, John Thomas Biddle, and Lorenzo William Crosta, Temple-buildings, Albert-street, Nottingham.

25702. Improvements in electrical resistances. John Henry Holmes, Queen Anne's-chambers, Westminster, London. (Complete specification.)

25729. An improved automatic earthing device and cut-out for the overhead conductors of electric railways. William Edward Thomson and Charles Benjamin Pinkerton, 11, Southampton-buildings, Chancery-lane, London.

25748. Improved magnetic separator. William Simpkin and James Bain Ballantine, 23, Southampton-buildings, Chancery-lane, London.

25754. Improvements in or relating to wave telegraphy. Alfred Julius Boult, 111, Hatton-garden, London. (Ferdinando Lori and Marquis Luigi Solai, Italy.)

25759. Improvements in or relating to protective devices for the frames or stators of electric machines. Coleman de Kando, 111, Hatton-garden, London. (Complete specification.)

25768. Improvements in means for insulating electric wires or cables. Paolo Coridori, 31, Bedford-street, Strand, London. (Complete specification.)

25771. Improvements in electric transformer furnaces. Otto Frick, 322, High Holborn, London.

DEC. 12.

25802. An improved electrical terminal attachment device. Stephen James Murphy, 10, St. George's-crescent, Liverpool.

25811. Improvements applicable to trolley standards for electric cars. John Aldworth, Lorenzo William Crosta, and William Boot, Temple-buildings, Albert-street, Nottingham.

25826. Improvements in and relating to means for automatically collecting up the subscribers of telephone exchanges to each other. Josef Peticky, Ivan Cizek, and Franz Suchanek, 72, Cannon-street, London. (Complete specification.)

25840. A new or improved means for conducting electric currents. Ferdinand Blaschke, 9, Warwick-court, Gray's Inn, London.

25855 Improvements in and relating to radiators for use with electricity, oil, gas, or other heating agent. Lester Betts and the Improved Electric Supplies Company, Limited, 1, Queen Victoria-street, London.

25858. Improvements relating to rail bonds for electric railways. Henry Harris Lake, 7, Southampton-buildings, Chancery-lane, London. (The American Steel and Wire Company, United States.) (Complete specification.)

25866. Improvements in or relating to electric telegraphy. Edward Raymond-Barker, 111, Hatton-garden, London. (Complete specification.)

25880. Improvements in electricity meters for alternating currents. Llewellyn Rolls Lester and the Rochdale Electric Company, Limited, Norfolk House, Norfolk-street, Strand, London.

DEC. 13.

1482A. Improvements in or relating to electrical contact makers or distributors. Percy Warren Noble, 18, Hertford-street, Coventry. (Date applied for under Rule 5 of the Patents Rules, 1905, Jan. 25, 1905.)

25893. Improvements in mercury or other vapour electric lamps. Joseph Skwirsky, 36, Newman-street, Oxford-street, London.

25944. Improvements in electric arc lamps. Joseph Tollerton, 8, Quality-court, Chancery lane, London.

25952. An improved dynamo-electric generator. Parnell Rabbidge, 111, Hatton-garden, London. (Complete specification.)

25971. Improvements in or relating to electrically-lighted miners' safety and like lamps. Thomas Anthony Jones and Anthony Jones, trading as Patterson and Co., 70, Chancery-lane, London.

DEC. 14.

26032. Improvements in or relating to electric ignition systems for internal-combustion engines. John James Henry Sturmey, 18, Hertford-street, Coventry. (Charles Edgar Duryea, United States.) (Complete specification.)

26046. Improvements in or relating to electric clocks. Conrad Hubert, 111, Hatton-garden, London. (Complete specification.)

26052. Improvements in or relating to apparatus for storing and paying out lengths of conductors or wires connected to electric instruments or apparatus. René François Joseph Samuel Baron, 111, Hatton-garden, London. (Complete specification.)

26066. Improvements in coin-freed electricity meters. John Mesny Tourtel, 146A, Queen Victoria-street, London.

26072. Improvements in telegraphs for transmitting orders. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 14, 1904, being date of application in Germany.) (Complete specification.)

26081. Improvements in or relating to tremblers for induction coils. Charles Henry Bryant and Francis Leslie Matthew Forster, 111, Hatton-garden, London.

26086. Improvements in arc lamps. Hermann Max Körting, 31, Bedford-street, Strand, London. (Complete specification.)

26089. Improvements in and relating to alternating-current dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26090. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26091. Improvements in and relating to alternating current dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26092. Improvements in and relating to alternating-current dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26093. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26094. Improvements in and relating to the alternating-current dynamo-electric machines. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 15, 1904, being date of application in Germany.) (Complete specification.)

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COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 4.

1904.

27168. Method of automatically regulating the voltage in electric light and power circuits with varying loads. Tilney.

27437. Arc lamps. Zingel, Wolf, and Reiner.

27859. Automatic electric cell switches. Elektricität's Akt. Ges. Westfalia and Kupferschlag.

28468. Systems of electric distribution and conductors therefor. Gati.

28858. Electric switch and circuit breaker. Hi·st ·nd Brook.

1905.

80. Electric arc lamps. British Thomson-Houston C.mpany, Limited. (General Electric Company.)

1638. "Party line" system of telephones. Stocks.

2401. Starting and control of direct-current electric motors Heath.

3857. Controlling devices for electric motors. Fairweather. (Diehl Manufacturing Company.)

4456. Conduits for electric conductors or cables. Devonshire.

4513. Electric clocks or the like. Chandler and Bonnikeen.

4731. Electric pushes or switches for operating electric bells, telephones, signalling, and for other purposes. Wansbrough.

4780. Appliances for testing electric batteries. Lake. (Jacobsen.)

5865. Construction of conduits for containing electric cables and wires and other wires, tubes, pipes, and the like. Hepworth-Collins.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £	Last price. £
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-7
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5 ..	1⅞-2¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	83-85
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¼-½
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅞
—— 4½ per cent. 1st Debenture Stock	100 ..	96-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	84-86
Callender's Cable, Debentures	100 ..	109-111
—— Ordinary	5 ..	11-12
—— 5 per cent. Pref.	5 ..	5⅝-5¾
Crompton and Co.	3 ..	2-2¼
—— 5 per cent. Debentures	100 ..	97-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3 ..	1⅜-1⅝
—— "A" Shares, 01-017,139	5 ..	2¼-2⅜
—— 5 per cent. Debentures	100 ..	92-97
—— 4 per cent. Deb. Stock, Red.	100 ..	85-90
Electric Construction, Nos. 1 to 112,100	2 ..	¼-⅜
—— 7 per cent. Cumulative Pref.	2 ..	1⅝-2⅜
—— 4 per cent. Perp. 1st Mort Deb.	100 ..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼ 9⅜
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	12½ 13½
—— 4½ per cent. Preference	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18½-19½
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Telegraph Construction and Maintenance	12 ..	32-34
—— 5 per cent. Bonds	100 ..	102-104
Electric Lighting and Supply.—		
Bournemouth and Poole, Ordinary	10 ..	12½-12⅝
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10½-10⅝
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11½-12½
—— 4½ per cent. Debenture Stock, Red.	100 ..	107-109
Bromley (Kent) Electric Light and Power Co.	5 ..	5¼-5⅜
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8⅜ 9⅜
—— 7 per cent. Preference	5 ..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	9-9½
—— Nos. 60,001-80,000	5 ..	8⅜-9⅛
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	102-105
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	5⅜-6⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	101-103 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5
—— ditto (1903) 40,001-80,000	5 ..	4⅜-5
Chelsea Electricity Supply	5 ..	5-6
—— 4½ per cent. Debentures	100 ..	110-112
City of London, Ordinary	10 ..	11-12
—— 6 per cent. Cumulative Pref.	10 ..	13½-14½
—— 5 per cent. Debenture Stock	100 ..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-103
County of London Electric Supply, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12⅜-12⅞
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	112-115
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	101-103
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	5¼-5⅜
—— 6 per cent. Cum. Pref.	5 ..	5⅜-6
—— 4½ per cent. First Mort. Deb.	100 ..	107-109
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm.Pf., 1-30,000	5 ..	2¼-3
—— 5 per cent. Debenture Stock, Red.	100 ..	87-92
Folkestone Electric Supply, Ord. Nos. 1-10,000	5 ..	5¼-5⅜
—— 4½ per cent. First Deb. Stock, Red.	100 ..	101-104
Havana Electricity, 1-15,000	10 ..	9-10
Hove Electric Lighting, Ord., 1-13,000	5 ..	8¼-8⅜
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100 ..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅞-1
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	10⅞-11⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100 ..	101-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅞-10½
London Electric, Ordinary	3 ..	1⅜-2¼
—— 6 per cent. Pref.	5 ..	4⅜-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	98-102
Metropolitan Ordinary, 100,001-300,000	5 ..	9 10
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	109-113
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5½
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-99
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,059	5 ..	8-8¼
—— do., 57,0 0-75,000	5 ..	8-8⅛
—— 5 per cent. Pref., 1-57,000	5 ..	6¼ 6⅜
—— do., 57,0.0-75,000	5 ..	6¼-6⅜
Notting Hill Electric Lighting	10 ..	13⅜ 14⅜
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	6⅜ 6⅞
—— 4 per cent. Debenture Stock	100 ..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5 ..	2 2⅛
—— 4 per cent. Debenture Stock	100 ..	76-80
South London, Ordinary	5 ..	3 3¼
South Metropolitan Electric Light and Power, Ord.	1 ..	13/16-15/16
—— 7 per cent. Cum. Pref.	1 ..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	105-108
—— Ditto, June, 1904	— ..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	12⅜-13⅛
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98 100
Urban Electric Supply Co., Ordinary, 8-30-007	5 ..	4⅛-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5¼
Westminster, Ordinary	5 ..	11¼-12½
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	5¼-6¼
Electric Tramways.—		
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5 ..	5⅞-6⅛
—— Ord.	5 ..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	142-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	105-107
Barcelona Tramways, Ord., 1-20,000	10 ..	13⅛-14⅛
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	9¼-10
—— 5 per cent. Deb., Red., 1-600	100 ..	98-101
—— 4½ per cent. Red. Deb. Stock	100 ..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1 ..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1 ..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	96-98
British Columbia Electric Railway Co., Ord. Def.	100 ..	119-122
—— Ord. Pref.	100 ..	109-113
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	106-109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40 ..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100 ..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	7⅛-8⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	10-11
—— 5 per cent. Perpetual Debenture Stock	100 ..	117-119
—— 4½ per cent. 2nd Deb. Stock	100 ..	97-99
Buenos Ayres and Belgrano Trams	5 ..	3⅛-3⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	107-109
—— Prov. Cert., all paid	100 ..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100 ..	98-100
Calcutta Tramways, 1-102,268	5 ..	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	107-108
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅝-1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4¼ 5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100 ..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	14½-15½
—— 6 per cent. Cum. Pref.	10 ..	15-16
—— 4 per cent. Debentures	100 ..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13¼-14¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 ..	94-97
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c Cum. Pref., Nos. 30,001-60,000	5 ..	2⅛-2⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	83-88
Kidderminster and District Lighting and Traction, Pref.	5 ..	8-8½
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	100-103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100 ..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1 ..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1 ..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	104-107
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100 ..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100 ..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	¼-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	12
—— 5 per cent. Cum. Pref.	10 ..	9⅜-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100 ..	101-104
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8⅜-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9⅜-10¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,132 6 per cent. Preference	1 ..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c. ..	100 p.c
Electric Railways.—		
Central London, Ordinary	100 ..	93-96
—— 4 per cent. Pref.	100 ..	101-103
—— " " deferred	100 ..	85-88
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	105-108
—— 5 per cent. Pref. Stock '91	100	119-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	114-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.	—	97-98 xd
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	94-97½
Waterloo and City, Ordinary	100	94-97

Name.	Amount paid.	Last price
Telephones.—	£	£
National Telephone, Preferred	100	110½-111½
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	98-100
—— 4 per cent. Deb. Stock, Red.	100	104-106
Oriental Telephone and Electric Company	1	1½-1¾
—— 6 per cent. Cum. Pref.	1	1½-1¾

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week. Ending	1905.	1904.	Increase or decrease. Week.	Current year.	Miles of single track open. 1905.	1904.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 16	1,151	1,0 8	+ 53	− 1,939h	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 16	171	170	+ 1	—	8	8	,, 15	14,328	3,316 380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 17	918	931	− 36	− 678	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10 08	2,338b	6·03
Birmingham Corporation	,, 16	390	314	+ 45	—	2	2	,, 31	17,133	4,709,738	265,526	·86	14·5	8,866	—
Blackburn Corporation	,, 13	836	765	+ 60	—	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	Nov. 2	340	350	− 10	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Dec. 16	144	153	− 9	—	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 17	1,804	1,678	+ 125	—	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 13	1,264	793	+ 471	—	16 82	16 82	,, 31	55,276	10,058,238	1,121,623	1 32	11 83	3,226	7·19
Bradford Corporation	,, 16	4,084	3,729	+ 354	—	96	77	,, 31	230,085	47,108,000	5,053,392	1·172	10·927	2,396	—
Brighton Corporation	,, 17	718	758	− 40	+ 451	9	9	,, 31	50,333	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 15	4,510	4,507	+ 3	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 16	1,061	987	+ 74	—	10 60	10·60	March 3	—	—	—	1·32	10·66	2,768	8·18
Burton Corporation	,, 17	249	288	− 39	− 1,438	8½	8½	,, 31	17,950	3,878,269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 16	1,803	1 831	− 28	− 33	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 16	146	171	− 25	− 663	8·5	8·5	Dec. 31	10,713	2,935,002	359,756	—	7·14	—	5·18
Central London Railway	,, 16	7,500	7,182	+ 318	− 576	6	6	,, 31	347,588	44,875,547	1,281,214	1 86	65·10	57,931	35·80
City and South London Railway	,, 17	3,270	2,960	+ 310	+ 593	6½	6½	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	,, 14	400	375	+ 25	+ 611	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 16	148	180	− 12	—	4½	4½	,, 31	11,250	2,853,800	284,343	94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 15	97	90	+ 7	− 32h	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T.	,, 15	4,509	4,403	+ 106	− 228	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dundee City Tramways	,, 13	924	787	+ 137	+ 1,742	25	25	May 15	44,695	11,611,525	933,006	·90	11·49	1,943	7 13
East Ham Corporation	,, 16	729	618	+ 11.	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6 79
Glasgow Corporation	,, 16	15,334	13,359	+ 1,975	+ 14,910h	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 16	1,200	1,171	+ 129	+ 2,024	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 16	2,156	2,115	+ 41	+ 860	27	26	,, 31	112,651	27,102,921	2,910,693	1	9·29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 13	104	95	+ 9	− 775	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 16	5,848	5 411	+ 437	+ 5,832	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 16	1,925	1,701	+ 224	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 2	10,3 4	9,631	+ 623	+ 9,639	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 17	1,322	1,432	− 110	− 1,650h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 19	13 8?0	11,9?0	+ 1,9 0	+ 7?,155	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 9	129	133	− 4	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 14	78	85	− 7	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 16	12 528	11,677	+ 851	+ 21,88?	149	131½	March 31	631,856	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Metropolitan District Railway	,, 17	8,188	7,778	+ 410	+ 5 827	24	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 17	17,807	17,256	+ 551	+ 2,613	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 16	120	103	+ 17	+ 459	—	2¾	,, 31	6,159	1,972,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 16	3,685	3, 07	+ 79	+ 3,233	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 17	1 512	1 353	+ 159	+ 15,672	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 9	1,449	1,333	+ 116	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	,, 7	555	542	+ 14	− 481	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 16	743	386	+ 357	+ 20,276	6½	4½	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	Nov. 9	534	497	+ 37	—	9½	7¾	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	Dec. 11	4,150	3,749	+ 401	+ 8,814	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 19	4,835	4,548	+ 287	+ 9,363	65¾	52½	,, 25	240,565	63,952,283	6,049 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 13	843	817	+ 25	− 311	—	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7·85
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 15	807	398	+ 409	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 17	1,216	1,116	+ 100	+ 1,780	20	20	,, 31	64,858	15,364,463	1,495,685	1 004	10·36	—	6·37
Swindon Corporation	,, 14	159	141	+ 18	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·63	1,371	
Wallasey U.D.C.	,, 16	683	676	+ 7	+ 961	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·64
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9 85	—	6 33
West Ham Corporation	,, 14	1,773	1,014	+ 759	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 13	746	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 mile of interlacing track. *a* Train mile. *b* Per mile of single track. *h* Half-year's figures.

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NOTES.

Electric Railway.—It is announced that a test is to be made of the Krizik direct-current three-wire system on the Vienna Stadtbahn, which is at present operated by steam. The locomotive will contain four 200-h.p. motors, and a voltage of 3,000 volts between the outer wires will be used. The section to be equipped is that between Praterstern and Hauptzollampt, a distance of 1·4 km., or a little over one mile.

Obituary.—We greatly regret to learn of the death of Mr. Charles Ravell Bellamy, who for some years had acted as general manager of the Liverpool electric tramways. Mr. Bellamy died at Liverpool on Saturday at the age of 50 from the rupture of an artery following a sprained ankle. When the Liverpool electric trams commenced in 1898 Mr. Bellamy was appointed general manager, and he had brought that system to its present high state of efficiency. The undertaking last year carried 116,642,663 passengers, and had a gross income of £547,624. Mr. Bellamy took an active interest in electric traction, and was prominent in several movements organised to benefit the industry.

Books Received.—We have received from the British Electric Transformer Company, Limited, of Hayes, Middlesex, a handsome copy of Whitaker's Almanac for 1906, bound in padded leather. Besides the storehouse of valuable information for which Whitaker's annuals are noted, a number of supplementary pages are inserted in the beginning of the book containing a list of officials and councils of the Institutions of Civil, Mechanical, and Electrical Engineers. There is contained also the names of some well-known customers of the British Electric Transformer Company, Limited, together with charts and statistics showing the development and present extent of the company's business.

New Publications.—We have received the December issue of the *Bulletin* of the Société Belge d'Electriciens, which opens with an account of the monument erected at Liége in memory of Zénobe Gramme, together with the reproduction *in extenso* of the addresses delivered on the occasion by MM. Emile Glosset and Emile Javaux. The latter's discourse revealed for the first time the actual methods followed by Gramme in the design of his dynamos. Other contributions are "A Report on the Mechanical Traction of Boats," as presented to the Congress of Navigation at Milan; "A Speed Indicator," by M. J. Garlier, and a further description of the electrical section of the Liége exhibition. The *Bulletin* for October of the Société des Ingénieurs Civils de France contains a number of interesting *mémoires* and a summary of the meetings of Oct. 6 and 14. The December number of the *Rhodesia Review* is one of general interest, but more particularly to settlers and shareholders in the many Rhodesian companies.

Heat Economy in Factories.—At an ordinary meeting of the Institution of Civil Engineers held on Dec. 19 a paper was read by Mr. H. A. Mavor, M.I.C.E., on "Heat Economy in Factories." He remarked that in an investigation undertaken in 1898 on the comparative costs of power in factories in the United Kingdom, he found great difficulty in obtaining accurate data, owing in many cases to the fact that the fuel consumed was applied for heating as well as for power. This circumstance appeared to offer inducements for further examination of the question, and his paper was an account of a method of inquiry which has resulted in a simplification of the problem and in the acquisition of useful results. The method consists in dealing with the heat production and distribution by a system of double-entry accounts, in which the boilers are debited with the heat represented by the coal and credited with the heat represented by the steam. These credits are carried to the debit of accounts dealing with the various uses to which the steam is put in the factories. These accounts, again, are credited with the work performed, the balances being carried to a balancing account, which brings out the efficiency of the prime movers and separates out the useful work and the losses in such form that the losses can be divided into necessary and avoidable losses, the whole giving a comprehensive view of the conditions of efficiency in terms of British thermal units. Specimen balance-sheets were given in the paper, and he described the methods of arriving at results showing the bearing which the ascertained efficiencies have upon existing methods of working.

Lighting in Westminster.—An instance of the unreasonable attitude which at times the local authorities adopt towards private contractors is afforded by the action of the Electric Lighting Committee of the Westminster Borough Council in regard to the provision of arc lamps in the borough. The St. James's and Pall Mall Electric Light Company, Limited, have been engaged for some time in carrying out electric lighting work in the borough. The standard illumination stipulated in the contract is 900 c.p. This power the company failed to obtain, and on the fact being pointed out to them by the city engineer they proposed to increase the candle-power by raising the current supplied to each lamp. This is now being done, but until all the lamps are altered the necessary candle-power will be obtained from the remaining lamps by the method of using smaller carbons. They, therefore, asked the indulgence of the Council that, if a lamp here and there was found at times to be slightly below the standard candle-power, they may be excused for a reasonable time until they have had the opportunity to accommodate everything to the new conditions. The committee, however, relying on a clause in the contract which provides that the contractor is to forfeit as liquidated damages the sum of 5s. per lamp per day for every lamp giving less than the specified power, have refused to accommodate the company, and have recommended the Council to enforce the terms of the contract. The committee may have just cause to decline to accede to the wishes of the company, but to an outsider their action may appear somewhat arbitrary.

Fireproof Curtains.—The accident which occurred on Tuesday through the bursting of a water-main in St. Martins-lane deserves the attention of all who are dependent upon hydraulic means of operation, and especially of theatre proprietors who rely chiefly or solely upon the hydraulic operation of their fireproof drop curtains. The importance of having an electrically-operated hoisting gear in addition to the hydraulic gear was emphasised by the incident which took place at the Hippodrome Theatre when the accident occurred. The fireproof curtain is raised and lowered hydraulically, but with the failure of the water supply the apparatus was rendered impotent. It came down of its own accord, and was afterwards raised by means of an auxiliary gear. At the Coliseum very slight inconvenience was caused, as the curtain was promptly raised by means of manual assistance. This theatre, we understand, obtains its hydraulic supply through another main. The New Theatre and the Duke of York's Theatre worked their curtains by pneumatic power and counterweights respectively, so that no inconvenience was caused. Had the theatre management taken the necessary precaution to provide electric operating gear for their fireproof curtain, the possibility of any breakdown would have been avoided, because theatres are always wired for a supply from two sources, so that, if the supply from one should fail, the load can immediately be switched over to

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the other. It is also to be noted that electrical control is cheaper to operate than hydraulic. The regulations of the London County Council provide that the drop curtain shall have two sets of releasing gear for each of different means.

Tramways and Light Railways.—The Board of Trade's annual return of the capital and traffic of tramways and light railways of the United Kingdom for 1904-5 shows the wonderful growth in tramway traffic since the advent of electrical traction. Comparative tables show that since the year 1878 the route length of line open for traffic increased from 269 miles to 2,117 miles, the capital expenditure from £4,207,350 to £52,675,152, the number of passengers carried from 146 millions to 2,069 millions, and the net receipts from £230,956 to £3,351,977. More instructive and interesting are the tables showing the ratio of progress represented by the "horse," "steam," and "electric" periods, the horse period being represented by the year 1879, the steam period by the year 1898, and the electric period by 1904-5. Thus we see that under the horse period the length of route open was 321·27 miles, which under the steam period increased to 1,064·19 miles, and to 2,116·78 miles after the utilisation of electric traction. Turning to the total number of passengers carried, we find the advance to be even more remarkable. In the year 1879, 150,881,515 passengers were carried, this figure rose to 858,485,542 in 1898, while the completed return for the year 1904-5 shows the huge total of 2,068,913,226. The capital expenditure per mile has increased since the days of horse traction; but, on the other hand, the percentage of net receipts to capital expenditure has increased in a rather larger proportion. The percentage of working expenditure to gross receipts from traffic shows under electric traction a marked reduction as compared with the time when steam traction was at its highest. The average fare per passenger shows a tendency to diminish, and has dropped from 1·84d. to 1·10d.

Electrolytic Purification of Water.—The growing demand for pure water on many of the American railway systems has lead to the introduction of a new process of purification which works electrically, and which, according to the *Railway and Engineering Review*, unites the advantages of efficient filtration and cheap electrolysis. The passing of hard water through the apparatus causes the precipitation of most of the mineral substances contained therein—the acidity is destroyed, and the iron is deposited at the cathode. The principal advantage which is claimed for the system, however, lies in the fact that it not only prepares good water for industrial purposes, but it prepares soft and pure water for drinking and domestic uses. The new process, instead of driving free oxygen from the water, liberates an excess of this important element, which, owing to the shape of the positive electrode, is kept in contact with the water and is eventually redissolved. This has the effect of strongly vitalising the water and at the same time sterilising it, owing to the bubbling through it of ozonised oxygen generated at the anodes. Analysis of crude polluted river water has revealed the fact that the electrical treatment entirely eliminates nitrates and nitrites which are always contained in water which has been contaminated by sewage. The apparatus consists of a cylindrical iron tank divided into two parts by a vertical partition. The anodes are baffle-shaped plates of iron, the cathode being the wall of the tank itself. By this arrangement, the hydrogen, liberated at the cathode, has free access for escape, while the oxygen, liberated at the anode, is held in confinement until enough has accumulated to overflow into the surrounding water. The solid matter is precipitated to the bottom of the tank, while the treated water overflows to the filter contained in the other half of the tank, thus making a very simple and easily transported outfit.

Rubber.—We have already drawn attention to the activity in the rubber market, and to the formation of two companies for the purpose of working rubber plantations in Liberia and Ceylon. The importance of the industry is seen by the fact that imports of rubber into Liverpool during the year 1904 amounted to nearly 402,000cwt., estimated at a value of over £6,800,000, which is only £1,000,000 less than the total value of rubber imported into the United Kingdom during that year. These figures are the highest during the last five years. From 1900 to 1902 there was a gradual decline both in the number of hundredweights imported and in their value, but an improvement set in in 1903, and continued during 1904. Most of the produce came from Brazil and West Africa, the former supplying us to the value of over £4,500,000. Notwithstanding the great improvement in the rubber industry in India, the Malay States, and Ceylon, only £900,000 worth was sent to the Colonies in 1904. We are informed that the plantation of the two species of rubber, Ceare and Hœvea, is making great progress in the Sandwich Islands, where two companies at Nahiku have already 1,250 acres with over 150,000 trees under cultivation. Climatic conditions in the Sandwich Islands, like those of Ceylon, are particularly favourable to the cultivation of these plants. The Belgian consul at Colombo reports that about 40,000 acres are consecrated to the cultivation of the Hœvea, Brasiliensis, and the Castillos. Important quantities of seeds have been exported to Malay States, Dutch Indies, Madagascar, and the English and German possessions in Africa. The latter States merit attention inasmuch as they promise to become important producers of caoutchouc, the produce amounting to 2lb. per tree in the seventh year and 6lb. in the tenth year.

Wireless Telegraphy.—This subject was treated in a paper recently read before the Glasgow Local Section by D. J. Erskine Murray, who confined himself to the consideration of typical systems of wireless telegraphy and to the recent advances made. Of the 300 British patents relating to wireless telegraphy, that which had been longest in practical use was Marconi's untuned coherer system. Untuned systems (said Dr. Murray) were being displaced by tuned systems, but their comparative simplicity and ease in working were recommendations which in many cases outweighed their disadvantages. Marconi's untuned system was mainly used for distances under 150 miles. A description of this system was given, and the methods of tuning and discrimination which depend upon the superposition of small wave motions were afterwards explained and illustrated. By the latter system interference between neighbouring instruments was prevented, and this was the system now in use for the transmission of long-distance messages. For long-distance telegraphy many improvements in methods of transmission had recently been devised, which related mainly to the production of long trains of powerful waves in the transmitter and to the use of several oscillating circuits of the same frequency coupled to one another in series in the receiver, thus obtaining a system which responded only to a wave train of exactly the same frequency. Dr. Murray claimed that the more important improvements in long-distance work were due mainly to Mr. Marconi and to Prof. Fessenden. Mr. Marconi maintained regular communication between England and Italy, a distance of about 1,000 miles, mostly overland, and had, of course, frequently achieved greater distances, including the whole width of the Atlantic. Mr. Fessenden had maintained communication over 600 miles, and was now putting up a Transatlantic

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station at Machrihanish, with a receiver 420ft. high, by means of which it was hoped to communicate with the United States. The De Forest Company had also arranged to put up a Transatlantic station in Tiree.

Plastic Rail Bond.—A new permanent type of plastic rail bond which can be applied to almost any rail section, and in the use of which the angle plates are made to carry the current, was recently described in the *Street Railway Journal*. When installing the bond, a hole is drilled through the angle plate on either side of the joint between the first and second bolt holes from the end of each rail. Under each of these holes a shallow cavity running lengthwise is milled in the top of the rail base. These holes in the angle plates and the cavities underneath the rails are amalgamated by the Brown process, as is also the lower surface of the angle plate over the cavities, and both holes and cavities are filled with a new kind of plastic alloy, which does not harden or permit the liquid to run out. This material being inelastic does not jar out of the hole, and in adhering to the amalgamated rail surfaces forms a flexible conductor of low resistance between the rails and the angle plates. To prevent dirt from entering the holes, they are sealed with composition discs in such a way that they can be easily removed to allow for inspection or repair without the necessity of removing the angle plates. The latter are drilled and amalgamated before being distributed along the road for making-up the joints, the cavities being quickly milled by a portable hand milling machine. The conductivity of the joint, when the weight per yard of the two angle plates is equal to that of the rail and the rail joint is double bonded, is practically equal to that of an equal length of unbroken rail. It is claimed that the plastic alloy will always maintain contact between the rails and the angle plates and keep the conductivity of the joint unimpaired. These plastic bonds have been in service on the lines of the Denver City Tramway Company and the Rochester Railway Company for nine years, and it is stated that they are in as good condition now as when first installed.

Mica.—A report on mica, its occurrence, exploitation, and uses has been issued by the Mines Branch of the Department of the Interior (Canada). This monograph has been prepared from data and general information collected by Mr. Fritz Cirkel. The object of the inquiry was to prepare a synopsis of all that is known from a practical point of view on the subject, and to stimulate a spirit of inquiry that will lead to the development of the large mica fields in Canada, to a wider search for the mineral, and to the development of those varieties of mica which at present possess but little commercial value. The report first sets out the different species of mica, and then proceeds to describe their chemical and physical properties. The distribution of mica over the globe is very general. As a mineral of commercial value, occurring as deposits of crystals of large size, which split up easily into fine merchantable sheets, mica is found only in three countries—British India, United States, and Canada—and it is with the industry of the latter country that the report is primarily concerned. The Canadian amber variety is most extensively used for electrical insulation. The most valuable property of Canadian mica is its non-conductivity; its market value is based on its freedom from streaks and iron stains. The relamination as effected in micanite is said to improve the insulating power of the mineral. The insulating power of mica is superior to that of any other substance applicable to armatures. Of special advantages are its evenly laminated structure, which permits its ready intercalation between the copper pole-pieces of the commutator, and its hardness, which prevents it wearing away too rapidly under the action of the brushes. High temperatures have no effect upon mica, nor does colour seriously affect its utility in electrical machinery, but the presence of magnetite inclusions affecting its insulating qualities renders it useless for this purpose. In comparison with East Indian mica, the Canadian product seems to hold its own, and a phlogopite which was sent to England for testing purposes was favourably reported upon both for its general physical and chemical properties and commercial value. The report describes mica mining in many countries, contains an abstract of the mining laws of Quebec, together with a useful bibliography and index.

Electric Lighting and Power Legislation.—In view of the fact that the life of the present Parliament has been for a long time past generally surmised as uncertain, promoters have shown considerable boldness in giving notice of proposals for electric lighting and traction schemes to be brought before the forthcoming session. The number of Bills for tramways and electric railways of which notice was given last month was the same as in the preceding year—viz., 51—which is much smaller than usual. As regards London underground railway Bills, promoters seem to have abandoned their original intentions, for there is quite a number of applications for modification of powers and extension of times; while, on the other hand, only in two cases are powers sought for constructing new lines. One is the scheme for an electric railway from Hammersmith to the city of London, which is again revived, this time in enlarged form, for it is intended to construct a spur line from the main line to Bermondsey, and a spur from the main line at Haymarket to a junction with the authorised North-West London line at Edgware-road. The other scheme proposes the construction of an outer circle railway for London north of the Thames, which will connect the outlying suburbs in Middlesex and Essex. The proposal for tramways over the bridges has more likelihood of being successful now that the London County Council and the City Corporation are working together for the purpose of securing this object. Of the tramway schemes in England and Scotland generally, there is little which calls for special notice, excepting the Edinburgh Corporation's Bill, which seeks to electrify the tramways. Hitherto cable and horse tramways have held the field, but the Corporation will probably supersede these with a surface-contact system. The æsthetic tastes of the citizens have evidently not yet become reconciled to overhead wires. In the domain of Power Bills the chief interest will be centred in the attempt to capture the metropolitan area. The large number of competitive Bills points to the probability of failure in Parliament coming to a decision before the end of the session. We have already given the names of the companies who are promoting Bills, but the Administrative County of London and District Electric Power Company, whose effort to get their Bill through last year just failed at the eleventh hour, are again in the field, and will meet in the Additional Electrical Power Supply Company and the London County Council doughty antagonists. Outside of the London area the proposed Bills are not numerous, and principally seek for powers of extension.

Trade in 1905.—We have been favoured with an advance proof of Messrs. Bolling and Lowe's trade review for 1905, which is one of the first to be issued, and among the information imparted is something of interest to electrical engineers. The iron and steel trades of the Midlands and the North display great strength. As the year advanced, considerable impetus was given to them by the growing demands of shipbuilders and the requirements

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of the bridge-building and structural industries. These demands were so pressing in the early autumn that prices rapidly advanced; although, singularly enough, "marked bars" did not move till November, when they rose to £8. 10s. per ton, whilst ordinary had advanced weeks before. On the Continent similar conditions prevailed. It is estimated that the British steel output will show an increase of 1,000,000 tons over last year, largely due to decreased imports. Exports here and there increased largely over 1904. In the copper market the production is increasing heavily, but not sufficiently to keep pace with the consumption. Users hold very small stocks, and the large producing mines are sold out months ahead, and are at their wits' end for metal for near delivery. A period of actual scarcity seems to have been entered upon, a scarcity which can only be accentuated if the auguries pointing to a general revival in trade prove correct. In the pig iron speculative market there was a severe squeeze in the early part of the year, which drove up prices of No. 3 Cleveland by May 14 to 55s., this price being maintained till May 19, when all the open accounts were squared off, and the cash price immediately collapsed to 45s. In July and August strong speculative buying, based upon improved reports from the home trade and abroad, initiated a fresh movement. Since then, however, the purchasing has been more or less scattered, while the attacks directed against the market have been concentrated. Which side will finally prevail cannot be estimated with any pretence to correctness at present, but ultimately improving trade must rise superior to merely temporary speculative movements. In October, hematite reached 73s. 9d, the highest figure for years. In 1902 3 the highest was 62s, and in 1904 57s. Many holders were so sanguine of higher prices that they spoke of waiting for 75s. to 80s. Much of the rise was due to speculation, but the chief demand came from the abnormal requirements of the iron and steel industries. American buying helped the situation materially. Stocks in stores are large, and this must be remembered in gauging the position. The following figures show the increases in the production in tons: Great Britain—1904, 8,563,000; 1905 (estimated), 9,500,000; increase, 1,000,000. United States—1904, 16,497,033; 1905, 22,900,000; +6,400,000. Germany—1904, 10,055,000; 1905, 10,500,000; +500,000. In September, 1904, 324 blast furnaces were working against 348 at present.

Canadian Society of Civil Engineers—In a paper read last month before the electrical section of this society, Mr. R. B. Owens gave a description of an electric accelerometer. He said the advent of the electric motor as a competitor of the steam-engine, especially in the traction field, had given rise to certain acceleration problems unfamiliar to engineers of a generation ago. At a time when the train mile was a satisfactory unit in which to reckon haulage costs, there was little occasion to bother with acceleration. Now, however, when neither the train mile, car mile, nor ton mile suffice, even when coupled with a speed factor as a basis of estimation and analysis, and when to maintain certain schedules more energy is expended in accelerating than in overcoming frictional and grade resistances, a simple, accurate, and reliable means of measuring acceleration is urgently demanded—a means at least comparable in simplicity and accuracy to those employed in the measuring of the quantities of which it is the second and first differential with respect to time. The measurement of length is familiar to all. Of practical methods of measuring velocity or speed, at least of machines, one of the most satisfactory, if not the most satisfactory, involves the use of a suitable constantly excited or permanent magnet dynamo mechanically driven by the piece whose velocity is to be measured, and electrically connected through an ammeter to a circuit of constant coefficients as shown in Fig. 1. S is the shaft whose velocity is to be measured; C is a mechanical coupler; A is the armature of a small permanent magnet or constantly excited continuous-current dynamo wound so as to have a negligible reaction within the limits of its use; R is a variable non-inductive resistance; and I is a zero centre direct-current ammeter. The reading of I will be proportional to the speed of S, and by adjusting R can be calibrated in the revolution per minute, feet per second, or miles per hour as desired. As the current through I is proportional to speed, it is only necessary to determine the rate at which the current varies in order to have a measure of acceleration. This is simply and easily done by inserting

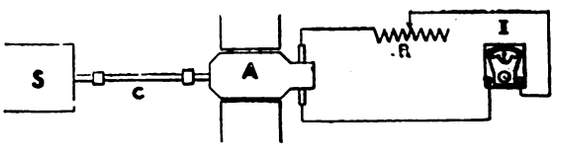

FIG. 1.

in the circuit with I a transformer, T, with its secondary connected, for purposes of adjustment, through a non-inductive resistance, R_1, to a zero centre direct-current voltmeter, V (see Fig. 2). The reading of the voltmeter, V, will then be proportional to the acceleration, positive or negative, of the shaft, S. Substituting recording instruments for the indicating ones shown, we have a recording speed indicator and a recording accelerometer. The transformer must have a straight line saturation curve and a large transformation ratio, as the secondary induced voltage is necessarily small, and the voltmeter, V, must also be sensitive. The calibration of the ammeter as a speed indicator is effected by driving the armature, A, at different constant speeds as shown by ammeter reading, and taking the revolutions in a given time by means of a revolution counter and stop watch. The calibration of the voltmeter as an accelerometer is best done by driving the armature, A, by a separately and constantly excited motor having applied to its armature, preferably of small momentum, a voltage varying approximately as a linear function of time.

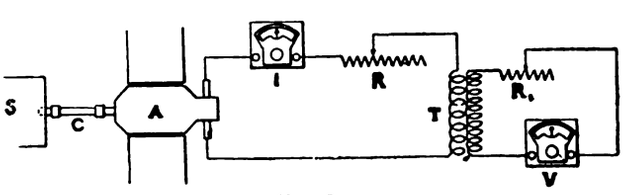

FIG. 2.

With proper manipulation of apparatus the ammeter readings plotted against time will be a straight line whose slope will be constant and equal to the acceleration and to the constant reading of the voltmeter to within a constant. In some tests made by Mr. Owen in his laboratory not long ago, A (Fig. 2) was the armature of a small low-voltage, separately excited direct-current generator; S, the shaft of a 3-h.p. separately excited direct-current motor, to whose armature by a potentiometer arrangement a steadily increasing or decreasing voltage could be applied; I and V, Weston ammeter and millivoltmeter, and T a small lighting transformer with a transformation ratio of 20; and excellent results were obtained, speed and acceleration being read to exactly the same degree of accuracy that Weston direct-current ammeters and voltmeters are capable of. With recording instruments substituted, this would seem to meet every requirement of a practical apparatus for the measurement and recording of velocity and acceleration in railway work, both steam and electric, and is applicable, of course, in many other connections.

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THE STUBAI VALLEY RAILWAY.

This line was the first to be equipped for working with single-phase alternating current of high tension and frequency ($42\frac{1}{2}$). It has now been in operation some 16 months, and having regard to the decision of the L.B. and S C. Railway Company to adopt the same system, a description by Egon E. Seefehlner in our esteemed contemporary *Elektrische Bahnen u. Betriebe* is singularly opportune and interesting, more especially so in that the results of the 16 months' working are available. We are assured at the outset that both the system itself as well as the special arrangements involved have proved eminently satisfactory.

General.

The Stubai Valley Railway was first thought of many years ago, at a time when there was no practical alternative to steam working—a fact to which must be attributed the tardy fruition of the scheme. No very glowing prospect could be painted for a railway undertaking which would necessarily entail heavy capital outlay and working expenses, bearing in mind that the residential population of the valley is only 50,000, while the annual visitors to Innsbrück and neighbourhood average about 100,000. These figures constituted the sole basis for calculation, and it was early recognised that the tourist element would furnish the bulk of the passengers obtainable. Had it been a question of deciding simply which system would best meet the requirements of a traffic varying greatly in density over a given

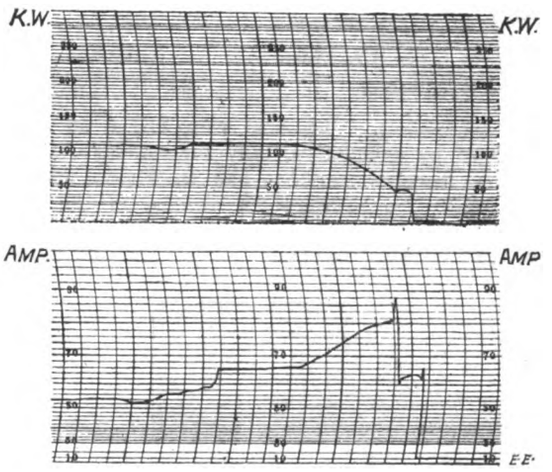

FIG. 1.—Curves for the Output and Starting Current, Stubai Valley Railway.

period, steam working would have held strong claims, but there were objections to this which could not be overlooked. It was necessary in the commercial interests of the undertaking to make the line as attractive as possible to purely pleasure seekers. Due to Tyrol's poverty in coal, steam working would also have been very expensive. The prospects of the scheme, however, at once improved when in 1902 the erection of electricity works was decided upon by the municipality of Innsbrück, in order to utilise the water power of the River Sill, and the town showed practical interest in the realisation of the railway project by making an offer to supply the necessary current for working it on favourable terms. It was then that capital was forthcoming and a start could be made with the work of construction. It was at first proposed to use continuous current, conveying it at a pressure of 600 volts to the trains by means of a third rail, in accordance with the established practice of the day. The construction of the track was commenced in the spring of 1903, the work of fixing the conductor rails and laying the feeder cables, etc., being planned for the following year. In the meantime, however, the well-known experiments with alternating current took place on the Spindlersfelde Railway. Now, the conditions obtaining in regard to the Stubai Valley project were such as promised great advantages from the direct employment of high-tension alternating current.

The direct use of single-phase alternating current of high frequency made it possible to dispense with a lot of transforming apparatus, which is both costly to purchase and to subsequently maintain. The money thus economised—the capital outlay being limited—could, it was recognised, be advantageously added to the sum set apart for rolling-stock. Thus, in place of the two-axled motorcars provided for, bogie cars could be obtained, thereby increasing the comfort of the passenger. The limited amount available for electrical equipment precluded from the outset the provision of a battery of accumulators, and in determining the size of the conductor rail the permissible minimum had to be approached. Continuous-current working in these circumstances would, therefore, have scarcely given the elasticity demanded by the character of the traffic. It would not have enabled the system to be temporarily overloaded to any required extent. On the other hand, the alternative method of direct working with high-tension alternating current enabled this requirement to be met. The overload capacity of the static transformers between the power station and conductor rail is

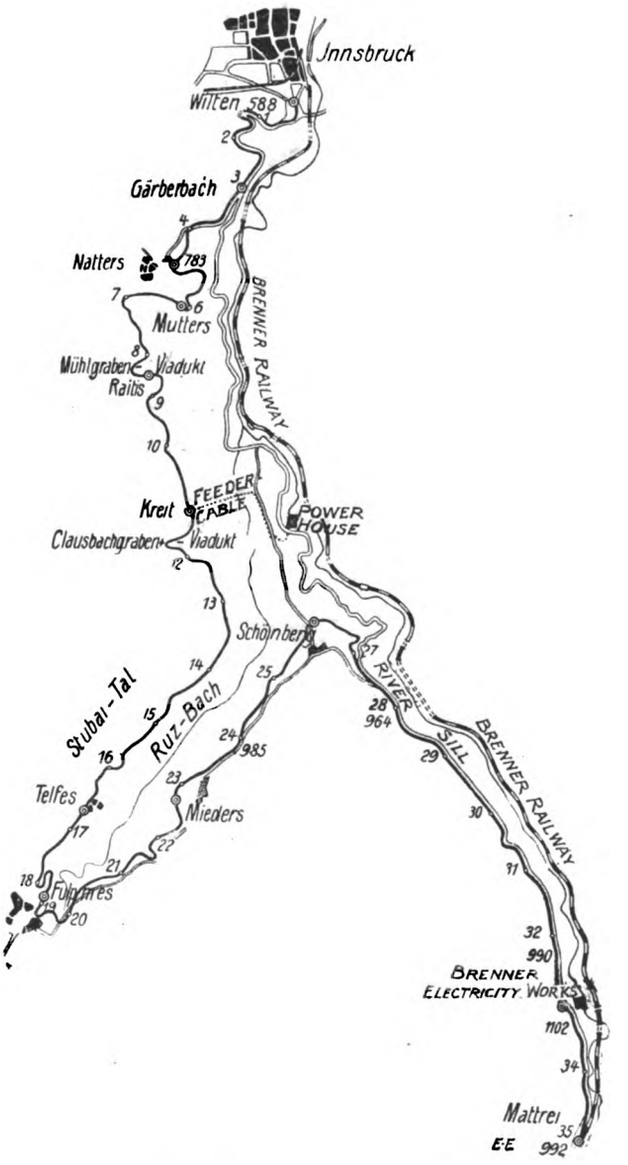

FIG. 2.—Map showing Route of the Stubai Valley Railway.

unlimited, in so far as it is confined to increased traffic during certain hours of the day. Moreover, by fixing the line tension sufficiently high, the ohmic loss in the line could also be kept within the permissible limits, even in extreme cases, without extra cost. Thus double trains may be dispatched, if required, with impunity.

There is no doubt that these advantages may also be obtained by adopting a polyphase system, but not to the same extent. Polyphase induction motors do not admit of speed control, and there is consequently no choice but to drive at the one fixed speed, thereby increasing the maximum demand so that the overload capacity of the plant is reached sooner than with the Winter-Eichberg alternating-current system of the Allgemeine Elektricitäts-Gesellschaft, which admits of the speed being reduced as

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may be necessary. In the case of polyphase systems the starting currents are also much more serious than with the alternating-current system of the Allgemeine Elektricitäts-Gesellschaft. This is apparent from the curve (Fig. 1) showing the energy consumed during the starting period. The watt consumption commences at a low value, and rises gradually to the value corresponding to the tractive effort without acceleration, whereas in the case of polyphase current at the moment of starting there is a sudden rush of current, and the watt consumption sinks slowly to the level needed for the tractive effort. The employment of cascade connections to minimise this difficulty would seem to be out of the question here, since the room available on narrow-gauge rolling-stock is scarcely sufficient for the four motors which are necessary. These considerations alone justified the adoption of single-phase alternating current. The double trolley line for polyphase current would have involved greater cost—apart from any consideration of the disadvantages and complications of having duplicate collectors. Besides, the latter would have been unreliable and the maintenance cost very high on a railway possessing so many sharp curves. Indeed, champions of the polyphase system argue that the cost of doubling the trolley line is insignificant when compared with the total expenditure on electrical equipment. But this view holds, as may be easily proved by calculation, only for railways on which there is a frequent service—five to fifteen minutes—when, in fact, the rolling-stock represents the greater part of the capital outlay. Railways of this character do not, as a rule, however, serve such an extended area as to call for the use of high-tension polyphase current. Nor could the absence of commutators in the case of polyphase motors, bearing in mind all other points, turn the scale against the adoption of single-phase alternating current, since the construction of reliable and efficient commutator motors for alternating current now presents no difficulties.

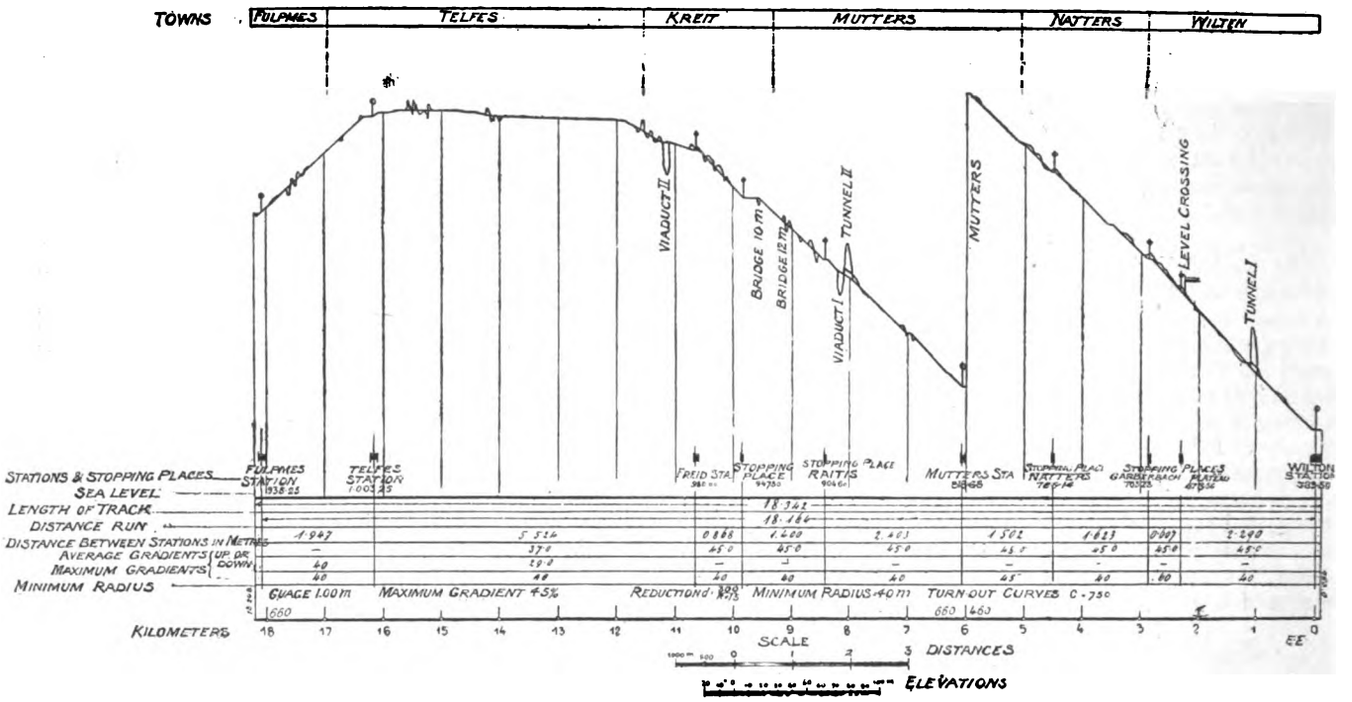

FIG. 3.—Diagram showing the Gradients, Stubai Valley Railway.

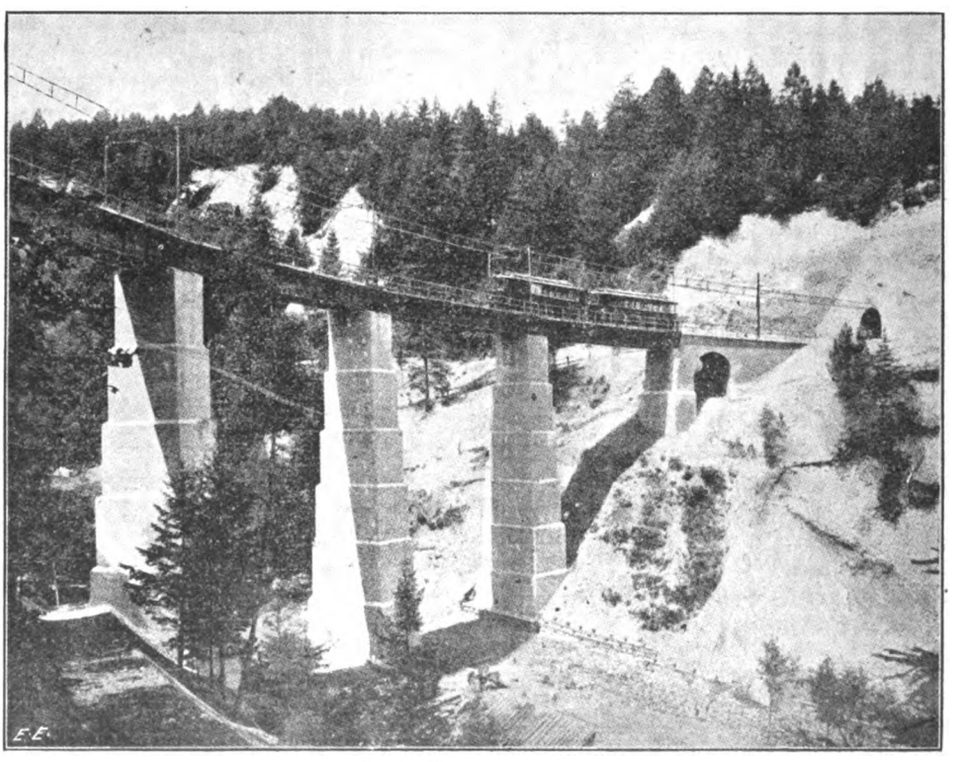

FIG. 4.—Viaduct at Mutters.

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Technical Description.

The Stubai Valley Railway lies between Innsbrück, the capital of Tyrol, and Fulpmes, a small manufacturing town. It has a length of 11·4 miles, and taps five places *en route* (see the map, Fig. 2). The accompanying diagram (Fig. 3) shows the gradients over three different sections of the track. There is a rise of 280ft. over the first 6·75 miles, the next three miles being practically level track, while the last section falls about 217ft. to Fulpmes. The highest altitude reached lies at 3,300ft. above sea-level. The heaviest gradient is 4·6 per cent, and the curves have a minimum radius of 130ft. Two tunnels and a like number of viaducts occur. One of the latter is shown in Fig. 4. The gauge is 1m. (3·28ft.), and is on private ground. It is provided with rails of Vignoles section, weighing 36lb. per yard.

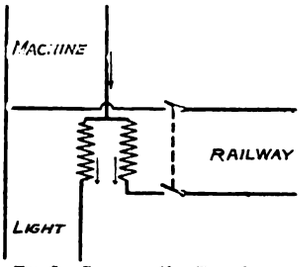

Fig. 5.—Compensating Transformer.

Provision is made for housing and overhauling the cars at Wilten, where repairs are also executed. The car-shed at Wilten has two rail tracks, and is 180ft. long. A further shed with accommodation for two cars is provided at Fulpmes. As has been mentioned in the foregoing, the railway is supplied with current from electricity works on the River Sill belonging to the Innsbrück Corporation. This current is conveyed overhead for a distance of about 1·9 miles at a voltage of 10,000 (see Fig. 2). The feeder cable consists of two wires, each having a sectional area of 50 square millimetres. Two-phase alternating current is generated, and provision is made for taking the supply from either phase. It is noteworthy that the traction current is furnished by the same machines which take the lighting load. On this account the conditions by which

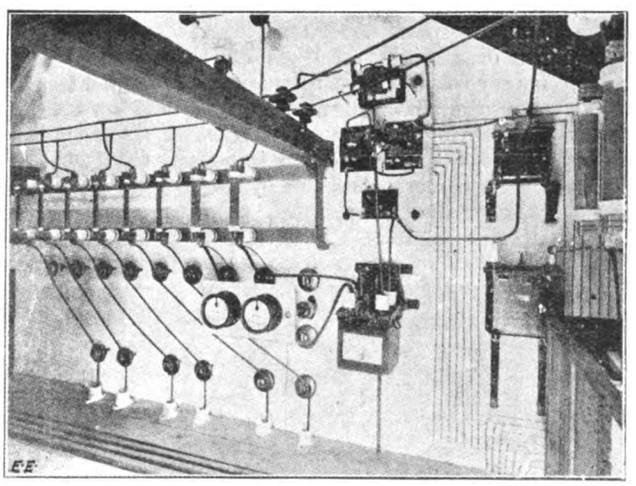

Fig. 6.—Interior of the Kreit Transformer Station.

the railway company are bound in regard to the fluctuations of their demand have been made very stringent, with the object of preventing unnecessary disturbances of the lighting supply. These disturbances are counteracted by means of a transformer, one winding of which is in series with the traction feeder cable and the other in series with the lighting supply (Fig. 5). A sudden demand from the railway thus boosts the lighting supply to compensate for the drop in the alternator. This compensation for the potential drop is most successful. The main 10,000-volt transmission line terminates at the Kreit distributing centre (Fig. 6). The primary current is conveyed from this centre by wires (two in each direction) of 25 square millimetres sectional area to the transformer stations. With the exception of a short length, the primary conductor is carried on the trolley masts. Porcelain insulators are used for its suspension. These are brown glazed, and, notwithstanding heavy snowfalls and unfavourable atmospheric conditions generally, have stood extremely well. During 14 months' working not a single failure occurred over the whole 10 miles of primary conductor due to failure of the porcelain insulators. At the distributing centre and feeding points the pressure is reduced to 2,500 volts. Two 75-kw. transformers (Fig. 7) are installed in each of the three transformer stations, a third unit being held in reserve. The three transformer stations are connected in parallel through the trolley wire and rails. Two of these stations suffice for the present needs of the service, the third having been erected in view of future developments. The transformers themselves are immersed in oil and require no attendance, the whole of the distributing system being supervised from the Kreit centre. The fuses at the different feeding points, which can be readily disconnected both from the 10,000 and the 2,500 volt sides, are so proportioned that they blow only on prolonged short-circuits. In the event of

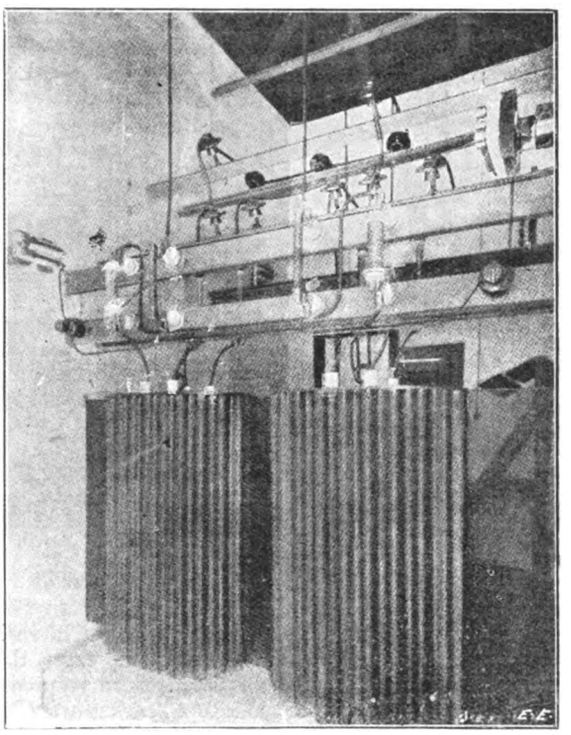

Fig. 7.—Two 75-kw. Units in Transformer Station.

line troubles, the automatic oil switches at the distributing centre are first to act. Hereupon the attention of the attendant is attracted by an alarum which is actuated by the automatic switches. According to the telephone message received, meanwhile the supply to the line may be wholly or partly restored. The necessary arrangements are so simple that one man suffices to look after the whole. Hence the supervision of the current supply to the line costs the company next to nothing. The connections are shown diagrammatically in Fig. 8.

The trolley line consists of a single hard-drawn copper wire of 53 square millimetres sectional area, fed with current at a mean pressure of 2,500 volts. This high working potential involves special precautions in order to secure mechanical reliability and ensure good insulation. Even when hard-drawn, copper is an inferior material so far as tensile strength is concerned, and having regard to the great differences of temperature experienced in the Stubai Valley, it would have been dangerous to have adopted the method of suspension commonly used for tramways. True, this meets requirements for low-tension systems, but, nevertheless, the inherent defect is there, that it subjects the trolley wire itself to a severe mechanical strain. The method of suspension adopted on the Stubai Valley Railway resembles that employed on the Spindlersfelde line, support being given to the trolley wire at intervals of 13ft. At these intervals it is suspended from a steel wire of 5mm. diameter by means of vertical wires.

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Any desired amount of sag can be given to the steel wire, and in this case it is so adjusted to the unequal intervals between the trolley masts that with 20deg. C. of cold there is a maximum strain of 440lb. The longest clear span is 160ft., while the tensile strength of the steel wire is 155lb. per square millimetre, whence it follows that at the weakest spot there is still a factor of safety of 7, quite apart from the supplementary strength lent by the trolley wire (see Fig. 9). This supporting wire—always in the vertical plane above the trolley line—is attached to high-tension porcelain insulators by means of cast-iron caps, these insulators being cemented to bolts, which are secured in turn by means of clips to U-shaped iron bracket arms. In order to further improve the insulation of the supporting wire, globe strain insulators are inserted, one on either side of each point of suspension, at a distance of about 2·3ft. from same. Should one of the high-tension insulators break, the insulation is, therefore, still maintained. Porcelain insulation is used throughout, being superior to every other material both in regard to surface leakage and durability. Due to the careful design of the insulators, the arrangement adopted has also proved equal to all mechanical requirements.

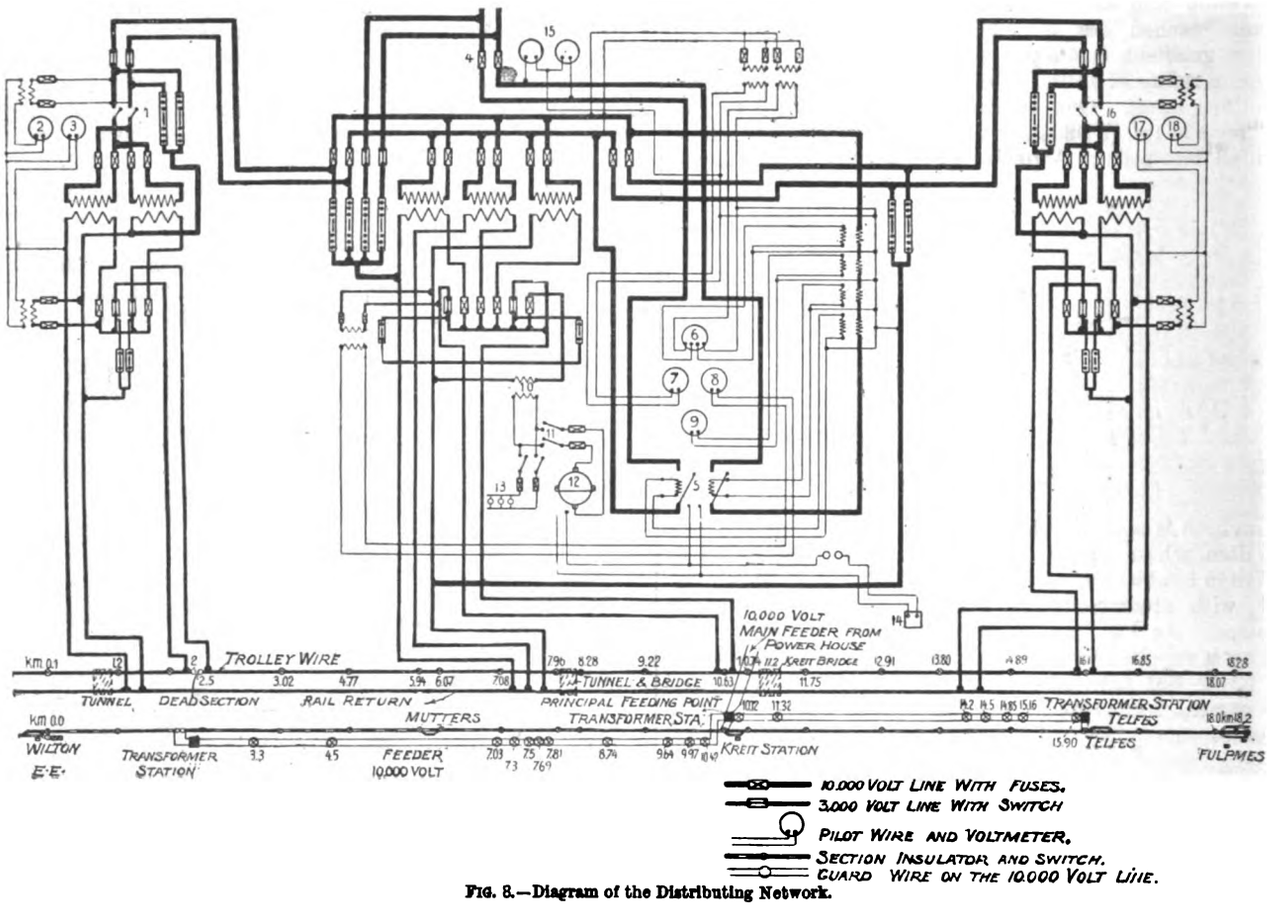

FIG. 8.—Diagram of the Distributing Network.

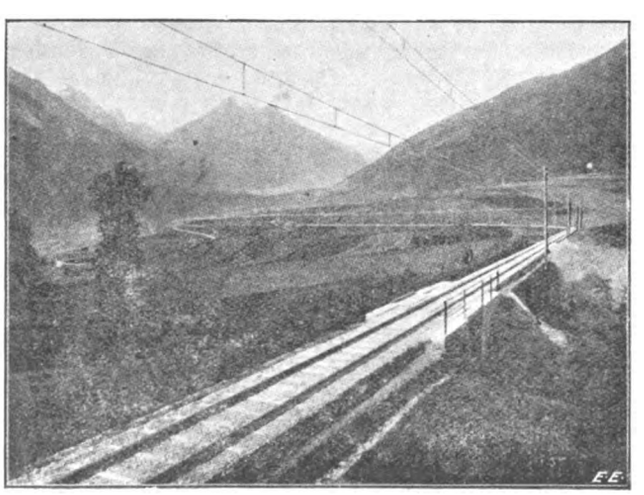

FIG. 9.—A Straight Run.

The vertical wires depending from the principal carrier are attached to the trolley wire by means of special terminals of extremely light and simple construction. Bow collectors are used on the motorcars, and the trolley wire forms a continuous conductor of ample elasticity in all directions, which, thanks to the method of suspension, presents no sharp obstructions to the passage of the bow over its contact surface, thus ensuring continuous sparkless collection even at the maximum permissible speed. At curves—indeed, the number of straight stretches on the Stubai Valley Railway is very small—the construction shown in Figs. 10 and 11 is adopted, similar insulators being used for the tie wires as for securing the principal carrier, as also at points and anchors. Span girder construction (Fig. 12) is employed where more than one track is laid, since the distance between the tracks is too small to admit of the erection of centre masts.

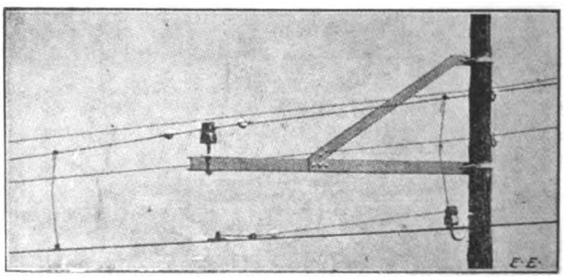

FIG. 10.—Arrangement of Tie-Wire on Curve.

It will be seen that rigid suspension has been rigorously avoided. An exception occurs in the case of two tunnels *en route*, in which the available headway did not admit of the same degree of elasticity being obtained (see Fig. 13). The individual points of suspension consist here of an ear and steel bolt cemented into a porcelain insulator, the latter being provided with an iron cap, which is screwed to a cross carrier. In the open the trolley wire is fixed at a height of 18ft. above the rail heads, and in the tunnels 13ft. Hence there is a difference in level amounting to 5ft, so that the bow collector lies almost in a horizontal position in the tunnels.

At intervals of five-eighths of a mile, at both sides of each

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station, and at the approaches to the termini, section insulators and section switches are provided in the trolley line. The former each consists of four high-tension porcelain insulators fixed into an iron frame, double insulation being provided. The arrangement is such that contact between the bow and insulators is impossible. At the

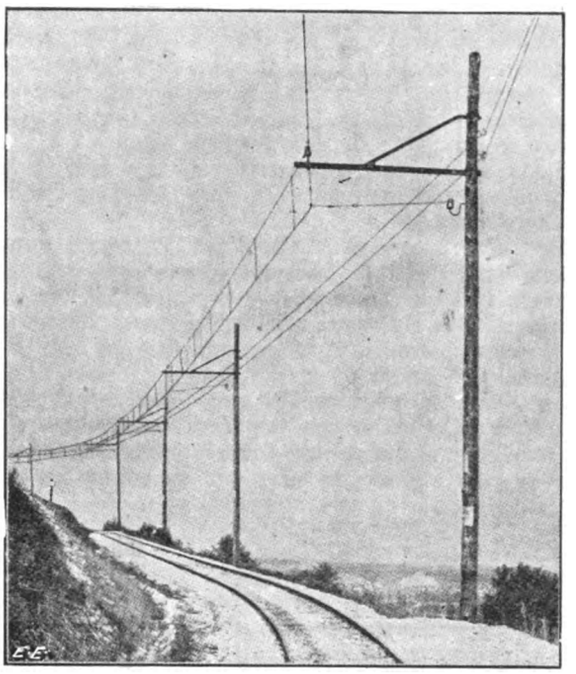

FIG. 11.—Overhead Construction on Curve.

same time provision is made at these points for taking up sag and anchoring the conductor.

Following are the approximate quantities of materials used: 9·5 tons of copper for the trolley line, 3·5 tons of steel wire, 28 tons of wrought-iron bracket arms, and 6 95 tons of copper for the feeders. The value of these materials is £2,000 in round figures. Had the polyphase system been adopted, an additional sum of

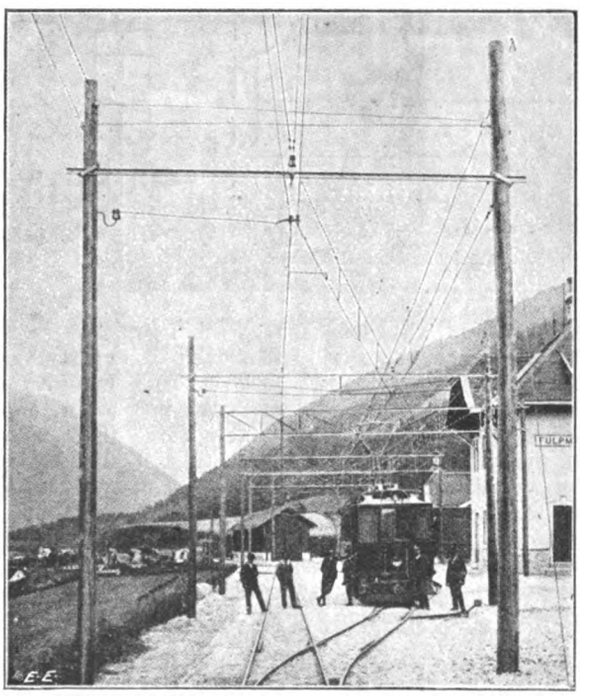

FIG. 12.—Span Construction over Double and Treble Tracks.

£760 would have been required for trolley wire alone. For the third-rail system 34 truck loads of steel, representing a value of roughly £3,200, would have been necessary. Hence there is undoubtedly a gain in favour of the high-tension system so far at least as the cost of the distribution work is concerned.

The track rails serve as a return conductor. They are polished at the joints, as likewise the fishplates, and coated with a metal paste which prevents oxidation of the contact surfaces. The removal of some of the fishplates after 14 months' wear showed that the surfaces thus treated were still thoroughly clean. The absence of copper rail bonds has proved very advantageous, since the maintenance

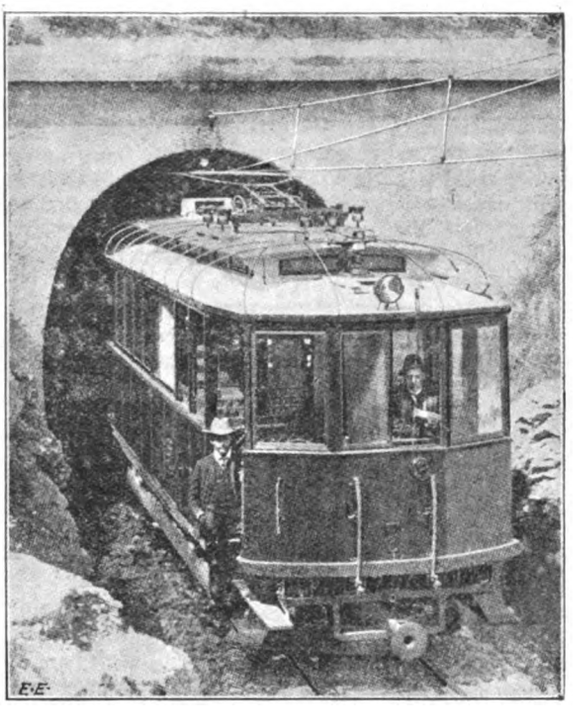

FIG. 13.—Overhead Construction at Tunnel Entrance.

of the rail return involves no special attention. The simple act of tightening up fishplate bolts which may have become slightly loose restores good electrical continuity—as long as the joints are tight the return is all right. But the impedance of the track per kilometre is nevertheless considerable, due to the light rails employed, the great distance between these rails and the trolley wire, and the high frequency (42 periods per second) of the current. In fact, numerous measurements, which coincide with the estimated figure, show it to be about 0·9 ohm.

(To be continued.)

TRAMWAY PRACTICE IN AMERICA.

London County Council Report.

The following is an abstract of an excellent report prepared by Mr. A. L. C. Fell, the chief officer of the London County Council tramways, on his visit to America in May last year. During his stay in America Mr. Fell visited New York, Washington, Pittsburg, Toronto, Niagara, Buffalo, Boston, Albany, and Schenectady, and inspected the various tramway undertakings. In the course of his inspection he found that the officials of the street railway companies and of the large manufacturing concerns placed every facility in his way for acquiring the valuable information presented in his report. The general impression gathered by Mr. Fell with regard to the tramway problem in the States was that American engineers and their financial supporters are much more inclined to take the view that where there is a main road out of a city, or a possibility of conecting two cities, there should be a street railway to develop the district. In many instances the undertakings do not prove a financial success for some years, but the country is being developed so rapidly that the risk is only a small one when the ultimate results are taken into consideration. The greatest incentive to the rapid development of street railways is the fact that on the interurban lines the speed is in the majority of cases unlimited, and in several instances he travelled at a speed of 50 miles an hour on tracks laid at one side of the road with perfect safety, so that with the cheap fares, high speeds, and rapid acceleration possible with electric traction, people with very moderate means are able to live a con-

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siderable distance from the centres of the cities where they work. In most of the smaller cities the trackwork is of the cheapest possible character, and apparently this is all that is required until the undertaking is in a position to instal the work in a more permanent manner. It does not, however, follow that the track in important cities is satisfactorily maintained. The condition of the paving in some of the cities which he visited is disgraceful, and would not be tolerated in this country. This point should be taken into consideration when comparing the operating costs with those of similar undertakings in London.

In view of the fact that the London system is the conduit one, special attention is paid by the author to the work in New York and Washington carried out by this system. The details of the Washington conduit are shown

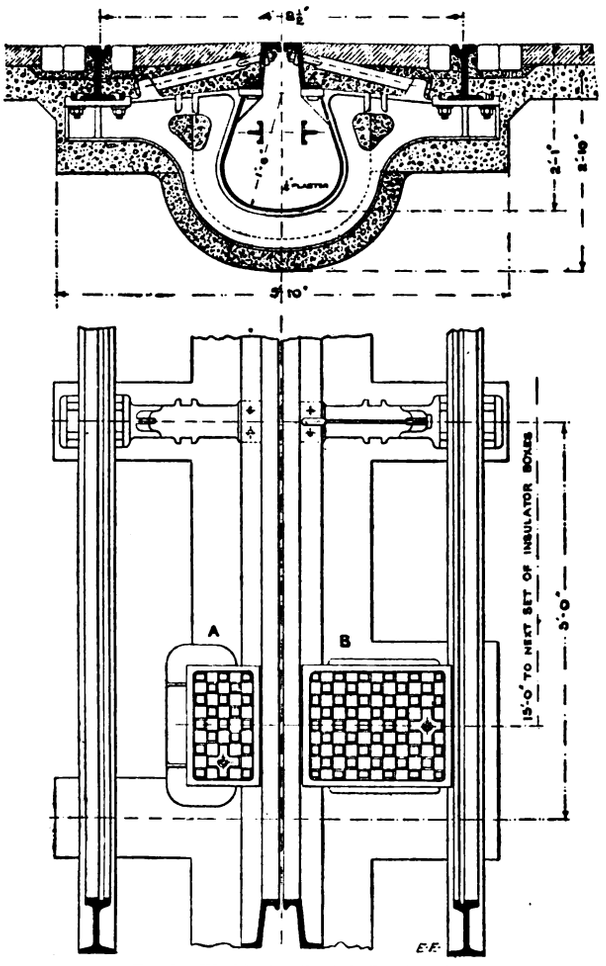

FIG. 1.—Washington Conduit Construction.

in Fig. 1. There are two companies operating in Washington, one using the trolley and the other the conduit system. The changing over from one system to the other is carried out in a pit under the track, where a man is employed to remove and replace the ploughs, the conductors on the cars attending to the trolleys. The time taken in changing from one system to the other is very short, but the pit is a dangerous obstruction in the roadway; it is covered by a folding iron trap-door, but this is left open when the man is in the pit. In a very busy thoroughfare it would be necessary to keep men constantly in the pits, and special arrangements would have to be made so that the trap-door over a pit would not be open unless covered by a car. The opinion is expressed that this arrangement is not so advantageous as the plough-lifting device used at Streatham. One very special feature in connection with the construction of the conduit lines in Washington is that a large manhole is placed every 31½ft. along the track, and the mud or dirt in the conduit is collected by an insulated hand scraper made to fit the bottom of the conduit. It is then removed with hoes or scoops through these manholes without difficulty. In London the sump pits and manholes are 40 yards apart, so that if there is an accumulation of mud or dirt in the bottom of the conduit it is practically impossible to push this along at one operation to the nearest sump pit, as the dirt builds up in the conduit and is liable to short-circuit the conductor tees, and trouble is caused by mud being splashed up on the insulators. In Washington the mud and refuse have to be pushed such a short distance that no trouble is experienced. No water is used in Washington for cleaning when the dirt in the conduit is comparatively dry, but the difference in the working conditions is emphasised by the fact that the conduit is only cleaned out about once in six months, whereas in London this has to be cleaned every few days. The method of arranging the intermediate manholes is shown on Fig. 1, at B Mr. Fell advises that the cost of cleaning in London could be reduced if more frequent manholes were provided.

The trolley tramways in New York, Pittsburg, Toronto, Buffalo, Boston, and the through system between Albany, Schenectady, and Troy, were viewed by Mr. Fell, and are described in his report with well prepared illustrations. We are most interested at the present time with Mr. Fell's conclusions on points of detail than on descriptions of systems. For instance, on the great question of conduit ploughs, those in use on the New York street railways are of a much lighter design than those in use on the Council's tramways, but a great deal more care has been taken in the

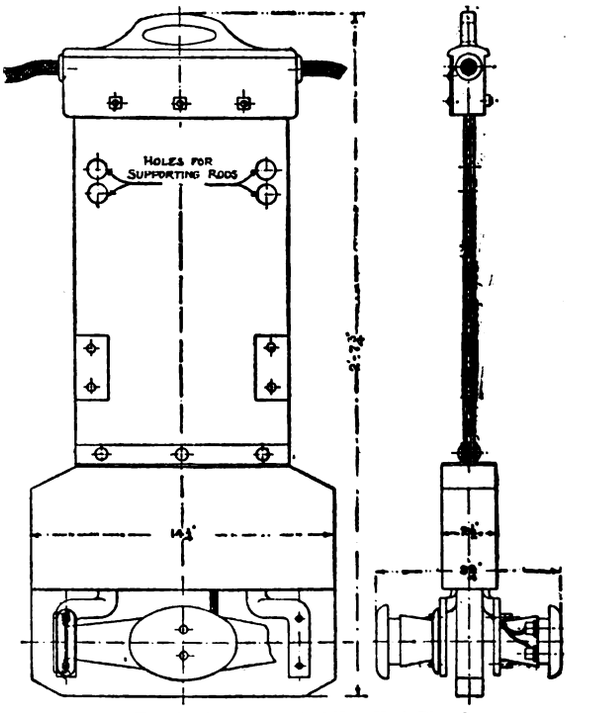

FIG. 2.—Arrangement of New York Plough.

construction of the ploughs in Washington than in New York, and apparently much less trouble is experienced in the former city. It must, however, be taken into consideration that the climatic conditions in Washington are much more favourable than in New York. Figs. 2 and 3 give particulars of these ploughs. Fig. 4 illustrates the latest type of plough on the Council's tramways. In New York the type of plough in operation is very cheap, and the question of repairs is reduced to a minimum. If any defect develops in the wooden base of the plough, it is simply scrapped, and apparently, from the size of the scrap heap, troubles in this direction are not infrequent. Apart from the base troubles, the blade of the plough frequently becomes twisted when passing through special work. Mr. Fell thinks this is chiefly due to the fact that the ploughs are mounted on two parallel round rods, which run through holes drilled in the plough blade. There is very little clearance in these holes, so that unless the plough is at right angles to the supporting rods it will not travel freely sideways, and if by accident the plough takes the wrong road at a junction it becomes jambed. With the ploughs in use in Washington and on the Council's tramways this is not possible, as the ploughs are free to drop out of the supporting frame. In Washington, as all the conduits are laid in the centre of the tracks, it is only necessary to have

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a supporting guide about 12in. long. In London, however, the supporting guides have to run the full width of the truck, as the conduit in the interlacing line at Greenwich, and also in all the car-sheds, is run close to one of the track rails. The ploughs on both the systems in Washington are substantially built, and every endeavour has been made to keep the moisture out of the base. The chief fault, however, is that the bases are made of wood, as was the case with the ploughs originally supplied for the Council's tramways, but as there is practically no mud in Washington, very little trouble is experienced with these ploughs burning out, and it is not found necessary to dip the wooden base in any compound, such as was required in London with the wooden ploughs, and which has to be extensively used on the ploughs in Paris. The Washington ploughs in their present state would not run more than a few days in wet weather in London. The engineers in both New York and Washington admit that there is room for improvement in their ploughs. Mr. Fell thinks that it would reduce their cost of upkeep appreciably if they adopted the Council's hard base rubber plough, which gives most satisfactory results in all weathers. After a careful examination of the ploughs obtained during his visit, Mr. Fell is of opinion that it would be false economy to sub-

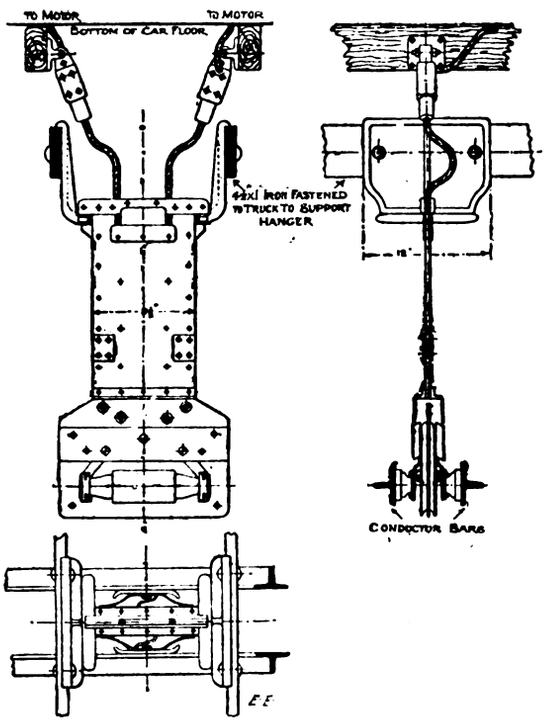

FIG. 3.—Arrangement of Washington Plough.

stitute a cheaper form of plough for that now in use in London, as so much depends on the proper working of the plough. A cheap plough will not only be an expensive item with regard to upkeep, but it may cause serious delays in the traffic, and heavy loss would be entailed.

As regards motors, there is in America a tendency to increase the horse-power and to employ motors ranging from 40 h.p. up to 75 h.p. each. The result is more rapid acceleration, and the resistance and controlling devices are so well arranged that full speed is attained in a very short distance without unduly jerking the car when starting. Many new features have been recently introduced into the design of the tramway motors which Mr. Fell is introducing into the specification for new cars now to be issued for the London system. Steel wheels are rapidly superseding chilled iron wheels in the States, due evidently not only to greater safety at high speeds, but to fewer flats being developed, which enables the car to keep in service for a much longer time before the wheels are taken out to be cleaned. At Buffalo steel wheels have been found to run on an average 35,000 miles before needing to be turned up.

As regards brakes, Mr. Fell found that on the majority of the lines inspected air brakes are in use. Electromagnetic track brakes have been largely superseded by air brakes, as it was found that the additional strains thrown on the motors greatly increased the cost of upkeep and decreased their life. He adds that the most recent types of electric magnetic brakes used in this country have not yet been tested in the States. In Toronto he noticed a type of brake called the momentum brake, which is made of steel and malleable iron, and weighs about 260lb. It comprises a friction disc formed on a sleeve which is keyed to the car axle, a second friction disc sliding longitudinally, with a feather key on the sleeve, in a flanged drum journaled on the sleeve between the friction discs. On this drum is wound a chain which is connected with the brake levers. On the sides of the drum annular friction surfaces of compressed wood fibre are fixed which engage the two steel discs. There are suitable mudguards attached to the drum flanges for the purpose of keeping grit from the friction surfaces. On the end of the sleeve is screwed an adjustable bevel-sided nut, and the hub of the movable disc is similarly bevelled, which forms a V-shaped groove with which the taper wedge wheels may be engaged to force the friction discs and drum into contact. The wedge wheels are supported from a suspension bar which is fastened to the car truck. There is also a connecting rod from the live wedge wheel lever to the brake mast, so that by turning the brake mast a quarter of a turn it will engage the wedge wheels with the nut and movable disc, and force the latter against the drum, which will be thus engaged between the friction discs and caused to rotate, thereby winding up the brake chain and applying

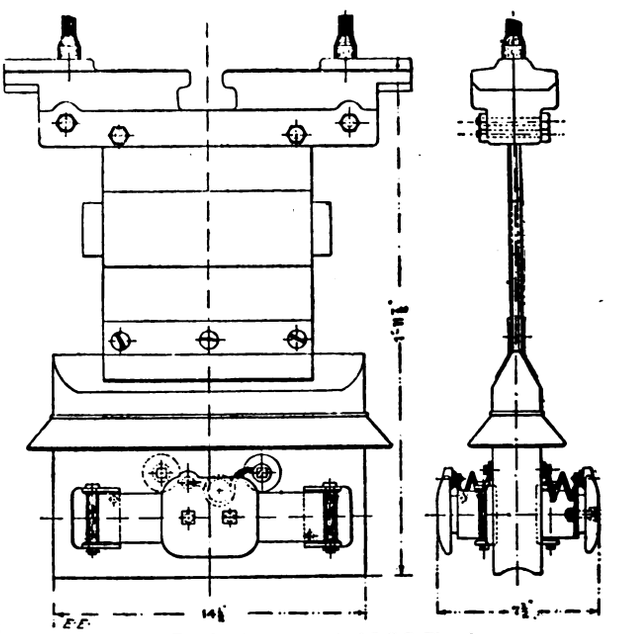

FIG. 4.—Arrangement of L.C.C. Plough.

the shoes to the wheels in the usual manner. To release the brake, the motorman simply places the brake mast handle back to the position in which it was in before application. This type is to be tried on a car in London.

As regards permanent way, extended yokes are used both in Washington and New York, as are shown in Fig. 1. These facilitate the replacement of rails when they have to be renewed. On the vexed question of junctions between tramway rails and paving, they seem to be not so far in the States as we are in this country. Certain cases are mentioned where the whole of the line work is in a very bad condition. Fig. 5 shows a section of the rail used in New York. Electric welding has proved very successful in Buffalo, where 32 joints have been made on the Lorain system. They have been in use since 1899 with only 1 per cent. of breakages. In Cleveland joints are now welded by the Thermit process. The question of rail corrugation is one that requires very serious consideration both in this country and in America, and unless the trouble is promptly dealt with serious damage will be done to the equipments and trucks, and the rails will have to be renewed before they are worn out. In this country corrugation has appeared on the rails of nearly every electric tramway system, the corrugations varying in length from 2½in. to 5in., the worst corrugations appearing at curves where

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a short wave is formed on the outer rail and a long wave on the inner rail. The corrugation at first appears on the outer rail. Corrugation gave great trouble shortly after the cable tramways started running on the Brixton section,

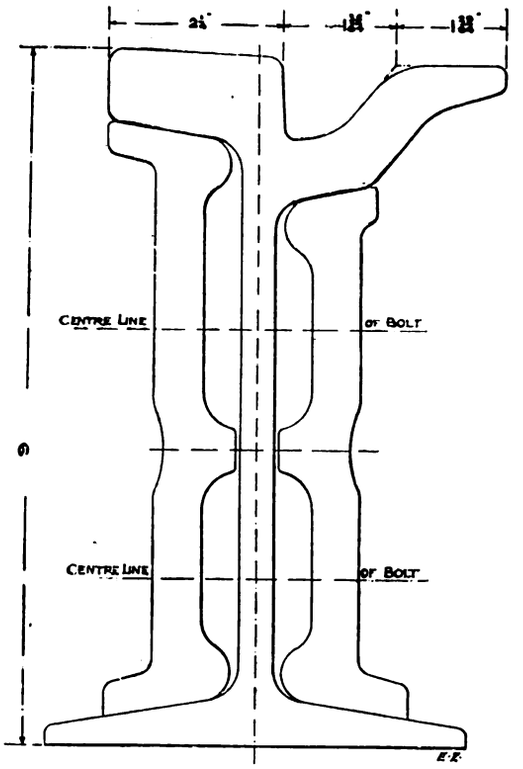
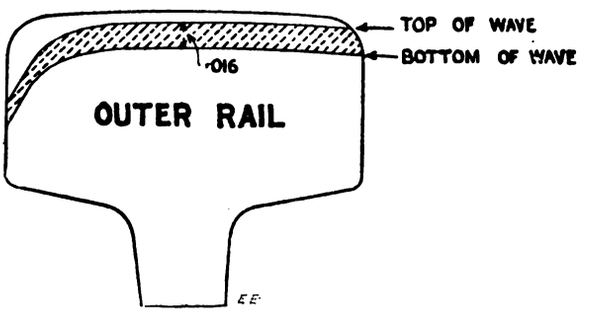
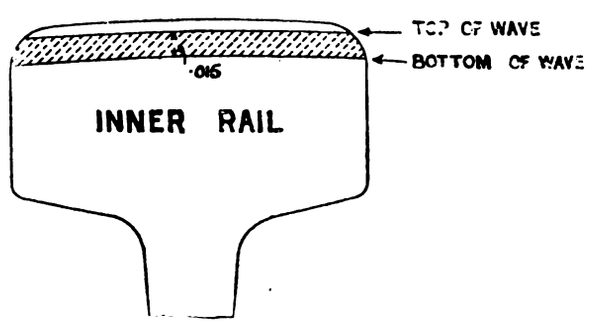


FIG. 5.—Section of Rail, New York.

but in this case it was found that the corrugation at the curves started on the inner rail, and was transmitted to the outer rail, and the long corrugation was on the outer rail, and not on the inner rail. No corrugation has been noticed on the rails used for horse traction, but it has



Sketch showing depth of wave or corrugation on the outer rail of Rollins Street curve, south bound. Radius 1,000ft., super-elevation 4in., gauge 4ft. 8¼in. Speed of trains about 25 miles per hour. Average length of wave 2ft. 7½in. Length of service 365 days.



Sketch showing depth of wave or corrugation on the inner rail of Rollins Street curve, south bound. Radius 1,000ft., super-elevation 4in., gauge 4ft. 8¼in. Speed of trains about 25 miles per hour. Average length of wave 2ft. 6 7/8 in. Length of service 365 days.

FIG. 6.

appeared on steam-driven tramways, but never on steam railways. In every city visited in America, except Buffalo, corrugation was to be found in a more or less marked degree. Apparently the higher the speed the greater the length of the corrugation wave. On several of the inter-urban lines the cars are run at speeds of from 20 to 30 miles per hour, and the corrugation in some instances was as much as 8in. long. On the Boston elevated railway, where the cars are run at upwards of 40 miles per hour, the corrugation was no less than 31in. long. Fig. 6 gives the actual dimensions of one of the corrugations inspected. The trouble on this line is so serious that the rails have to be renewed every few months.

Before going to America Mr. Fell had for a considerable time been engaged in investigating this matter, and formed the theory that the trouble was originally caused by unevenness on the rail surface setting up a slight jumping or bounding action in the car wheels. He considers that the unevenness might be due to three causes: (1) chattering or vibration of the rollers when commencing to roll the ingot into a rail, causing a rough rail surface: (2) uneven or wide joints between rail ends rigidly supported on a concrete bed; (3) jumping action set up in car wheels by variations on the wheel or track gauge. To ascertain if his first theory was correct, he made some tests in the New Cross car-shed before the rails had been used in any way by the cars. A long emery block, fitted under a truck, was run lightly over several lengths of track, and a distinct corrugation was noticeable on the rail surface, although in some instances it was not very regular in form. About nine months ago he had a water tank car fitted up with a grinding apparatus, consisting of a carborundum block, 10in. long by 2½in. wide, which could be pressed down on to the running rails. By this means some of the worst corrugations were ground out, and have not yet reappeared. The corrugation of the rails is becoming somewhat serious on all the sections, but additional grinding apparatus is being fitted on the new water tank cars which will shortly be delivered, and he hopes to be able to grind out the waves. No attempt has been made hitherto in America to get rid of the trouble in the manner now suggested. With new rails arrangements should be made, if possible, for passing them through a grinding machine after rolling; the corrugations are so slight that very little would have to be done to prevent the trouble developing in a serious manner at a later date.

There then follows a large section of the report devoted to the use of steam-turbines in generating stations providing energy for tramways. This subject has been so frequently dealt with in our columns that we do not propose to give more than Mr. Fell's advice that turbines should be used when completing the second half of the Greenwich generating station. This would contain 5,000-kw. turbines instead of four 3 500 kw. reciprocating engines. The single-phase system of traction is also dealt with in the report, and some figures given which were obtained by the General Electric Company on the Ballston line. These figures (reproduced herewith) give a comparison between the direct-current and alternating-current single-phase system over the same length of track.

—	Direct-current line.		Alternating-current single-phase line.
Length of run	1·6 miles	...	1·6 miles
Weight of car	31·55 tons	...	31·55 tons
Time	180 seconds	...	180 seconds
Average current power	229 amperes	...	346 amperes
Average voltage	606	...	425
Kilovolt-amperes full speed on level	98	...	110
Volt-ampere-hours per ton-mile of given run	86·3	...	125·5
Average speed	32 m.p.h.	...	32 m.p.h.
Schedule speed, including 15 sec. stops	29 5	...	29·5

The car operated on this line is equipped with compensated motors and weighs 30·4 tons total without passengers, and is geared for a maximum speed of about 43 miles per hour on the level. The car has a 32ft. body, is 43ft. over all, and has a seating capacity of 44 passengers. The body is mounted upon trucks having 6ft. wheel base, each truck carrying two compensated motors, each motor equivalent to a 75-h.p. direct-current motor, standard railway rating.

In conclusion, Mr. Fell states: "In the foregoing report I have only briefly dealt with a few of the innumerable matters of interest brought to my notice during my short stay in America, but the information which I gained will, I feel certain, be of the greatest service when considering the future developments of the London tramways. I cannot close this report without acknowledging the valuable aid

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which I received from the general managers and engineers of the systems which I inspected in the various cities, and the officials of the General Electric Company and the Westinghouse Company."

OUTER DARKNESS, OR WHAT MIGHT HAVE BEEN.

BY THE WORM.

I was out of a job. I often am. Now I don't mind being out of work, as a rule, but I found running light was so very inefficient that I decided to go on load again. So I decided to look round for what is euphemistically known as a "situation." I prefer to call it "a fix," so I searched the "Fixes Vacant" columns; but though I have hitherto been able to get into a fix fast enough, yet in this case I wasn't in it, so to speak. At last I struck the following:

TAFFYSHIRE COUNTY ASYLUM.—Wanted, at once at the above asylum, an assistant engineer (mechanical and electrical experience essential). Applicants with institution experience and a knowledge of music preferred. Wages, 30s. per week.

"That's me!" said I. "Institution experience and a knowledge of music. I attended all the meetings of the I.E.E. for two years. There's the institution experience, and I'll play them anything they like on a piano, from "Bill Bailey" to Chopin's "Funeral March" in five flats, which ought to suit 'em. It's as good as got."

So, being close to the asylum, I decided to apply personally. I didn't like the look of the front door—it had a gaoly look—so I hunted round and found a small side door, at which I knocked. It was opened with amazing suddenness by a very short, fat man. He was dressed in grey and wore knickerbockers. He was just a broad smile embodied. His "fair round belly" (quotation), his dimpling, clean-shaven face, his sleek, curved hair, all seemed to smile; and when he moved, his plump calves simply shook with laughter.

"Good morning!" he said, with pleasant dignity. "In what way may I serve you?"

"I've called about the assistant engineer's appointment. 'Knowledge of music and institution experience preferred,' you know."

"Ah, yes. I've been expecting you." And he led the way into a large drawing-room, at one end of which was a grand piano.

"Pray be seated. You will understand that executive musical ability is of great importance in an organisation of this kind. The soothing and refreshing effect of sweet music on an overworked brain cannot be too strongly emphasised. Kindly oblige me by playing a selection—something in the lighter vein"—and opening the piano, he waved me to the stool. I sat down and plunged into that popular cake-walk, "Down South." I heard behind me a series of bumps, and, on turning my head, discovered him capering around with amazing agility. He hopped and skipped and jumped and pirouetted, advanced and retired, set to partners with himself, and always came in on the beat with a vigorous nod of his head. This finished, he smilingly resumed his dignity as I would put on my hat, and proceeded, "In a matter of this kind it is essential that I should know something of your social position. What class of society do you move in?"

I was about to reply when a tall, pale lady dressed in white drifted in. She was carrying some pieces of celery and the top of a cauliflower. He bent gracefully over her extended hand, and made inquiries about her health. Then turning to me he said, "Allow me to present the mayoress, my wife. I'm the mayor, of course" ("And corporation,' I said to myself, admiring his rotundity) I bowed, and murmured my felicity with one eye on the door.

"My dear," she said to him, "how often must I tell you I'm not your wife and not the mayoress." Turning to me she continued, smiling, "I'm Ophelia and he's Hamlet."

"I'm not Hamlet," he said, looking red and angry.

"Oh, how can you say so? Why, I saw you this morning with your stockings down." And, ignoring his snort of indignation, she turned to me and handed me a piece of celery.

"There's rosemary for remembrance." I bowed again, this time with both eyes on the door. "Now play me something weird, and I'll go mad for you."

"But, madam," I expostulated, "why should you?"

"Why shouldn't I?" she replied, surprised.

Just then a man in uniform came in, and, finding what I had come for, he conducted me to an office, leaving my two friends arguing as to who was who. The next man I interviewed was not nearly so pleasant. He had a cold, fishy eye, and was sarcastic. He inquired my business. I stated my qualifications, adding that I reckoned my own demagnetising smile would bring down the voltage of any high-pressure lunatic he liked to trot out. He received my remarks with obvious incredulity, requested me to send in my application by letter, and advised me to avoid the neighbourhood of lunatic asylums in future, unless I wanted to commit mental suicide. I came out by the front door, directed by the man in uniform. I'm still out of a job. But I've got my rosemary, and I remember.

FORTHCOMING EVENTS.

SATURDAY, DEC. 30.

Robertson Social Club.—At 7.30 p.m., dance.

Royal Institution of Great Britain.—At 3 p.m., "Astronomy," by Prof. H. H. Turner.

TUESDAY, JAN. 2.

Royal Institution of Great Britain.—At 3 p.m., "Astronomy," by Prof. H. H. Turner.

THURSDAY, JAN. 4.

Royal Institution of Great Britain.—At 3 p.m., "Astronomy," by Prof. H. H. Turner.

Rontgen Society.—At 8.15 p.m., "The Present Position of Radio-Activity," by Prof. F. Soddy, M.A. (presidential address).

SATURDAY, JAN. 6.

Royal Institution of Great Britain.—At 3 p.m., "Astronomy," by Prof. H. H. Turner.

Institution of Electrical Engineers (Manchester Local Section).—Students' visit to Chloride Electric Storage Co.'s works.

Institution of Civil Engineers.—Jan. 9, at 8 p.m., papers.

Royal Institution of Great Britain.—Jan. 9, at 3 p.m., "Astronomy," by Prof. H. H. Turner.

Association of Engineers-in-Charge.—Jan. 10, at 8 p.m., "Storage Batteries," by Mr. F. Crewster.

Liverpool Engineering Society.—Jan. 10, at 8 p.m., "Some Economic Aspects of Electric Power Supply," by Mr. H. W. Wilson.

Institution of Electrical Engineers (Manchester Local Section—Students' Section).—Jan. 12 at 7.30 p.m., "The Electrical Equipment of Automobiles," by Mr. J. C. Ward.

Institution of Civil Engineers.—Jan. 12, at 8 p.m., students' meeting "The Theory of Machines," by Prof. J. D. Cormack.

APPOINTMENTS VACANT.

Draughtsman. Apply to G A 5, *Electrical Engineer* Office. See advertisement.

Premium Pupil, City Electrical Engineer, Carlisle. See advertisement in last issue.

Junior Technical Assistant, Northampton Institute. Applications by Jan 8. See advertisement.

Draughtsman, Manchester electrical engineering works. Apply, Box 519, General Post Office, Manchester. See advertisement.

Sales and Assistant Manager, electrical manufacturing and contracting company. Applications to 5,722, *The Electrical Review*, 4, Ludgate-hill, London, E.C. See advertisement in last issue.

Mechanical Engineer (with electrical experience), Southend Corporation Electricity Works. Commencing weekly salary of £2. 10s., rising by annual increments of 5s. per week to a maximum of £3.

Station Superintendent and Mains Superintendent, Calcutta Electric Supply Corporation. Salary for each appointment, Rs.450, Rs.500, and Rs.550 per mensem for each year respectively. Applications by noon on Jan. 3 to Calcutta Electric Supply Corporation, Salisbury House, London-wall, London, E.C. See advertisement.

Lecture.—On Monday Councillor J. A. Turnbull delivered an address on "Borough Electrical Undertakings," under the auspices of the Amalgamated Society of Engineers (Woolwich 4th Branch), at the Engineers' Institute, Glyndon-road.

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TO CORRESPONDENTS.

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TO ALL OUR READERS—

A Happy, Healthy, and Prosperous Year.

NATURAL v. ARTIFICIAL.

Another year in the history of the electrical era has ended, and the era may be said to have reached its twenty-fifth birthday, if we place the date of its birth in the year 1880. Two years previously—that is, in 1878—the International Exhibition of Paris turned attention to the possibilities of electricity, and in 1880, as was shown at the exhibition, also at Paris in 1881, one of the most important problems had been solved. The perfecting and the extension of electrical engineering has gone on with giant strides from then till now. Twenty-five years—a quarter of a century—and yet some of those who were in the forefront of the battle have gone to their rest, have joined that silent band, and passed to the bourne from whence no traveller returns. The history of almost every great departure is hid in obscurity. Those who have taken a practical hand in the earlier stages seldom or never leave a connected narrative of their actual labours; hence the historian has from disconnected data to make as good a guess at actualities as he can. Some, as we say, have gone, but others, and probably the more important workers, are still among us. Might we venture to urge them in some shape or other to compile and make public the exact steps due to them in the inauguration of a new and seemingly almost boundless industry. If we remember aright, it was Froude in one of his essays who discussed the probability of the truth of any one of the stories of history, and who pointed out the great difficulty of getting at the real truth of any one incident that happened in the street at any particular time of a day. Ten people who saw the incident would tell ten different accounts, each with different details. Is there a single departure that has been made in electrical engineering that is credited to the right man or men? We know of but one in which we could truthfully say to that man, and that man alone, was this new departure due—and this in the twentieth century, when reading, writing, and printing are as common as stones on the road. We do not wish to rake up old troubles, but are there two men living who can with any degree of accuracy tell us the exact position of Edison and Swan in the realm of incandescent lighting? That is but one of a score of questions, each more obscure than the other, where the aim is exact truth. Some years ago we tried to ascertain certain phases in the evolution of cable work, but no one seemed to know anything about the matter. References were to be found in the literature of the forties, but the few of these early workers living in the nineties had forgotten or never knew the exact truth about the incident to which reference was made. Ought we not at this stage of the world's history to be able to state with certainty the "who" and the "what"?

Has the ordinary man ever considered that each successive advance in civilisation brings with it new dangers, in that the advance is usually contrary to Nature's requirements. Sanitary engineers are continually fighting the insanitary conditions arising from concentrated population. The doctors have for years been preaching the dangers of the modern strenuous life. The manual worker has decreased his hours of labour and, if we may venture to say so, his daily and annual output. The strenuous life does not appeal to him, except he happens to be on piecework. It is upon the heads of departments and the principals of the undertaking that the trouble falls, and with them mental

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and nervous diseases are increasing. Every fad and fashion seems to give rise to a special physical trouble. Not for the first time, but very forcibly, a writer in the *Times* of Dec. 26 directs attention to the "telephone in business." With the exception of the last paragraph of his letter we have no fault to find, but to that we give an absolute and emphatic denial. While objecting to that paragraph we must also protest against the position the *Times* takes in matters telephonic. Its articles hardly appear to be unbiassed, and seem to be from interested sources. Our appreciation of the great merits of the *Times*, of its unique position, of its evident desire to put the truth to its readers, renders it necessary that we should speak thus strongly. Dealing with this matter first, our information is from scientific men well versed in all electrical matters yet not engaged directly in telephonic enterprise, and these do not corroborate in the slightest the dictum of the *Times* correspondent or the *Times* leading article, which seems to adopt its correspondent's words, that the "British system . . . is . . . immeasurably inferior to that of all American cities."

We do agree with the view that a business man may be "completely broken down from strain and worry" because of the "constant strain of the telephone," and we do agree with the view in the *Times* leader, "that the evils . . . may be largely mitigated, if not entirely overcome, by a combination of efficiency with good sense and good manners." The introduction of the telephone meant for many men an attempt to add to their mental and nervous work more than their system could bear. They did not and many will not realise that flesh and nerves are incapable of unlimited use, or, indeed, of too much overstrain in a given amount of time; hence, if they persist in saying yea, nature steps in and says nay. One great want of the early years of the twentieth century is the realisation that physical powers are limited, and that the introduction of devices that require the physical energy to be used up at an accelerating rate must be met, in order to enjoy physical robustness, by a determination not to constantly attempt to carry an overload.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."*

THE COST OF POWER.

SIR,—I wish to call your attention to some figures which appear in the last number (Nov. 25) of *Science Abstracts* in the electrical engineering section. Abstract 1,575 gives a report on a paper read before an American electrical association by C. H. Hile. In a table apparently drawn up by the abstractor the cost of power in kilowatt-hours on the Boston Elevated Railway is given amongst other figures. The abstractor gives the average cost as 0·00778 cents = 0·00389d. per kilowatt-hour. To the minds of Englishmen all American figures are more or less open to suspicion, and none more than this. I strongly suspect that the word "cents," which is repeated, should be replaced by "dollars," giving the cost as ·778 cents = ·389d. As I believe the railway is direct current, the above cost is even then very low, and I can think of no other reason for these remarkable figures.—Yours, etc.,

ERNEST P. HOLLIS.

RE ANSWER TO QUESTION No 820.

SIR,—I thank Mr. E R. Alexander for his reply to my letter, in which he explains his argument very clearly.

I have to admit that he is perfectly correct in his argument, but it only holds within infinitesimal limits. It is quite true that two motors taking the same current at same voltage may give the same brake horse-power with their power factors differing from one another by quite an infinitesimal amount. The difference in such a case will be counterbalanced by the difference in all-round efficiency which will be caused by differences of iron and friction losses.

But the current varies inversely as the power factor, and, therefore, the ohmic losses vary inversely as the square of the power factor. As soon as the power factors differ by an appreciable amount, the ohmic losses in the motor with the lower power factor will quickly overwhelm the slight advantage of efficiency in the matter of iron and friction losses.

I would further say that it is decidedly in the consumer's interest to have a high power factor, as this means a smaller machine for a given output with given pressure and current. If a man wants a certain power, he must pay for the current required for that power and for the current used up in the ohmic losses. And this latter current varies *inversely* as the *square* of the power factor of the motor.—Yours, etc.,

P. WEIL.

THE PRODUCTION OF A DISINFECTANT (HYPOCHLORITE OF SODIUM) BY ELECTROLYSIS.

In an article on the above subject by Mr. C. V. Biggs, which appeared in our issue of Dec. 22, the author referred to the report for Maidenhead, made by Prof. Robinson, as having been made by Dr. Robinson. Of course, most of our readers will be aware that these experiments have been made by Prof. Henry Robinson, of Parliament Mansions, Victoria-street, Westminster, S.W., but as many of them are interested in the question of sterilising of fluids, we hasten to point out this small inaccuracy in order to save inquirers time and trouble.

MUNICIPAL ELECTRICAL WORK AT TURIN.*

As had been foreseen, the general vote in Turin has been given in favour of the municipalisation of the electrical works. The committee appointed to promote the matter presented a most favourable and promising report accompanied with flattering rhetoric on the future of the city, the support of the poor, and the necessity of waging war against greedy speculators. The same proposal advanced in its true aspect with correct proportions probably would not have found an equal consensus of approval; we are, therefore, proposing to look into it. We do not know how the matter may finish, as the technical advisers of the municipality are beginning to shift their responsibility, and some of those who voted in favour of the principle involved reserve the right of voting on either side in regard to financial points or on unforeseen details which they may consider it necessary to criticise.

The history of this undertaking commences with the purchase by the municipality for a figure above £13,000 of a good fall of water, the utilisation of which had been sanctioned by the Government. The waterfall is located at Chiomonte, in the valley of the Dora Riparia; its effective height is 1,050ft., and the volume of water about 880 gallons per second, so that something like 17,000 h.p is theoretically available. Against this fact the opponents to the project state that they have made independent measurements of the water during the driest times, and have found that a quantity of only 585 gallons per second was passing.

The definite scheme for the canal has been worked out by Engineer E. Perini, and the line for it was established after careful consideration of the nature of the ground to be traversed; it is partly in open cutting and partly in tunnel. The material of the locality will be used throughout in its construction. The greatest care in the design has been given to the intake to avoid damage from heavy rocks and stones being washed into it at the time of the torrent caused by the rapid melting of the snow on the adjacent

* *Elettricità*, Milan, Nov. 17, 1905.

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mountains. The length of the canal from the intake to the turbine-house will be a little more than five miles, with a uniform gradient of 2 per 1,000. The width varies from 5ft. 3in. to 6ft., and the maximum depth for the water from 3ft. 9in to 4ft. 3in. There are in all eight tunnels having a total length of 4,500 yards, the shortest tunnel being 36 yards and the longest 1,740 yards; in five cases aqueducts will be constructed to carry the canal over rivers or streams. From the head-race two tubes are taken to the turbine-house, each of 3ft. 7in. internal diameter, with length of about 700 yards. For commercial and technical reasons the upper lengths of 270 yards are constructed of riveted sheets of thickness varying from $\frac{3}{16}$in. to $\frac{1}{2}$in., whilst the lower portions of the tubes are constructed of welded steel varying in thickness from $\frac{15}{32}$in. to $\frac{7}{8}$in. The upper part is anchored to the surrounding earth, and the lower portion is firmly supported by a masonry construction. The intermediate lengths rest on the rock-bed, supported at the joints, which are constructed with flanges and rings. The turbine-house is constructed on the left side of the River Dora, the total superficial area being 760 square yards; the floor is constructed above the maximum height that can possibly be attained by the river. The actual difference in level of the head-race and tail-race is 1,062ft.; an allowance of 12ft. is made for the pipe friction, leaving a net fall of 1,050ft., with a volume of 880 gallons per second. Taking the efficiency of the turbines at 75 per cent. there will be 12,800 h.p. available on the shafts of the hydraulic motors, which may be reduced in times of greatest scarcity of water to 8 500 h.p.

The most important machinery at the generating works will consist of seven turbo-generators, each 2,300 h.p., the three-phase alternators working at 4,000 volts and 50 periods; three other turbines, each of 200 h.p., coupled directly to exciters; seven transformers to raise the pressure to 40,000 volts; a comprehensive distributing switchboard and other accessories, including an overhead traveller for erecting or dismounting the machinery. The electrical energy will be transmitted to Turin, a distance of 37½ miles, by means of a double set of conductors carried on iron poles. The distributing centre will be established in the north-west district of the city, and will contain seven transformers, with necessary accessories, to reduce the tension to 3,000 volts.

It is intended to put down some steam plant in connection with this distributing centre, to be used in case of necessity when there is insufficient water to meet the requirements of the supply; the capacity of the steam plant will be determined at a later period. For the present a steam-turbine coupled direct to an alternator of 1,500 kw. will be put down.

The network in the city will consist of underground cables with auxiliary overhead conductors to distribute the energy to various points where large motors are required. At various points sub-stations are to be constructed from which local distribution will be effected. Taking account of the whole of the losses in the turbines, alternators, transformers, lines, etc., there results available energy of 8,000 h.p. at the consumers' premises, which may be reduced to 5,000 h.p. under the least favourable circumstances when the services of the steam-turbine would be required.

The estimates put before the municipality as a result of careful examination of the problem give the following results converted to English pounds: hydraulic works, £103,400; machinery at the generating station, £41,300; high-tension lines between Chiomonte and Turin, together with a telephone line, £39,600; distributing centre in Turin, £34 500; sub stations and distributing network, £128,000; purchase of concession, £13 200—total, £360,000. This estimate, however, is accompanied with the statement that the actual work will be carried out for somewhat smaller figures than the above. The estimate of working expenses, taking account of all the costs that may be introduced, are given at £42,500 per annum, equivalent to £5. 6s. per horse-power per annum, for the 8,000 h.p. available at Turin; or again, reckoning that 14 lamps of 16 c.p. can be lighted per horse-power, the cost works out at about 8s. per 16-c.p. lamp per annum.

The assertion is made that the future of Turin is essentially industrial; the small and medium-size industrial works have increased during the recent years at the rate of 500 h.p. per annum, and there is no reason to suppose that this rate of progress will cease, but rather that, by reducing the price of energy, it will be accelerated. At the present time the cost of energy per horse power per annum at Turin is put at £13. 10s. to £10, so that it may be said that the municipal project will reduce the cost by one half.

PLUMBISM DUE TO ELECTROLYSIS*

BY BALDWIN LATHAM, M.I.C.E., M.I.M.E., F.G.S., ETC.

There has recently occurred in the district of the South Hants Waterworks Company a case of lead-poisoning arising from the use of the company's water in a cottage on the Twyford Lodge estate at Twyford, Hants. The water supplied by the South Hants Waterworks Company is procured from wells in the chalk, one of their pumping stations being located at Timsbury, near Romsey, while the second pumping station is located at Twyford, about three-quarters of a mile from the place where the case of lead-poisoning has occurred. The water from both places is softened before being supplied to the public. The district in which lead was discovered in the water draws its supply from the Twyford pumping station, the waters of which are taken from a well and are softened with lime by the Haines' method. The waters are noted for their remarkable purity for chalk water, and are softened down to 4deg. or 5deg. of hardness before being passed into the mains of the district. The analysis of the water at Twyford, both before and after treatment, before the discovery of the lead in the water supply is given in Table A.

TABLE A.—Analysis of Twyford Water by Messrs. G. H. Ogston and Moore before and after Softening.

—	Well water. 4/9/1905. Grains per gallon.	Well water. 7/10/1905. Grains per gallon.	Softened water. 4/9/1905. Grains per gallon.	Softened water. 7/10/1905. Grains per gallon.
Total solids	19 81	19·46	11·34	10·50
Chlorine	1 00	1·00	1·00	1 00
Sulphuric acid	·38	·33	·36	·38
Nitric acid	1·08	1 08	1·08	1·08
Lime	7·56	7 42	3·15	2·66
Magnesia	·40	·35	·42	·40
Total hardness	13·16	12 83	5 20	4·70
Permanent hardness	3·00	3·00	3 00	2 90
	Parts per million.	Parts per million.	Parts per million.	Parts per million.
Free ammonia	nil	nil	nil	nil
Albuminoid ammonia	trace	·005	·005	·008
Appearance	bright	bright	bright	bright

A letter bearing date Oct. 11, 1906, was sent to the secretary of the South Hants Waterworks Company by Dr. G. A. E. Roberts, of Twyford, the medical officer of health of the New Winchester Rural District Council, pointing out that in a sample of water taken from a cottage at Twyford there was a considerable trace of lead. He pointed out that the pipe, which was a ¾in. lead service, was rather long, but he said that he did not think that the water supplied by the South Hants Company had any solvent action upon lead, and asked Mr. Burnett, the secretary, if they knew of a similar case, and if he could account for it in any way, and he went on to state that an inmate of a cottage at the end of this lead service pipe was suffering from lead-poisoning. He said he had tested several samples of water from the cottage, and that there were traces of lead in it, even after a considerable quantity of water was drawn.

On Oct. 16 a piece cut out of the service pipe was sent to the author by Mr. G. Greenslade, the manager of the waterworks, which contained a white deposit. The manager also explained that the company's water near the end of the lead service was cloudy, but drawn from the same service near the company's main it was quite clear. The author was requested by the manager, if he thought necessary, to forward the sample of pipe to the company's chemists, Messrs. Ogston and Moore, with a view to ascertaining what was

* Paper read before the British Association of Waterworks Engineers.

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the nature of the deposit, and this the author did in due course. A sample of lead pipe was also sent to the same chemists with a view to having the pipe itself analysed, and it was found to be perfectly pure lead. A sample of water taken from the house in which the case of plumbism had occurred was submitted to the chemists and was found to contain 0·14 grain of lead per gallon. The chemists reported at the same time that they had made a test with the company's water taken from the Twyford pumping station as to its effect upon lead, and stated: "We placed some pieces of pure lead in a small quantity of water (both the well and the reservoir), allowing them to stand for 24 hours, when they were tested for lead, but could find no trace of it. We repeated the experiment, but this time allowing them to stand for 48 hours. In this case there was the faintest trace, but not estimatable. We made another experiment, this time using composition pipe, but without result. The water had no action upon it. We may mention that side by side we made the same experiments with the water supplied to our laboratories here by the New River Company, and in each case found strong evidence of lead. We can only conclude on this evidence that the water supplied by the South Hants Water Company has no perceptible action upon lead, therefore the contamination must be looked for in other directions."

Subsequently the author made an inspection of the site in conjunction with the manager, and he reported to the directors of the company on Oct. 24 that after inspecting the site and considering the circumstances he was clearly of opinion that the presence of lead in the water was entirely due to electrolysis. The water service had clearly been attacked after passing the engine-house and storage batteries used on the place for the electric lighting of Twyford Lodge, and as the directors had been extremely anxious about the matter, and that it should be fully investigated, the author added: "You may feel confident that it is utterly impossible for water such as that which you supply to the district to have any effect whatever upon lead pipes, as water such as yours, which is alkaline is character, cannot by any possible means of itself become a solvent for lead—in fact, in all cases in which water has an action upon lead, the use of lime, such as you adopt in the softening of the water, is often the remedy prescribed."

It appears from the valuable investigation made by Dr. Houston, the present water examiner for London, that lead pipes are liable to attack by certain soft waters containing, as a rule, peaty acid, in which case the lead becomes dissolved in the water, and has produced dangerous illness among those using the water. Lead pipes are also subject to what he termed "erosion," which action bears no relation to the acidity of the water, in which case the surface of the lead disintegrates, and lead in a relatively insoluble form is deposited. It is the solvent action of water on lead that is the source of danger in drinking water. With regard to the "erosion" of the surface of lead, which is manifested chiefly on a bright surface, Dr. Power, C.B., F.R.S., of the Local Government Board, says that "erosion" is a factor not to be neglected, but is relatively of much less importance than the dissolving action of water upon lead. The analyst reported that the deposit in the lead service pipe was carbonate of lead, which, he stated, was no doubt formed by the action of water in the pipe, and said: "Your directors will undoubtedly wish to go further into this matter at once; therefore, to save time, will you please send us two pieces of leaden service pipe about 2ft. long, and two pieces of old pipe, besides the usual quantity of water, both from the well and from the reservoir, so that we may endeavour to find the cause of this action."

The samples of pipes were sent in due course, and the tests showed, as usual, that with the new lead pipe solvent action was perceptible which amounted to ·02 grain per gallon when allowed to remain in contact overnight, but on the second day the action was nil. The old lead pipe gave a rather larger quantity of lead. In the interval the chemists had received a communication from the author with regard to the position of the service pipe with reference to the electric cable and electric works, and stating his opinion that there was an escape of electricity, and that the action was due to electrolysis. The chemists stated that it was a very important and interesting point, and suggested that they should make some experiments at their laboratory, and report the final results of their experiments. In their report to the directors on the result of this experiment the chemists state that "we passed a current of electricity through the water contained in the pipe, allowing the action to go on over-night. In the morning the water was tested, and it was found a decided action had taken place, the activity having increased from ·005 to ·03; on the surface of the water we noticed some white powdery substance floating, and on the inside of the pipe several white patches had appeared. On examination, the powdery substance was found to be carbonate of lead, and we have no doubt the white patches are also carbonate of lead, which is beginning to form a crust on the inside of the pipe. We are of opinion, therefore, that the pipe in question is affected by its vicinity to the electric cable spoken of by Mr. Baldwin Latham, and that the corrosion of the pipe is entirely due to electrolysis."

At that time, having regard to the suggestion which had been made by the author that the action was due to electrolysis, it appears that Dr. Roberts discovered a feeble current of electricity from the tap in the house in which the case of lead-poisoning had occurred, and he also found it in other portions of the water company's district, and he communicated these results. The consequence was that the company determined to carry out a further investigation, and the directors instructed the author on Nov. 11 last to take immediate steps to trace the source of electricity in the pipes, on which he instructed Messrs. Lucas and Pyke, electrical engineers, of Westminster, to make an inspection of the premises and to test the mains at Twyford with a view to ascertaining what was taking place. On Nov. 14 they made a test at Twyford in the presence of the electrical engineer, of the owner of the property affected, and others. Messrs. Lucas and Pyke say in their report that the pipe in which the electrolysis had taken place was a lead pipe between 200 and 300 yards long, connected to the cast iron main of the water company. After it left the cast-iron main of the company, a branch from it was carried to Twyford Lodge, the residence of the owner of the property, and it then ran away in an opposite direction from the house in question, and passed near the engine-house where the electric plant supplying the current to Twyford Lodge is situated, and a branch water-pipe was carried into the engine-house, and the pipes continues thence, and is forked to supply two cottages, this latter portion of the pipe being a comparatively new pipe. It was in the most distant of these cottages that the case of lead-poisoning took place, the subject being a man who was said to be a water drinker.

They reported that they were shown two sections of pipe, one removed from the older part of the pipe before it reached the engine-house branch, and the other from the branch pipe supplying water to the cottage in which the case of lead-poisoning had occurred, the latter of which showed a considerable deposit of what they understood had been ascertained to be carbonate of lead. The older section showed very little of this deposit, but, as might be expected, showed a strong deposit of oxide. In order to ascertain the possible source of leakage of electric current to these pipes, tests were made to find out any difference of potential between any section of the pipes themselves, and the pipes and the surrounding earth. The result of these tests was to indicate that the earth immediately under and round the engine-house showed a positive charge as compared with the pipes running away from this house, the isolated branch pipe supplying the engine-house showing the biggest difference when connected with the lead pipe that was continuous to the cast-iron main. The main was proved to be negative as compared with any part of the ground in the immediate vicinity of the engine-house. A distinct difference of potential was obtained, not of large amount, or exceeding 0·2 of a volt in any case, which Messrs. Lucas and Pyke state would not be sufficient in their judgment to account for the comparatively extensive electrolysis that had occurred, and they also state that it was clear, from the fact that the South Hants water-main was negative in every case, that the current could not have come from that direction. They, therefore, proceeded to examine the nature

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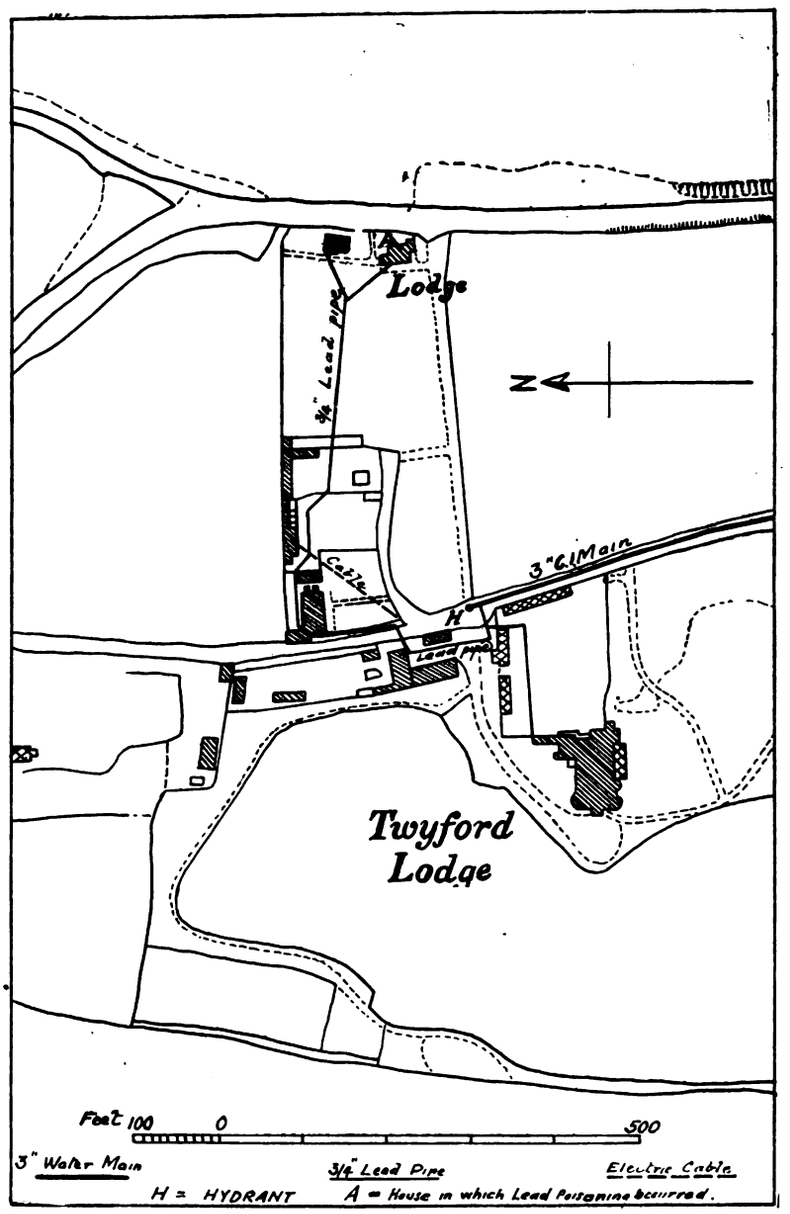
of the installation supplying the current to the premises, and found that an earthed return system had been adopted. From the information obtained, and the inspection of what could be seen, it appeared that a copper uninsulated strip was run back from the engine-room to the house, which strip for a part of its run was enclosed in the same bitumen trough as the positive insulated main. There was no evidence of the strip having been properly connected to earth in the engine-house. A measurement of the resistance to earth of this nominally "earthed" return was taken, and it showed as high a resistance as eight ohms. Moreover, the potential of the ground immediately surrounding the engine-house was distinctly above that of the nominal earthed return main, but again not amounting to more than ·2 of a volt.

They observed also that the small leakages through the battery it is almost impossible to eliminate, and they expressed an opinion that they did not think them harmful.

On the discovery of the escape of the 1·8 volts of electricity into the lead pipe, the author communicated the fact to Messrs. Ogston and Moore, and they immediately instituted a further series of experiments, causing an electric current of 1·8 volts to pass through the water in a lead pipe, and on testing it found it to contain ·07 grain of lead per gallon. Two tests were made—in one case the current was allowed to pass through the water for the whole night, and in the other case for only four hours—and in each case the amount of lead subsequently found in the water was identical, so that it was amply demonstrated that a current such as that which was shown to be leaking from the electrical installation in question is ample to produce cases of plumbism, and may seriously affect all persons using such water supply. It is, therefore, of the utmost importance that water engineers should have a knowledge of this fact, so that in any case occurring within their own practice they may be able to effectually deal with the subject.



Up to this point the electrical engineers reported that the results obtained indicated a slight positive leakage round the engine-house, which occurred when the installation was completely cut off and no current passing through the mains, and was due to the creeping from the battery, and they did not consider that they had obtained sufficient evidence of a leak to account for the electrolysis. It, therefore, became necessary to seek for some other source of leakage, and the high resistance between the nominally earthed return and the earth itself seemed to indicate the direction of the leak. A test was then made with the house installation connected on, and a current of 30 amperes passing through the mains, when immediately an E.M.F. was detected between the earth return and the water-pipe running to the house of 1·8 volts, which in the engineers' opinion accounted for the whole trouble which had occurred.

The accompanying plan shows the position of the lead service pipe relative to the cast-iron main of the company, also the position of the electric cable. The lodge, marked A, is the residence in which the case of lead-poisoning occurred.

Wigan.—The Town Council have confirmed a resolution passed by their Electric Light and Tramways Committee to the effect that the Council contribute a certain sum towards the promotion in the ensuing session of Parliament of a Tramways Bill.

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ELECTRIC MAINS FOR POWER TRANSMISSION WORK.*

BY PROF. JOHN T. MORRIS, M.I E E, MEMBER.

This paper is an attempt to present a brief account of some of the main theoretical and practical considerations which affect extra high-tension transmission, giving at the same time an account of various details of transmissions of this description which are in actual operation. It deals almost exclusively with the apparatus used for the actual *transmission* of currents at voltages of from, say, 5,000 to the maximum voltage that has been attempted for power transmission work.

Use of Direct and Alternating Currents.—Extra high-tension power transmission is usually carried out with three-phase currents, which system includes nearly the whole of extra high-voltage power transmission work. There are a few examples of direct-current, a few of single-phase, and a fair number of two-phase transmissions.

Effects depending on Current employed—Direct Current—Thury System.—In this system, as is well known, a constant current is maintained in the circuit, and variations in the load are dealt with by adjusting the voltage to suit. Usually, the current is transmitted by overhead wires, and it is only necessary to carry a single wire through each town or village on the route in which power is required, these all being linked upon a single circuit. The circuit returns to the station by a different route. This system has the advantage that the capacity and inductance of the circuit do not in any way affect the ordinary working of the line; also, of course, there is no trouble from losses due to lagging or leading currents. The following table gives the most notable examples of this system of transmission:

Direct-Current Power Transmission, Thury System.

	Max. volt.	H.P.	Length of circuit, miles.
La Chaud de Fonds	14,000	3,000	32
St. Maurice-Lausanne	23,000	4,600	35
Moutiers Lyons, in course of construction	60,000	6,000	114

Single-Phase System.—Up to the present time single-phase currents have been but little used for extra high-tension power transmission work, though it is quite possible that in the near future such currents may be employed, particularly at low frequencies.

Two-Phase System.—This system is adopted for power transmission work, but owing to the necessity of using in it a greater weight of copper and insulation than is required for three-phase work, transmissions on this system are not much favoured.

Three-Phase System.—At the present time this system undoubtedly holds the premier position for long-distance power transmission, chiefly because the weight of copper required is smaller than in any other alternating system, when the same voltage is the determining factor.

All alternating systems labour under the disadvantage of the possibility of increased losses in the line due to lagging or leading currents, also that any synchronous machinery is apt to be thrown out of step by a sudden short-circuit.

Overhead Mains.

Materials for the Conductor.—Practically only two materials are employed—hard-drawn copper and aluminium.

Copper.—American practice seems to show that up to 0·3in. diameter, solid hard-drawn copper wire is employed. Above 0·4in., stranded copper wire is almost always used. With regard to intermediate sizes, practice varies.

Aluminium.—Aluminium wire is usually stranded for the work, and is stronger than copper for the same conductivity, but the wind pressure is greater with aluminium owing to the greater surface for a given conductivity.

Wind Pressures.—Experiments conducted on a span 950ft. in length, supported on poles 45ft. high, give as a relation between velocity of wind and pressure on cable $P = 0{\cdot}0025\ V^2$ for a stranded cable, where P = pressure per square foot of projected cable area and V = actual velocity of wind in miles per hour. Apparently 65 miles per hour may be taken as a reasonable maximum for wind velocity if such exceptional events as tornadoes are left out of account. The following table gives some of the principal constants:

Properties of Aluminium and Copper.

	Aluminium.	Copper.
Elastic limit in pounds per square inch	14,000	40,000
Coefficient of expansion per degree C.	0 000023	0 0000173
Modulus of elasticity	9,000,000	16,000,000
Electrical conductivity	62 p.c.	100 p.c.
Specific gravity	2·68	8·9
Melting point	625deg. C.	1,080deg. C.

It will be observed that the expansion of aluminium is to that of copper in the proportion of 4 to 3, which means that if copper and aluminium wires of equal span are erected, there will be a greater sag in the aluminium span for a given rise of temperature. This fact, though not important as regards short spans, shows that with a long span the height of the poles for aluminium circuits must be greater. To quote an example of one of the longest existing spans, there is an aluminium line on the West Coast of America having a single span of 1,800ft.—rather over a third of a mile. It may be mentioned that steel is not very far from competing with copper and aluminium for long span work, particularly on account of its smaller coefficient of expansion, and also its greater tenacity.

Brush Discharge from Wires.—When the voltage on a bare wire in air is raised above a certain point, the wire becomes visible in the dark. The voltage at which this occurs is dependent on the diameter of the wire, as well as on the barometric pressure. The chief reason for the dependence of the brush discharge on the diameter is that the potential gradient—that is, the drop in volts per millimetre—passing away from the wire at right angles to the axis, will be greater for the smaller wire if the same voltage is applied in the two cases, owing to its radius being smaller. Signor Jona has determined the relation of the voltage for wires of different diameters at which brush discharge begins to occur, and he further notes that when all the wires are at the same potential, the outside diameter of the brush discharge is practically the same for each, which, to quote his own words, "is that diameter which reduces the potential gradient below the dielectric strength of air." The figures given in the recent British Association lecture delivered at Johannesburg by our vice-president, Prof. W. E. Ayrton, show very clearly the fact that once a wire has begun discharging in the air a further increase of voltage will increase very largely the brush discharge distance.

Pole Construction.—Poles are either made in wood, or some kind of wrought-iron or steel construction is adopted. It is practically essential for long spans to use the latter, on account of their greater strength and durability. There is, however, a drawback with regard to small steel towers, from the point of view of continuity of supply, which is, that should an insulator break and the wire fall, the line will have at once to be shut down, while with wood construction several minutes will probably elapse before a blaze is started which will short-circuit the line. Indeed, a case is known of a 40,000-volt three-phase circuit, with grounded neutral, where the wire lay on a dry cross-arm for several hours before the circuit could be switched over, and even in this case the cross-arm was not badly charred. It may be of interest to note that an extremely rough rule for giving the distance between wires is that the distance in inches is equal to $1\frac{1}{2}$ times the number of kilovolts used.

Loss in the Line.—A reasonable loss in the line is about 5 per cent. of the energy transmitted per 50 miles, though a smaller loss than this may well be obtained.

Insulators.—Porcelain and glass are practically the only two materials used for insulators. In some of the earlier power transmissions in the States, until about the year 1897, the insulators employed for voltages up to about 15,000 were formed and pressed in iron moulds, but this method of manufacture was rather apt to produce an insulator with flaws. On testing these insulators, it was found that the only part which was really effective for insulating was the glaze on the surface, and not the body. Now, however, American practice has reverted to making the insulators in pieces on the potter's wheel and separately glazing the parts, afterwards cementing them together either with sulphur or litharge and glycerine, or with Portland cement. The following are some of the main

* Paper read before the Junior Institution of Engineers.

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points requiring attention in the design of high-tension insulators: there must be no flaws or cracks; the material should have a high dielectric strength; the surface leakage must be small, even when rain is falling, and the distance from the edge of the "umbrella" to the pin supporting the insulator must be sufficient to prevent arcs from starting; the mechanical strength also must be ample under working conditions. An unforeseen difficulty has been experienced in the use of white porcelain for the insulators in America—they form such an attractive mark for unscrupulous rifle shots! Brown porcelain and glass are much more generally employed now. One advantage possessed by glass is that a flaw can be at once seen. It is preferable to design the insulator in one piece, in order to distribute the electrostatic stress more uniformly throughout the insulator, but, as is generally the case in extra high-tension work, the insulator has to be built up of several pieces, and a cement should be used which has dielectric properties comparable with the component parts of the insulator. Glass is apparently better than porcelain as a dielectric, but has the serious defect of mechanical weakness. It would appear that this weakness is almost entirely due to internal strains which occur during manufacture. These strains can, of course, be greatly reduced by good design, and also by subsequent annealing. Specimens of various insulators are exhibited, including one suitable for 60,000 volts, and weighing 26lb.

Distribution of Electrostatic Stress in and around an Insulator when at work.—Take, for example, one of the insulators used in the Shawinigan-Montreal transmission line, which works at 53,000 volts three-phase, and consider as an extreme case 50,000 volts between the line wire and pole arm when rain is falling. The whole of the upper side of the "umbrella" will be at the same potential as the wire. If the potential gradient is too steep at the surfaces of the insulator, then a brush discharge will start from the edges, and this means that the surrounding air is rendered partially conducting, or is ionised, as it is called, which possibly will reduce the effective thickness of the dielectric, and this may cause a breakdown. It should be noticed that the intermediate voltages which the surfaces will assume will depend partly on the relative capacities of what may be looked upon as the condensers, which are electrically in series. It is obvious that these condensers are shunted by the surface leakage paths, but expert opinion in the States seems to incline to the belief that the surface leakage effect is in reality extremely small.* This is mainly due to the fact that at these extra high voltages surface leakage cannot permanently exist, since the conducting path will vanish, owing to the heat produced by the leakage current itself. As is well known, when conductors are connected in series, the voltage divides in the inverse ratio of their capacities.

Burning of Pins.—Pins are usually made either of locust, oak, or eucalyptus wood, carefully treated so as to exclude moisture. Iron pins are also largely used. After a line has been in operation for some months, the pins carrying the insulators, if of wood, are sometimes found to have a charred appearance. This is caused by a discharge, which can be seen at night, and which produces an appreciable sound. This charring effect is practically absent below voltages of 20,000, but at 40,000 becomes a factor requiring serious attention. Opinions differ as to the cause of this burning of pins. Some authorities consider it to be due to surface leakage, whilst others attribute it to the effect of a brush discharge between the inner part of the insulator and the pin. Undoubtedly, however, this effect has to be reckoned with, as in some lines pins have had to be replaced two or three times in a year. Iron pins are much better from a mechanical point of view, but the attachment of the insulator to them requires care. The iron pin may be enlarged at its upper end, and then fixed in the insulator by means of lead or cement. Or, the metal pin may have a wood sleeve having a thread on its outer side, and the insulator may be screwed on to this pin, as in the Locke insulators, specimens of which are on the table. It may be of interest here to refer briefly to some troubles peculiar to overhead work which have actually been experienced in America. These are of various kinds, such as lightning actually striking the line; insulators destroyed by being shot at, as previously mentioned; loose pieces of bare wire being thrown at the line by reckless "experimenters"; cranes or geese flying into the line; green hay carried by the wind; an engine starting up under the line, etc.

* Exceptions must be made in the case of lines close to the sea-coast, where the salt in the air gets deposited on the insulators, also in the neighbourhood of chemical factories, and under other special conditions.

Underground Mains.

Insulating Material.—For underground main work there are practically only two kinds of insulating materials which can be employed. These are rubber and paper.

Rubber.—Rubber is seldom used for this extra high-tension work on account of its great expense, though it has a very high dielectric strength. If well vulcanised and kept free from brush discharges in air and not alternately wetted and dried, rubber is said not to deteriorate appreciably with time.

Paper.—A good manilla paper is chosen for this purpose. It should be laid in thin and regular layers round the conductors. The layers must neither be wound on too tightly, which would sacrifice flexibility, nor too loosely, as there is then risk of the paper insulation crumpling. After the winding, the cable must be properly dried in a vacuum (at a *moderate* temperature, otherwise the paper would become brittle) and afterwards impregnated with some form of resin oil, which will not harden with age.

Insulation Resistance.—Formerly the insulation resistance of a cable was regarded as the most important factor to be taken into account. Nowadays, however, it is almost left to take care of itself, and instead, attention is directed to breaking-down strength and bending tests, and, after the cable is laid, to its withstanding about double the ordinary working pressure for a period of an hour. It is of interest to note that if the temperature of an impregnated paper cable be raised 20deg. C. the insulation resistance will fall to one-thirtieth part of its previous value—an enormous reduction—but, fortunately, one which does not appreciably affect its breaking-down strength.

Dielectric Strength and Specific Capacity.*—Signor Jona gives the following data for dielectric strength and specific capacities as good working averages for materials used in cable manufacture:

Dielectric strength of rubber in lengths on cable—
12,000 to 15 000 volts per millimetre.
Dielectric strength of paper in lengths on cable—
8,000 to 10 000 volts per millimetre.

Specific Capacity of Various Materials.

Paper cables	3–4
Paper	about 2
Resin	2–3
Mixtures used for impregnating	3–4 or above
Pure vulcanised rubber, about	3

The addition of certain materials to rubber raises its specific capacity without appreciably altering its dielectric strength. The following table gives facts relating to some of these mixtures as compared with pure vulcanised rubber.

				Sp. capacity
Pure vulcanised rubber				about 3
Per cent.	Per cent.	Per cent.	Per cent.	
58 Para ...	2 sulphur ...	26 talc ...	14 zinc oxide ...	4–4 2
40 " ...	5 " ...	55 carbonate of lime	...	4·6
64 " ...	8 " ...	16 talc	... 4 zinc oxide 8 per cent. minium ...	5·
56 " ...	22 " ...	22 " ...	— ...	6·1

Arrangement of Conductors.—A three-phase cable consists, as is well known, of three cores of copper equally spaced inside a lead sheath, and approximately the thickness of the dielectric between any pair of cores and between any core and the lead sheath is equal. The application of theoretical considerations to cables of this section is by no

* Two terms are in common use to denote this quality: dielectric constant and specific inductive capacity. The author regards the former as unsuitable, as it might equally well be applied to the dielectric or breaking-down strength. Further, is it not a misnomer, since the "constant" in many cases varies for a given material? The latter term, specific inductive capacity, seems unsatisfactory, as it contains the word "inductive," which tends nowadays rather to confuse than elucidate the idea. In view of this consideration the term specific capacity would appear to be preferable, though it still is open to the objection that "specific" should refer to a property of a body which is independent of its dimensions.

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means easy, but some light will be thrown upon it by a study of the simpler case of a concentric cable. Take the case of a concentric cable, in which

r = the external radius of the inner conductor in millimetres;
R = the internal radius of the external conductor in millimetres;
x = the radius in millimetres at some point r and R;
V = volts between r and R.

Then it can be shown that the drop in volts per millimetre—*i.e.*, the potential gradient—is given at any point by the expression

$$\frac{\cdot 434\ V}{x \log_{10} \frac{R}{r}}.$$

Which means that in a concentric cable the electric stress each layer supports in inversely proportional to its radius, or the potential gradient is in the inverse proportion of the electric capacity of each layer. This implies that in this case the dielectric is not uniformly stressed, the inner layers being more highly stressed than the outer. In some cases the stress on the inner layer may be as much as four times that on the outer. A stranded wire as compared with a solid wire of the same section will always have a greater potential gradient very close to the surface of the conductor, owing to parts of the outlines of the section of the conductor having more sudden curves. It is for this reason that Signor Jona, in attempting to construct a single-core cable for an extraordinary high voltage, adopted the bold expedient of encasing the stranded wire with a thin sheath. This cable is described in the next section of the paper.

Examples of Cables.—Originally a three-core cable was made by taking three stranded cores, each of *circular* section and each insulated separately, and combining the three into a single cable, the interstices being filled in with jute or some other material until an external circular surface was obtained. This was then further covered with insulation, and a lead sheath tightly enclosed the whole. The disadvantage of the arrangement was that the dielectric was by no means uniformly stressed, and hence for a given breaking-down strength and section of core the diameter of the finished cable was unnecessarily large. A specimen is shown of a Henley 6,000-volt three-phase cable, each core 0·15 of a square inch, supplied in 1899. Within the last three or four years the above design had been modified in the majority of extra high-tension three-phase cables in this country, which now have cores of a 120deg. sector shape in place of the circular, the three corners being more or less rounded. This results in making the dielectric stress more uniform, owing to the fact that the dielectric is more uniform in thickness between the cores and also between each core and the sheath. In the recently introduced so-called "Laminæ" Henley cable, this idea is even more perfectly carried out. Lead sheathing is naturally fairly fusible and not of very great conductivity, and it is conceivable, though unlikely, that a severe short-circuit might result in a portion of the lead sheathing assuming a considerable difference of potential with respect to the earth in which the cable is laid, which might cause more than unpleasant surprises to passers-by! To minimise the risk, the Board of Trade has favoured the introduction of a number of thin copper strips placed directly beneath the lead sheath; the object being to increase the conductivity and diminish the fusibility of the sheathing as a whole. Occasionally, as in some of Callender's mains, the internal copper sheathing is replaced by external galvanised armouring, in direct contact with the lead sheathing.

It is interesting to note the various means employed by manufacturers to diminish the lost space due to the section not being quite filled with copper as, for example, the "hammered" sections, B.I. and H.C.; the introduction of a few wires in the strand of different diameters, as in Siemens; and the almost complete use of the space, as in the Henley "Laminæ" cable. Another cable of special interest from the point of view of insulation is that referred to above, designed by Signor Jona, of Messrs. Pirelli, Milan. It is a single-core cable, having, as previously mentioned, a thin lead sheath encasing the stranded conductor, and has graded insulation from the inside outwards. This has the effect of giving a more uniform distribution of potential gradient. There is first a layer of dielectric of specific capacity 6·1, then a layer of specific capacity 4·7, then one of specific capacity 4·2, and, finally, a layer of specific of 4·0, over which the ordinary lead sheath is placed. This particular cable has successfully withstood a pressure of 150,000 volts for one hour. For further information on the principles underlying this grading of insulation, members are referred to two standard papers on this subject: "Insulation on Cables," by M. O'Gorman; "Insulating Materials in High-Tension Cables," by E. Jona.

Energy Losses in Cables.—By far the greatest loss in cable is due to the resistance of the conductors. The various losses may be stated as follows: ordinary C^2 R losses in conductors, eddy-current losses in conductors, eddy-current losses in lead sheathing and copper strips, increased eddy-current losses due to iron armouring, energy losses in the dielectric. From some tests made a few months ago by the author, at the East London College, it was shown that in a particular sample of an ordinary stranded three-core cable having 0·1 square inch section per core working on a supply at a frequency of 50 cycles per second at a current of 100 amperes per core, the eddy-current core loss is 2·1 per cent. of the ordinary C^2 R loss, and the lead sheath loss is about 1·2 per cent. of the ordinary C^2 R loss. This sample has no copper strips nor iron armouring, both of which would have some effect in increasing the total loss. If the energy losses be taken into account in the dielectric as well, it seems probable that the total increase of the losses in a three-core cable supplied with three-phase currents might be some 6 to 10 per cent. in excess of the ordinary C^2 R loss. This, however, is relatively unimportant when compared with the total power supplied by a transmission, as the transmission losses themselves are of the order of 5 per cent., while these minor losses are not greater than 10 per cent. of this 5 per cent., which means only ½ per cent. of the total.

Heating of Cables.—When current is flowing in the conductors of a cable, heat is developed at a certain rate. Since the greatest care is taken to electrically insulate the conductors, they are in consequence remarkably well insulated thermally—that is, heat cannot be rapidly dissipated from them. This results in a prolonged though gradually diminishing rate of rise of temperature during the passage of a current of constant value, until a steady temperature is finally obtained. This steady condition would not be reached in ordinary cables until after the lapse of some hours. In consequence, a rise of 20deg. or 30deg. C. or even much more may be quite common. The initial rate of rise in temperature of a copper cable is practically determined by the current density employed, and will be approximately proportional to the square of the current density. At 1,000 amperes per square inch the initial rise, if no heat were lost, would be at the rate of about 0·75deg. C. per minute, so in any practical cable the rate of rise cannot exceed this figure for the same current density, but will be less by an amount depending on the construction of the cable.

(To be continued.)

LEGAL INTELLIGENCE.

TRAMWAYS AND TREES.

The record was closed recently in an action at the instance of Wm. Kinross Gair, writer, Falkirk, against Messrs. Bruce Peebles and Co., East Pilton, Edinburgh. The pursuer concluded for £100, and avers that it was not necessary for the construction of the tramways authorised by the Falkirk and District Tramways Order Confirmation Act, 1901, that defender should lop the pursuer's trees overhanging on the Camelon-road so closely as they did, and the lopping was more extensive than the pursuer was by the defenders' letters led to believe, and to the extent to which it was unnecessary it was wrongful and illegal. Moreover, the work was conducted in a careless, unskilful, and untradesmanlike manner, and with a total disregard of the pursuer's interests. The stumps of the branches were left in a torn, damaged, and undressed condition. The trees were disfigured, their

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value as timber substantially reduced, and the ornamental effect of the plantation seriously diminished. The pursuer further averred that by the said operations the defenders had seriously injured the amenity and privacy of his property by depriving to a large extent the shelter and screen afforded by the trees.

The defendants in their defence state that they sub-contracted with the British Electric Equipment Co., London, for the execution of the work relating to the overhead electrical equipment. The work of lopping the trees along the road was necessary, and was not included in the sub-contract, but was made the subject of a subsequent separate order by the defenders to the Equipment Co. The defenders communicated to the Equipment Co. correspondence which took place between pursuer and defenders and the proprietors of the ground fronting Camelon-road. The defenders deny that the operations of lopping off the branches in question were carried out by them, but, on the contrary, were entirely carried out by the said British Electric Equipment Co. The defenders aver that the work was carried out carefully. No lopping was done except in cases where it was absolutely necessary. The defender further averred that the pursuer was well aware that the operations were carried out, not by them, but by another firm, and that the operations were extended in virtue of powers conferred by Parliament upon the Falkirk and District Tramways Co.

Parties' agents were heard in debate in the Sheriff Court on the 18th inst. on the preliminary pleas stated for both pursuer and defenders, and Sheriff Moffatt made *avizandum*.

SOUTHPORT TRAMWAY ACCIDENT.

An action was heard in the Southport County Court before his Honour Judge Collier on the 19th inst., in which Messrs. Peter Rigby and the Southport Carriage Co. sued the Southport Tramway Co., the action being for damages in respect of a collision due to the negligent driving of the defendant company's servant between one of the plaintiff company's cabs and one of the defendant company's tramcars.

Evidence in support of the claim was to the effect that the tramway gong was not sounded, or that the tram, considering the locality, was going at too great a speed, and that the driver had not his brakes under control, or did not put them on in sufficient time.

The defence denied negligence, but the jury found for plaintiffs, and his Honour awarded them £15 damages.

COMPANIES' MEETINGS AND REPORTS.

BURMA ELECTRIC TRAMWAYS AND LIGHTING.

The annual general meeting of the shareholders of this Company was held on the 21st inst., Mr. E. C. Morgan (chairman) presiding.

The CHAIRMAN said that the accounts submitted covered a full year's working from Aug. 1, 1904, to July 31, 1905. Turning to the revenue account, he observed that the traffic receipts amounted to the respectable sum of £13,777, received from 2,807,287 passengers on a mileage of 553,494 car miles. On the other side they had spent £11,329, which leaves a surplus on the year's working of £2,457, or about 2½ per cent. on the preference shares. This sum, however, is not at present divisible, said Mr. Morgan, as it is fully employed in stocks and stores in hand. Under the head of power expenses fuel figured for the large sum of £2,075. You are no doubt aware, continued Mr. Morgan, that at present we are obliged to keep our furnaces going with wood, which is the only fuel available. This is not only dear, but is also a wasteful form of fuel, as the consumption is necessarily greater than that of coal. I may say, however, that our inquiries have been consistently directed to obtaining a better and cheaper fuel, and we are now informed that we may shortly expect to obtain good coal from fields which are being exploited on the Chindwin River, not very far from Mandalay, which are said to contain large quantities and of good quality. If these representations are realised, we may confidently anticipate to make a considerable saving on the amount paid for fuel. I may mention that the charge of £750 for directors' fees, though not large in itself, seems perhaps more than the undertaking at its present stage can fairly bear, and the directors resolved at a Board meeting in October last that until the full dividend on the preference shares is earned they will limit their drawings to £500, such reduction to take place from the commencement of the current year. As regards the general outlook, Mr. Morgan said that the traffics are now showing appreciable and satisfactory increases, and they trust that these will be maintained and tend to further expand. So far, said the chairman, I have dealt with our existing system, but our inquiries lead us to believe that we may profitably increase this system. Our present lines, you will recollect, form more or less a "T," with the Zegyo Bazar as the centre, whence lines radiate to the east, west, and south. We have, however, no line at present running north of Zegyo, which, whilst, perhaps, less densely populated than the other points, still serves a very considerable population, not only of actual residents, but of people coming in from the northern suburbs. Although we are not yet quite certain as to our facts, I may say that the conviction is being forced upon us that we should derive great advantage by constructing a line from the Zegyo Bazar, Northwood, to the municipal limit. This, of course, would entail the outlay of further capital, but the outlay would be quite moderate, as it would only mean the construction of permanent way and overhead lines and feeders, our existing power plant and cars being sufficient to undertake the needful service. If this scheme is carried out it would, of course, be necessary to raise further money, and this must be in the form of debentures ranking in front of the preference shares; but we should only recommend such a course if we were reasonably convinced that it would add materially to the value of the preference shares, by securing more quickly their full dividend after payment of the debenture interest. I am not prepared to-day to make any recommendation; but I think it right to mention the matter, so that it may receive your consideration, and that you may be prepared to deal with our proposals if and when they are made. In conclusion, I may say that we have every reason to be satisfied with our plant and equipment, which are of the best quality and do their work admirably. The only difficulty we have had has been the somewhat inadequate traffic hitherto secured; but this is apparently disappearing, and there is reason to hope that with a little patience we shall find ourselves in possession of a property of increasing value.

The report was adopted.

PROVINCIAL TRAMWAYS.

The annual general meeting of this Company was held at the offices on the 22nd inst., Mr. Andrew Beattie presided.

The CHAIRMAN, in moving the adoption of the report (copy of which appeared in our last issue), said that the Company had not been successful in getting their Bill for an extension of the Grimsby tramway system approved by the local authorities. There had been unavoidable delays in opening the Gosport and Fareham tramways, but the inspection by the Board of Trade was taking place that day, and they hoped that the lines would be opened for traffic in the course of a few days. On the question of reducing the nominal value of the ordinary shares the directors had circularised the shareholders, and there had been a large response, but there was still a considerable percentage of the shareholders who had not answered either way. The directors would take no steps in this matter without a deliberate and definite mandate from an overwhelming majority of the shareholders. They did not want to court litigation from any shareholder who disapproved.

Mr. SAMUEL HERN seconded the motion, which was carried.

Special resolutions were afterwards passed to authorise the Company to supply electric energy for power and lighting in the districts of Fareham, Gosport, and Alverstoke, and to adopt the provisional order granted by the Board of Trade to the Gosport and Alverstoke Electric Lighting Co.

DELAGOA BAY DEVELOPMENT.

The annual meeting of this Company was held on the 20th inst.

Mr. J. C. A. HENDERSON, who presided, said that their business was in a development stage, and its growth must depend on the growth of the port. With regard to their telephone system, there was not much to say except that the present switchboard was full. The directors did not feel prepared to incur any outlay for enlarging it until the concession was placed on a more satisfactory basis, and negotiations with that object were now being carried on with the authorities. Respecting the electric tramways, he observed that at present these were the least satisfactory of their various undertakings. A scheme for enlargement was, however, under consideration, from which, he said, better results might be looked forward to. The companies' total earnings for the year were £31,432 and the expenses £38,399, leaving a loss of £6,967.

The report was adopted.

LIENS REGISTERED.

Webster Electrical Engineering Co., Limited, Bradford.—Lien registered Dec. 13 for £375 6 per cent. debentures, part of £1,000; amount previously issued, £625 No trustees. Charged on the undertaking property, and uncalled capital.

Electrolytic Alkali Co., Limited, Middlewich.—Lien registered Dec. 8 for £300 4½ per cent. debentures, part of £50,000; amount previously issued, £20,850. Trustee: Liverpool Mortgage Insurance Co. Charged on the undertaking and all the property, including the uncalled capital.

W. T. Henley's Telegraph Works Co., Limited, London, E C.—Trust deed registered Dec. 13, for securing £300,000 4½ per cent. first mortgage debenture stock. Trustees: Right Hon. Sir A. C. Lyall, 18, Queen's-gate, S.W., and H. L. M. Tritton, 54, Lombard-street, E C. Secured by a first charge on the freehold works at North Woolwich and Gravesend and the leasehold offices of the company, and by a floating charge on the undertaking and all other property.

PERSONAL.

Mr. A. Hugh Seabrook having been appointed engineer and manager to the West Ham Corporation electricity supply, the Urban District Council and officials of Barking, together with the electricity consumers in the town and neighbourhood, last week at a special meeting of the Council marked their appreciation of his services during the five years in which he has occupied the position of engineer and tramways manager by presenting him, on behalf of the Council and officials, with a handsome gold watch, suitably inscribed, and with a vellum testimonial which reads as follows:—"Urban district of Barking Town, in the county of Essex. To Mr. A. Hugh Seabrook, electrical engineer and tramways manager, Barking: The Urban District Council of Barking Town have received with regret your resignation of the position you have held as electrical engineer and tramways manager of the Council upon your preferment to the important and responsible position of electrical engineer to the

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county borough of West Ham. They desire to congratulate you on your well-deserved promotion, and to express to you their appreciation of the manner in which you have discharged the duties that have fallen upon you whilst in their service. You have acted as electrical engineer for a period of nearly five years with conspicuous ability, and during that time have shown yourself to be an expert electrician, which combined with your knowledge of the working of a generating station, the laying of mains, etc., and the management of workmen, have proved of great value to the Council. The period during which you have acted as head of the electricity department has been a most anxious and trying one, and you are to be congratulated upon the fact that the undertaking, which upon your appointment showed a loss of over £1,000 per annum, has, under your management, become more than self-supporting. You have the best wishes of the Council for continued success in your future career.—Given under the seal of the Council this 28th day of November, 1905, J. Wilson (chairman of the Council), H. Hargreaves (clerk of the Council)." Mr. H. J. Mackrow (general manager to Messrs. Page, Calnan, and Co.), on behalf of the chief consumers in Barking, presented a handsome silver-mounted spirit tantalus to Mr. Seabrook and an elegant cut-glass silver-mounted scent bottle to Mrs. Seabrook.

We have been asked to state that Mr. D. G. Sutherland, who for the last five years has held the important post of chief engineer of Messrs. Bruce Peebles and Co.'s contract department, will resign his position at the end of December to become partner in the old-established firm of engineers, Messrs. Mitchell Graham and Son, 46, Buccleuch-street, Edinburgh, and that electrical and mechanical engineers are invited to forward lists and catalogues to him at this address.

We are informed that Mr. F. E. Mackee, who has been with the British Insulated and Helsby Cables for nearly 11 years, has started business with Mr. O. M. Robinson at 13, Castle-street, Liverpool.

Mr. Sharp, who has acted as construction superintendent and clerk of the works at the Brighton Corporation's Southwick station, has been appointed superintendent, and his salary has been increased from £4 to £5 per week. Mr. G. Claughton, who has been acting for the Westinghouse Co., is to be assistant superintendent at £4. 10s. per week. Three high-tension switchgear operators are to act as shift engineers at £2. 10s. each. The salary of R. Tonge, foreman fitter, has been raised from £2. 2s. 6d. to £2. 10s. per week, and that of F. W. Markwick, boiler-house foreman, to £2. 10s. per week.

NEW COMMITTEES.

GRAVESEND.—*Electrical*—Councillor Enfield, chairman.

KING'S LYNN.—*Electricity*—Mr. Gemmell, chairman.

LOWESTOFT.—*Electric Lighting*—Councillor Fry, chairman.

STOKE ON TRENT.—*Electricity and Destructor*—Councillor Yoxall having declined the office of vice chairman, Councillor Brooke has been appointed.

WALSALL.—*Electricity*—Alderman William Brownhill, chairman; Alderman Noake, vice-chairman.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Pontypridd.—The Urban District Council invite tenders for cable conduits. Tenders to the Clerk by Jan. 1.

St. Marylebone.—The Electricity Supply Committee invite tenders for house service fuse-boxes. Tenders by Jan. 10. See advertisement.

St. Marylebone.—The Electricity Supply Committee invite tenders for various stores. Tender by Jan. 10. Full particulars in advertisement columns.

St. Pancras.—Tenders are invited for supplying (Section A) arc lamp columns and cradles; (B) open-type arc lamps. Tenders by noon on Jan. 9. See advertisement.

Leyton (Essex).—The Urban District Council invite tenders for the construction of nine miles of double tramway track, and for all materials connected therewith. Tenders by 7 p.m. on Jan. 8.

Aberdeen.—Tenders are invited for six tramcar top-deck covers. Tenders to Mr. J. Bell, city electrical and tramways engineer, Electricity Works, Aberdeen, by noon on Jan. 6. See advertisement.

Croydon.—The Guardians invite tenders for the installation of electric fire-alarms at the infirmary. Tenders to Mr. H. List, clerk, Union Offices, Mayday-road, Thornton Heath, by 4 p.m. on Jan. 8.

Madrid.—The Public Works Department require tenders for a concession to construct and work an electric tramway between Santander and Astillero. Guarantee, 8,195 pesetas. Tenders by Jan. 30, 1906.

Gravesend.—The engineer has been authorised to forward specifications to a number of firms asking for tenders for economisers to be submitted to the town clerk so as to be available for committee during January next.

Manchester.—Tenders are invited for laying underground telephone pipes, with other appurtenant works. Tenders to the Chairman of the Special Committee re Telephones, City Surveyor's Office, by 10 a.m. on Jan. 2.

Launceston (Tasmania).—Tenders are invited for the supply of 500 or more electric meters and for maximum demand indicators. Tenders to Mr. C. W. Rocher, town clerk, Town Hall, Launceston, Tasmania, by 12 noon on Jan. 15.

Rochdale.—The Electricity Committee invite tenders for the supply of cables. Firms wishing to tender are requested to make application on or before Jan. 1 to the Borough Electrical Engineer, Electricity Works, Dane-street, Rochdale.

Grimsby.—The Corporation require tenders for contracts contained in Specifications No. 35-39 and 43-45, for electrical plant, cables, and buildings. Tenders by Jan. 5, 1906.

Sofia (Bulgaria).—Tenders are invited for the electric lighting of the Government Cadet School. Tenders by Jan. 19. Offers must be addressed in the Bulgarian language and be accompanied by a deposit of 5 per cent. of the amount of the tender.

Spain.—The *Gaceta de Madrid* contains a notice inviting tenders, which will be opened at noon on Jan. 30 at the Directorate-General of Public Works, Madrid, for the concession of an electric tramway between Santander and Astillero. A deposit of about £208 is required to qualify any tender.

Brussels.—Tenders are required for the electric lighting of the marine hospital. Conditions may be obtained from the Secrétaire général de l'administration des hospices et secours de la ville de Bruxelles, Boulevard du Jardin botanique, hôpital St. Jean, Brussels. Tenders by Jan. 5, 1906.

Cardiff.—With regard to the contract for the electric wiring of the new asylum at Velindre, Whitchurch, it has been decided to ask the six firms whose tenders were lowest when the contract was first advertised to send in fresh tenders on the old specifications, and that the successful tenderer be debited with the value of the work done by Messrs. Firth and Sons.

Southport.—Tenders are to be obtained by the Town Council for the supply of a battery of accumulators and a booster to be worked in connection with the traction sets; a shaping machine is to be purchased for the workshop; and the electrical engineer has been instructed to rewind the field magnets of three alternators as soon as convenient, and to provide an atmospheric exhaust to the No. 3 traction set.

RESULTS OF TENDERS.

Burslem (Staffs).—The Town Council have accepted the tender of E. M. Evans, at £104. 17s., for lighting St. John's Market by electric arc lamps.

Paddington.—The Metropolitan Electric Supply Co. have been awarded the contract for re-wiring the existing portion of the town hall and for the electric lighting installation of the whole of the new building at £636.

Tokio.—We hear that C. A. Zadig and Co., engineers and contractors, of 73, Queen Victoria-street, London, E.C., have secured an order for 200 miles of portable railway and 240 switches for the Japanese Government.

Car Contracts for London Tube Railways.—According to the *Railway Times*, the contract from the London Underground Electric Railways Co. to the American Car and Foundry Co. for the whole of the steel cars for the Charing Cross, Euston, and Hampstead Railway has now been supplemented by the statement that the number of these cars is 150, of which 60 are motorcars and 90 are trailers. The builders of the cars will also construct the trucks. The Underground Railways Co. have also awarded contracts to French and Austrian firms for the steel cars required for the Great Northern, Piccadilly, and Brompton Railway. The number of these cars is 216, of which 72 are motorcars and the remainder are trailers. The firms which have obtained the contracts are Les Ateliers de Construction du Nord de la France, Blanc Misseron, and the Hungarian Railway Carriage and Machine Works, Raab. These firms will also construct the trucks.

BUSINESS NOTES.

Mansfield.—There has been an increase of 11,300 units generated during the last month.

Southport.—The Corporation's engineer has been instructed to lay down a telephone cable to the sewage-disposal works.

Leyton.—The Urban District Council intend to apply for sanction to borrow £21 000 for extensions to the electric power station.

Alexandria (Dumbartonshire).—A town's meeting has decided in preference of having electric tramways over motor-omnibuses

Weston-super-Mare.—The electric light failed for a short time on Saturday owing to an accidental discharge from the storage cells.

Ross (Herefordshire).—The electric light and power company are putting down a new 100 h.p. direct-coupled set at their works here.

Southend.—The engineer is to lay mains to consumers at a cost of £460 in addition to the £1,902 in Alexandra-street and Leigh-road.

Kilkeel.—The Sanitary Committee of Rostrevor have been asked to furnish the Council with details of the proposed electric lighting scheme.

Llanelly.—The Llanelly Chamber of Commerce will oppose at the forthcoming inquiry any proposals to increase the indebtedness of the town on electric lighting.

Abercarn.—The District Council have decided to apply for a provisional order to enable them to supply electricity for all public and private purposes throughout the urban district.

Wantage.—We learn that the Wantage Engineering Co.'s works, Berkshire, were partially destroyed by fire on Saturday. The main building, containing a large electric light installation, was saved.

L.C.C. Tramways.—Colonel Yorke conducted the Board of Trade inspection of the section between Aldwych and the Angel yesterday in the presence of a representative gathering of municipal authorities.

Torquay.—At the last Town Council meeting the offer of the National Electric Construction Co. to lease or purchase the electric lighting undertaking was discussed. An amendment not to entertain the offer was carried by 15 to 14.

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Dunfermline. — The Electric Lighting Committee have been instructed to continue negotiations with the Fife Electric Power Co. re the proposed agreement, and to invite Messrs. Crossley, Birmingham, to meet the Council in committee.

Rickmansworth.—The Rural District Council and Parish Council have passed resolutions protesting against the granting of an electric lighting order in the district. The County Council suggest the better plan would be for the local authority themselves to apply for an order.

Midlothian.—The County Council have passed resolutions to oppose, so far as affecting the county of Midlothian, the Edinburgh Corporation provisional order, the Edinburgh and Queensferry Tramways provisional order, and the Inveresk electric lighting provisional order.

"Useful Hints."—Under this title the electricity department of the Sutton Coldfield Corporation, of which Mr. Trevor Duesbury is the engineer and manager, have issued a well got-up pamphlet which gives all the information a consumer, and those who desire to become such, need require.

Perth.—At the last meeting of the Electricity Committee of the Town Council a letter from Mr. Duncan Cumming, sanitary inspector, was read, drawing attention to the alleged smoke nuisance at the electricity station. A special committee was appointed to inquire into the whole matter and report.

Bootle.—A small mishap occurred at the Corporation electricity works last week, when, owing to a short-circuit, one of the new dynamos caught fire. There was a loud explosion, and big blue flames shot up. The dynamo was damaged, but the town's electricity supply was cut off only for about 20 minutes.

Seaham.—Notice has been given to the local authorities concerned by the Seaham, Murton, and Hetton Tramways Syndicate of its intention to apply to the Board of Trade for a provisional order to distribute electricity for motive power and all public and private purposes within the urban district of Seaham Harbour.

Glasgow.—The Glasgow Corporation tramways department have paid £43 784. 7s. 1d. of taxes this year, as compared with £38,781. 15s. 9d. last year. Of the former amount £791. 11s. 7d. is for water, £14,955. 12s. 8d. to Glasgow, £1,533. 10s. 9d. to other burghs, £21,947. 2s. 6d. to parishes, and £4,556. 9s. 7d. to counties.

Southampton.—The Town Council have adopted the recommendation of the Tramways Committee to proceed with repairs to the Shirley route. The issue of books of tickets will be discontinued on and after Jan. 1 next, having regard to the small percentages of passengers using the same, and also the loss sustained by the committee on the sale of such books.

Burnley.—The Town Council have adopted the borough electrical engineer's report to fuse the lighting network by means of disconnecting fuse pillars into five areas, at an estimated cost of £450. The above will meet the requirements of the Board of Trade regulations, and reduce a total failure in the supply due to a fault on the mains to a minimum.

Kingston (Surrey).—The Town Council have agreed to supply a large consumer with current for motor power at 1½d. per unit, on condition that there be a minimum payment of £150 a year for seven years. The Lighting Committee have also decided to reduce the general rate for current for motor power, cooking, and heating to 2d. per unit after March next.

Handsworth (Birmingham).—At the last meeting of the District Council it was stated that close upon £50,000 had been spent in erecting and equipping the electric lighting station, and that the time had arrived for the adoption of a tramway scheme for Handsworth. Notice has been given to bring this matter before the Electric Lighting and Tramways Committee.

Dundee.—A deadlock has arisen between the Town Council and the Broughty Tramway Co. in the matter of fares for the through journey. Negotiations between the parties have so far been devoid of agreement, and the result is that, failing agreement in the meantime, when the suburban line is opened each party will charge its own fares, the through journey costing the burgh plus the company's rates.

Brighton.—The electrical engineer having reported that he had been unable to arrange with the railway company to supply them with electricity, and that one of the two new feeders for which application for sanction to a loan of £4,500 had been made would not be required, it has been resolved to withdraw the application in respect of the feeder referred to, and to reduce the amount applied for by £2,650.

Kilmarnock.—At a meeting of the Town Council on the 20th inst. it was stated that the drawings of the tramways during the first year amounted to £8,543, while the working costs were £6,200, and, after allowing £2,300 for interest on capital and expenses of the opposition to the order, the net profit was £42. A motion to insert a clause for payment of trade union wages in all Corporation contracts was defeated by 12 votes to 11.

E.P.S. Batteries.—The Electrical Power Storage Co., 4, Great Winchester-street, London, E.C., have issued their usual most useful and ornamental diary, blotting pad, and calendar. We notice two inserts drawing especial attention to the company's laboratory batteries for demonstration and lecture purposes, students' practical use, testing, and miners' electric safety lamps, hand lamps, etc. The company's prices for complete cells, renewals, and plates have recently gone up 5 per cent.

Paddington.—At their last meeting the Borough Council adopted a minute of the Finance Committee recommending that the attention of the London County Council should be directed to the recent quinquennial assessments of the municipal electric undertakings of Bermondsey, Fulham, Hackney, Hammersmith, Hampstead, Islington, Poplar, St. Pancras, Shoreditch, Stepney, and Woolwich. It was suggested that the assessments should be raised to the real values of the undertakings.

Edinburgh.—The Town Council have decided to appoint a Tramway Committee, consisting of 16 members, as one of the standing committees, and ordered that all remits on the subject of the tramways should be transferred to this committee. In addition to the Lord Provost, the following councillors have been appointed: Messrs. A. A. Murray, Bailie M'Michael, Currie, Bailie Dobie, Grieve, Mallinson Treasurer Brown, Neil M'Leod, Bailie Clark, Dean of Guild Wilson, Chisholm, Cunningham, Macpherson, John Murray, and Smith-Elliot.

Calcutta.—The policy of the Corporation in requiring the tramway company to contribute freely to the widening and improvements of such roads as happen to need rectification for their lines appears to be a wise one, for, after all, the tramway extensions only run in sure directions and only follow the most remunerative routes which will plentifully and increasingly recoup any outlay incurred in making them. It is, therefore, only reasonable for the Corporation to insist on the tramway company carrying out in such cases the necessary road improvements.

Erith.—The Electric Light and Tramways Committee of the Borough Council recommend that the rate of pay of conductors be increased from 5½d. to 6d. per hour, as from Dec. 31. With reference to the proposal that the London County Council should construct the authorised tramways from Abbey Wood to the existing Bexley lines in High-street, Plumstead, it was stated that the Highways Committee of the County Council were giving careful consideration to the suggestion, and a communication would be sent so soon as a definite decision had been arrived at.

Great Yarmouth.—An arc lamp which consists of a pair of 23-c.p. lamps with reflectors, placed back to back, has been adopted as the most suitable type to give the best results. Fifty lamps at £3. 3s. are to be placed on short posts, and the lamps are to have a reflector placed over the top. The General Purposes Committee have asked the Electricity Committee to give instructions so that the alternate arc lamps in the borough may be kept lighted until half-past six in the morning from the end of October until the end of January without extra cost to the former committee.

North London Tramways.—Colonel Yorke, on behalf of the Board of Trade, on the 20th inst. inspected the length of tramway which has been constructed from the Highgate Archway to the Archway Tavern to link up the tramway systems of the Middlesex and London County Councils. This short length of tramway has been constructed by the London County Council on the overhead electric system, but, until their own tramways have been electrified, will be leased to the Metropolitan Electric Tramways Limited, and will be worked by them in continuation of the line from Whetstone to the Archway which they already lease from the Middlesex County Council.

Ayr.—The County of Ayr Road Board have recommended the County Council to petition against the order to construct the tramways between Stevenston and West Kilbride, *via* Saltcoats and Ardrossan, unless and until a satisfactory agreement with the promoters had been adjusted. It was pointed out at the last meeting of the committee that several parts of the road were too narrow to admit of a tramway line. At some parts the actual roadway was as narrow as 15ft. The promoters proposed to put down the line on the north side of the road, but the committee were of opinion that the line should be put in the middle of the road, and that the road should be not less than 22ft. between kerbs.

Tramway Men's Loan Clubs.—Two cases are reported in which drivers and conductors employed by the London United Tramways Co. who belong to loan clubs were this Christmas unable to participate in the annual "share out" owing to the disappearance of the men entrusted with the funds. In one instance, so far as can be estimated, between £450 and £500 is missing, together with the treasurer. In the second case the members had anticipated a distribution of some £200. Both the money and the man who had it in his keeping are missing. The clubs are purely private enterprises, promoted entirely by the employés at the depôts, and in no way is the London United Tramways Co. responsible.

Cardiff.—Mr. Arthur Ellis, electrical engineer and manager for the city, on Friday asked the Finance Committee that in the electric lighting department actual and not estimated profits should be dealt with. He said that the Electric Lighting Committee estimated that the profits of the year would amount to £5 000, and the Finance Committee allocated £3,000 towards the relief of rates. The electric lighting profits only amounted to something over £2 000, with the result that the city treasurer's accounts showed that there had been a loss on the working of the department. What he suggested was that for one year nothing should be allocated from estimated profits towards the reduction of rates, and that subsequently the actual profits should be dealt with. The committee agreed to the suggestion.

Accident.—The *Glasgow Evening News* contains the following account of an accident which occurred on the 27th inst. Alexander Melville, an electrical engineer in the employment of the British Westinghouse Co., 65, West Regent-street met with a terrible death this morning at the new sub station in Stirling-road, in connection with the Corporation electricity department. Along with a man named William Scott, Melville was at work on the platform from which the high-tension switches are controlled, conveying a current of 6,500 volts. Evidently under the impression that the current was off, Melville got hold of one of the switches, and the electricity passed through his body, killing him instantaneously. When the current was turned off, which was done in a few seconds, the body dropped to the floor. Dr. Duff was called in, and he pronounced life extinct.

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Private Bills.—The London and North-Western Railway Co. has inserted in its omnibus Bill for next session powers to create £500,000 additional capital, and further borrowing powers to the extent of £150,000. The new capital will provide mainly for the construction of over 21 miles of new railways, of which over 14 miles will be laid down in South Wales and nearly six miles in the construction of a railway from Shepshed to form a junction with the Great Central Railway at Loughborough.

Delagoa Bay.—Speaking at the annual meeting of the Delagoa Bay Development Corporation, Mr. J. C. A. Henderson, the chairman, alluded to the electric tramways, which, he observed, were at present the least satisfactory of the corporation's undertakings. The freight car traffic was a prominent feature. He informed the shareholders that Messrs. Mordey and Dawbarn, of Westminster, had been consulted with reference to the working of the tramways, and a scheme was under consideration which would produce, he hoped, better results.

Birkenhead.—The Corporation have decided to apply for an injunction to restrain the railway company from running their motor-omnibuses. The Corporation are acting on counsel's opinion, which is that the company have no powers authorising them to run such a service. Grounds put forward by the Corporation are that the motor-omnibuses will involve extra expense to the rates, for maintenance of roads and other purposes, amounting to £11,000 a year, equal to a rate of nearly 6d. in the pound, and that the value of property in the better-class residential districts traversed by the vehicles will be reduced.

Bury.—The annual report of the Bury Corporation tramways states that the total revenue was £19,544, and the working expenses £11,041. After paying interest on capital and repayment of sinking fund, there is a net balance of £510, which has been carried to reserve fund. The number of passengers carried was 4,065,455. The average revenue per car mile was 9·21d., and the average working expenses per car mile, including power cost, was 5·20d. Since the complete system had been working the average number of passengers carried per week had been 96,448, and an average of 8,805 workpeople per week had been carried at half-fare.

Wash-outs—Insignificant damage—elaborated and magnified by the daily Press, hard up for copy during the holidays—was done to the basement of the Charing Cross and West-end Electrical Supply Co. by the bursting of a water-main near St. Martin's-lane on Boxing Day. A similar incident occurred in Arthur-street in the City on Christmas Day. There a distribution area was cut off for about 20 minutes; at the first-named place no inconvenience was caused at all. We only mention the matter because of the exaggerations complained of, and also because there was a similar case in the West-end some time ago, and which is at present *sub judice* but which we are informed will probably be amicably settled between the parties when the case is called in March next.

Dundee.—The *Dundee Advertiser* publishes in full the correspondence which took place between the Corporation and Messrs. Gourlay Bros. and Co. *re* the supply of electrical current to Camperdown Shipyard. In their last letter Messrs. Gourlay wrote to the Dundee town clerk, under the date of Dec. 11, 1905: "That owing to the Electrical Committee's refusal to supply us with continuous current as arranged, and also seeing that they now propose to supply three-phase current, which is not so suitable for our purposes, and seeing that we have been quite unable to ascertain any date upon which either current would be available, we are obliged to abandon the scheme to take the Corporation current, and have, therefore, to-day entered into a contract whereby we shall generate our own current."

Vienna Telephones—The *Daily Telegraph* Vienna correspondent says: "Telephonic communication with Pesth, which was lately extended to Belgrade and Sofia, has also been opened up with Bucharest. At present Vienna is in touch with Berlin on the north, and with Pesth, through which it can also reach the capitals of Bulgaria, Servia, and Roumania with powerful transmitters. The rate from Pesth to Bucharest is fixed at 2s. 6d. for three minutes, or 5s. for urgent use. Up to the present the interurban telephone is not much used by the general public, but is largely patronised by the Press and by operators on the Bourse. It was probably the telephone which permitted the Vienna papers to give the recent debates of the German Reichstag at Berlin at a length of seven and eight columns the next morning."

Barnstaple.—An inquiry has been held into an application of the Town Council for sanction to borrow £4,000 for purposes of electric lighting. Mr. J. Jordan, borough accountant, stated that the number of consumers was now 256, and they started with 98 three years ago. The capital expenditure was £29,783. The revenue for the year was £3,085, and the expenditure on the revenue account, including interest and redemption debt, £3,110. He said that no surplus was shown, because the Christmas accounts, which amounted to £514, were not included. Mr. C. E. R. Chanter opposed the application as a large ratepayer and an owner of property, but Mr. Bosson, the town clerk, submitted that Mr. Chanter appeared in no other capacity than as vice-chairman of the gas company, and was assisted by the secretary of the company (Mr. Schofield).

Dewsbury.—It seems as though the projected tramway from Dewsbury to Earlsheaton and Ossett will be taken in hand at an early date. The Dewsbury Town Council have passed a resolution in favour of applying to the Board of Trade for a provisional order for the purpose of reviving and extending the time for the exercise of the powers of the Dewsbury Corporation Tramways Order, 1904. Negotiations have been proceeding between the local authorities and the Wakefield and District Light Railway Co., and it is hoped the company may be induced to undertake the construction and working of the line. The Ossett Town Council have also passed a formal resolution to extend the time for carrying out the construction of an electric tramway from Ossett Market-place to the borough boundary—part of the proposed scheme of tramways from Ossett to Dewsbury.

Bo'ness.—We have previously referred to the differences between the Town Council and the National Electric Construction Co. with reference to the interpretation of certain clauses of the working agreement for the electric lighting of the borough. The chief subject under dispute referred to the right of the Town Council to appoint an independent inspecting engineer to examine the plant and system, and charge the company all expenses incurred in so doing. The Town Council have now accepted an offer of the company to pay at the end of five years a lump sum of 40 guineas towards the fee of an engineer making the inspection. The Council have also resolved to accept a tender of £100 towards the payment of interest on a balance of £5,000 lying at the credit of the Town Council pending the receipt of a certificate from the consulting engineers in London before paying the Construction Co. the final instalment.

Lancaster.—The Electricity Committee have decided to supply current to the L. and N.W. Railway works at the rate of 1½d. per unit net, subject to their guaranteeing a minimum consumption of 42,000 units per annum for a period of seven years. This will amount to £262. 10s. per year, a sum which would cover the repayment on the cost of the main (£860) and the increased cost at the works, and leave a small balance of profit. The matter has not yet been confirmed by the Town Council. Amongst other things under consideration is the purchase of the following plant, estimated to cost £280. 5s.: one large wheel lathe, with motor complete, £237. 10s.; one armature cradle (the one in use being inadequate for present requirements), £24; one tyre furnace (for removing and replacing steel tyres and wheel centres) £4. 15s.; one jib crane (for handling axles and wheels when shrinking tyres on centres), £14.

Faraday House Testing Fees.—We have received from the Electrical Standardising, Testing, and Training Institution a pamphlet describing the facilities for testing at Faraday House, together with a list of charges. The scope of the institution's work embraces everything that is supplied by the electrical and associated industries, and the scale of fees is very reasonable. The institution is prepared to test complete sets of tramway insulation, fees for which will be quoted on application. For testing the resistance of rail bonds the fees range from one guinea, and for electrical and mechanical tests of globe strain insulators the fees are 31s. 6d. The laboratories and workshops at Faraday House are provided with instruments and apparatus requisite for this class of work, and are connected with the public electricity supply mains, from which a constant supply of both direct and alternating current is always available.

Paris.—All the navvies who were on strike have now returned to work on the Metropolitan Underground Railway, but the masons and tube-layers are still out. The navvies have not obtained all their demands from the contractors and engineer, but they are now manifestly satisfied with the agreement proposed, although they refused it on Nov. 30, after they had been a week out. Under this agreement piece-work is abolished, extra pay is given for working in water, and no fines will be imposed. In the meantime, the inquiry ordered by the Municipal Council as to the manner in which the contractors and engineers of the underground line are conducting and completing the works is continuing. The members of the Municipal Council who are engaged on the investigation are accompanied by workmen, who point out the deficiencies in the construction of the line under the Place de la République and elsewhere.

London Gazette—The Electrical Ore-Finding Co. has been wound up voluntarily, and Mr. J. D. A. Norris, Suffolk House, Laurence Pountney-hill, London, appointed liquidator. The first meeting in the estate of W. Leslie, lately carrying on business as an electrical engineer at 22, Bangleore-road, Putney, will be held at 132, York-road, Westminster Bridge, S.E., at 12.30 p.m. on Jan. 2. The Atmospheric Electrical Purification Co. has been wound up voluntarily, and Mr. E. E. Groome, 21 Spring-gardens, Manchester, appointed liquidator. The Shanghai Electric Tramways Co. has been wound up voluntarily, and Mr. G. G. Walker, 19, St. Swithin's lane, London, E.C., appointed liquidator. The St. Helens Cable Co. has been wound up voluntarily, and Mr. A. Wenham, 10, Walbrook, London, appointed liquidator. The discharge of A. E. Brooks, electrical engineer, 110, Cheapside, London, has been suspended for two years.

London County Council.—A trial trip on the first underground tramway constructed in London by the County Council was held in the early hours of the 22nd inst. So far the underground tramway, the authorised southern terminus of which is on the Embankment close to Waterloo Bridge, has been completed only to the crescent of Aldwych, but as the electrification of the tramway to the Angel at Islington is now complete, it was thought desirable, with a view to its anticipated opening for traffic early in the New Year, to test the working arrangements as regards of gauge, curves, gradients, continuity of current, and other matters. A single-decked inspection car bearing the number 101 ran smoothly along the tunnel, and with ease it climbed the steep ascent up to Theobalds road, and on emerging was shunted by a pointsman in readiness on to the down line, and the descent was made with equal smoothness. Through runs to the Angel and back followed with satisfactory results.

Littleborough.—The Electricity Committee have now been empowered to take such steps and obtain such expert assistance as they deem necessary in order to submit a complete electric lighting scheme, with estimate of the cost, to the Council at a future meeting. The approximate cost is stated at £2,000. This means an annual expenditure on interest and depreciation at 6 per cent. of £120. The Central school uses 2,655 units per annum, the Council offices 613, fire station 93, stables 84, textile school 617, and free library 1,174. By obtaining current from the Rochdale Corporation at about 2d. per unit, and with the sum of £120 for interest and repayment, there will

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be a total annual expenditure of £155. 7s. It is considered that a reduction to a reasonable sum of the price of current to the Central school would mean, at 4d. per unit, an income of £42. 6s. Compared with the present cost, the Council will be able to save 2d. per unit on the remaining 2,000 units, which would amount to £16. The scheme would, therefore, mean an expenditure of only £97 per annum, and some revenue which may be expected from private lighting.

Twickenham and Teddington Electric Supply Co.—The company's new Bill contains provisions as to exercise by Twickenham and Teddington Electric Supply Co. or Edmundson's Electricity Corporation of powers of and exemption of Hampton Urban District Council and Teddington Urban District Council from liabilities under Hampton Electric Lighting Order, 1901, and Teddington Electric Lighting Order, 1901; power to make agreements for such purposes, and confirmation of existing agreements; provisions as to transfer of such orders; further powers with respect to supply of electrical energy, laying of electric lines, etc., and breaking up streets, railways, etc., within Twickenham, Hampton, Teddington, Hampton Wick, Sunbury, Feltham, Hanworth, Ashford, Shepperton, Ham, East and West Molesey, and Esher and the Dittons, and powers to supply in adjoining areas; agreements with and powers to electric undertakers and others in such adjoining areas; confirmation of and powers to maintain existing works, etc.; terms and conditions of supply; provisions as to purchase by local authorities; incorporation and amendment of Acts and orders, etc.

Rochdale-Heywood. — The length of tramway between the Rochdale boundary and the Heywood Market-place was inspected by Colonel Druitt (on behalf of the Board of Trade) on the 20th inst., who sanctioned its immediate use for traffic. A satisfactory agreement was come to between the Rochdale and Heywood representatives on certain points in the draft agreement for the working of the new lines. The terms of the settlement provide that Heywood shall supply current and keep the track and overhead equipment in order, and that Rochdale shall supply cars and work the lines. The through fare from the Rochdale centre to the Heywood Market-place is 3d., and Heywood's share of this is to be calculated on the basis of car mileage, giving Heywood 1·17d. and Rochdale 1·83d. To the Rochdale borough boundary at Heywood Cemetery the distance is 2·16 miles, and the fare so far has been 2½. From Heywood Cemetery to the Heywood Market-place the distance is 1·37 miles, making a total distance of 3½ miles from the Rochdale centre. The only point that has been left over for settlement by the respective sub-committees is the question of the overlapping stages and the basis on which receipts taken on these shall be divided. An agreement will now be drawn up in accordance with the draft signed last week.

Nottingham.—The town clerk has prepared for the City Council a report on the proposal to amend the Notts and Derbyshire Tramways Act, 1903, the Bill for which will be promoted in the next session of Parliament. The principal clauses that may affect the Corporation deal with extensions of the time for purchasing land and for the construction of the tramways until Aug. 11, 1908, and the Corporation's power of purchase, which is now put at 21 years, or at the expiration of the lease. By Section 11 of the Bill power is given to the company to run motorcars, omnibuses, or other vehicles in connection with or in extension of their tramway system. By Section 34 of the Bill power is given to the promoters to sell to the Corporation: (1) the tramway commencing at the present system in the Gregory-boulevard and going along Abbey-street, Dunkirk-road, Beeston-road to the city boundary; (2) the tramway commencing at the present system in Bentinck-road and going along Alfreton-road and Nuthall-road to the city boundary; (3) the tramway commencing in Sneinton Market and going along Carlton-road to the city boundary; (4) the tramway commencing at the termination of the present system on the Mansfield-road at Winchester-street and going along the Mansfield-road to the city boundary. The remainder of the sections in the deposited Bill do not affect the Corporation.

Harrow.—At the last Urban District Council meeting the surveyor presented a special report on the proposal of Northwood to apply to the Board of Trade for an order to supply electricity for lighting and power in the district. The application embraced power to cut, stop up, and divert roads in the district, and he suggested that the application be opposed with a view to the insertion of protective clauses. Clauses would have to be inserted for the protection of the sewers, the price to be charged restricted, and the power obtained to limit the period of the order. At present power was taken for 42 years, and not until the expiration of that time could the Council purchase, even if they wished to do so. Mr. Hogg thought there should be a clause prohibiting the opening of a number of roads at the same time. The report was adopted, the clerk and surveyor being instructed to make all necessary preparation for opposing. The surveyor also presented a report on the proposal of the North Metropolitan Electric Power Co. to obtain powers to extend their mains from Edgware Bridge to Stanmore corner. He pointed out that the company did not propose to light Little Stanmore. They undertook to carry out the work within two years, and to supply electricity for private as well as public purposes. The power sought by this company would preclude the Council from executing any work of a similar character, and he suggested that the usual steps be taken for insuring protective clauses. The Council agreed.

Islington.—After a long debate on the report of the Lighting Committee, which appeared in our last issue, the matter has been deferred to two committees for further report. The report referred to in our issue of Dec. 15 with regard to the extension of arc lighting came again before the Council last Friday, and was referred to the Finance and Lighting Committees. The report stated that in the interests of the borough and also of the electric light undertaking, it was desirable that there should be a considerable extension of street arc lighting, and they proposed to extend the supply to about 15 miles of streets at present lit by 714 incandescent gas lamps. These they proposed to supersede by 245 electric arc lamps. If their suggestion were adopted, they proposed that the sum of £15,734 allocated to the electric lighting department for street-lighting last year should not be increased but remain a fixed charge, and in that event the cost per unit would be nominally reduced from 3½d. to 2½d., and the cost per lamp per annum, exclusive of carbons and trimming, nominally reduced from £32. 2s. to £20 12s. A statement had been prepared by the electrical engineer, from which it appeared that the present sum paid under contract to the gas company for gas would be more than enough to pay the interest on the loan, together with the cost of maintenance and charges for carbons. The electrical engineer's estimate of the amount required to carry out the complete scheme was £21,011, of which £3,812 had already been sanctioned by the London County Council, leaving an amount of approximately £17,000 to be raised by loan in the usual manner. The committee recommended that the estimate be approved, and that the Lighting Committee be authorised to proceed with the scheme, application being made to the London County Council for sanction to the borrowing of £17,200.

Heckmondwike.—Mr. G. H. Carter, the District Council's electrical engineer, in his report on the working of the station in Bath-road for the six months ended Sept. 30 last, gives the following figures: Units generated — traction, September, 1905, 130,453 (September, 1904, 124,305); lighting, 160,915 (68,742) — total, 291,368 (193,047). Units sold—traction, 118,548 (117,482); private, 20,515 (15,090); power, 81,047 (12,645); street-lighting, 17,327 (13,814)—total sold, 237,437 (159,031). Consumers connected, 18 (14); equivalent 8-c.p. lamps, 2,685 (1,626); number of consumers, 197 (149); total lamps connected, 22,823 (13,326). The cost of generation and distribution over the same periods per unit sold were: coal, ·31d. (·33d.); oil, waste, and water, ·05d. (·04d.); wages, ·23d. (·26d.); repairs, ·10d. (·03d.); management, insurance, rent, rates, and general charges, ·30d. (·34d.); cost per unit sold, 1·01d. (1·03d). The financial results of the six months' working are as follows: Expenditure—fuel, 1905, £311. 11s. 2½d. (1904, £221. 18s. 3d.); wages, £231. 13s. 10d. (£177. 5s. 10½d.); oil, water, and stores, £55. 8s. 3d. (£39. 13s. 2d.); repairs, £101. 1s. 4½d. (£25. 5s. 0½d.); works costs, £699. 14s. 8d. (£454. 2s. 4d.); management, £171. 13s. 10½d. (£138. 14s. 2d.); general charges, £23. 10s. 3½d. (£20. 4s. 6d.); insurances, £8. 5s. 9d. (£4. 2s. 3d.); rent and rates, £97. 2s. 6d. (£67. 3s. 4d.)—total costs, £1,005. 7s. 1d. (£684. 6s. 7d.). Income—Sale of energy: private, £313. 9s. 7d. (£209. 14s. 3d.); power, £340. 4s. 7d. (£59. 7s. 7d.); street-lighting, £204. 16s. 6d. (£214. 1s. 6d.); traction company, £972. 15s. 7d. (£865. 3s.); meter rents, £15. 2s. 1d. (£10. 19s. 1d.); baths, £12. 10s. (£12. 10s.)—£1,858. 18s. 4d. (£1,372. 15s. 5d.); costs as above, £1,005. 7s. 1d. (£684. 6s. 7d.)—balance, £853. 11s. 3d. (£688. 8s. 10d.); six months' interest and sinking fund on £20,843 at 6½ per cent., £677. 7s. 6d. (£677. 7s. 6d.)—£176. 3s. (£11. 1s. 4d.).

PROVISIONAL PATENTS, 1905

DEC. 15.

26097. An apparatus for centralised control of electric switches connected to alternating-current distributing networks. Joseph Duncan Spark, 3, Fairholm-road, West Croydon.

26109. Improvements in and relating to conductors for the electric lighting of miners' safety lamps. Didymus Thomas and William Phillips, Bryn Awel House, Treharris, Glamorgan.

26122. Improvements in and relating to incandescent and other electric lamps. William John Fowler, 3, Lincoln's-villas, Highwood-hill, London.

26144. Improvements in and connected with fuses for electrical circuits. Walter Edward Richards, 16, Great George-street, Westminster, London. (Complete specification.)

26149. An improved system of electrical distribution. Roderick McKenzie Palmer, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 22, 1904, being date of application in United States.) (Complete specification.)

26162. Improvements in couplings for electrical wires. Henry Fairbrother, 33, Cannon-street, London. (John Griffith Thomas, U.S.A.)

26182. Intercommunication by means of telephones or other electric signalling apparatus over lines used as feeder cables, pilot wires, or the like. Reginald William Klitz, 15, Herbert-road, Wimbledon, London.

26187. Improvements in means for controlling the lights in railway carriages lighted by electricity or gas. J. Stone and Co., Limited, and Alfred Henry Darker, 77, Chancery-lane, London.

DEC. 16.

26207. Improvements in protective devices for use in the distribution of electricity by overhead wires for electric tramways and the like. James Robson, 3, Devonshire-place, Selly Park, Worcestershire.

26219. A spring improved raising and lowering electric light device. Walter Verum, The Dendles, Latham-road, Twickenham, Middlesex.

26223. Improvements in or connected with electric tramways on the conduit system. Henry James Peddie, 14, Fountainhall-road, Edinburgh.

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26281. Improvements in electromagnets for alternating-current circuit breakers and the like. Michael Birt Field and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED

To be published Jan. 4.

1905.

5980. Alternating-current dynamo-electric machines. British Thomson-Houston Company, Limited. (General Electric Company.)

10794. Electrical signalling apparatus particularly adapted for signalling in mines. Woodworth.

14441. Means for suspending and sustaining electric lamps at any desired height. Whitaker and Wass. (Date applied for under International Convention, July 14, 1904.)

15289. Telephone call registers. Meyer.

15594. Conveying currents to electrodes arranged in electrically insulated tubes. Garz und Co. Energieverei und Maschinen Fabriks Act.-Ges. (Date applied for under International Convention, Aug. 26 1904.)

17181. Thermo-electric couples. British Thomson-Houston Company, Limited. (General Electric Company.)

19138. Dynamo-electric machines. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, Sept. 22, 1904.)

19201. Constant-current electric distributing system for the utilisation of variable sources of power. Böhm.

19752. Road vehicles. British Thomson-Houston Company, Limited. (Allgemeine Elektricitäts-Ges.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	'00	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	98-100
British Westinghouse Elec. and Manuf. 6 per cent. Pref., 275,001-375,000	5	..	1⅞ 2⅛
—— 4 per cent. Mortgage Debenture Stock	100	..	80-85
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	½-⅝
—— Non. Cum., 6 per cent. Pref.	2	..	1½-1⅝
—— 4½ per cent. 1st Debenture Stock	100	..	96-100
—— 4½ per cent. 2nd Debenture Stock	100	..	84-86
Callender's Cable, Debentures	100	..	109-111
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5⅜-5⅝
Crompton and Co.	3	..	2-2½
—— 5 per cent. Debentures	100	..	97-100 p.c.
Edison and Swan United, "A" Shares, 1-99,261	3	..	1⅜-1⅝
—— "A" Shares, 01-017,139	5	..	2½-2¾
—— 5 per cent. Debentures	100	..	92 97
—— 4 per cent. Deb. Stock, Red.	100	..	85 90
Electric Construction, Nos. 1 to 112,100	2	..	½-¾
—— 7 per cent. Cumulative Pref.	2	..	1⅝ 1⅞
—— 4 per cent. Perp. 1st Mort Deb.	100	..	92-95
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-93
General Electric Company (1900), 5 per cent. Cum. Pref...	10	..	9¼ 9⅜
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-100
W. T. Henley's Telegraph Works, Ordinary	5	..	12½ 13½
—— 4½ per cent. Preference	5	..	5⅜-5⅝
—— 4½ per cent. Debentures	100	..	109-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18½-19½
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Telegraph Construction and Maintenance	12	..	32-34
—— 5 per cent. Bonds	100	..	102-104
Electric Lighting and Supply.—			
Bournemouth and Poole, Ordinary	10	..	12½ 12¾
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10½-10⅝
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11½-12½
—— 4½ per cent. Debenture Stock, Red.	100	..	107-109
Bromley (Kent) Electric Light and Power Co.	5	..	5½-5⅝
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	8⅜ 9⅜
—— 7 per cent. Preference	5	..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	9-9½
—— Nos. 60,001-80,000	5	..	8¾-9½
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	102-105
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	5⅜-6⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	5½-5⅝
—— 4 per cent. Debenture Stock, Red.	100	..	101-103 xd
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— ditto (1903) 40,001-80,000	5	..	4⅜-5
Chelsea Electricity Supply	5	..	5 6
—— 4½ per cent. Debentures	100	..	110-112
City of London, Ordinary	10	..	11-12
—— 6 per cent. Cumulative Pref.	10	..	13½-14½
—— 5 per cent. Debenture Stock	100	..	124-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	101-103
County of London Electric Supply, Ordinary	10	..	8½-9½
—— 6 per cent. Cum. Pref.	10	..	12⅝-12⅞
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	112-115
—— 4½ per cent. 2nd Debentures Prov. Certs.	100	..	101-103
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	5½-5⅝
—— 6 per cent. Cum. Pref.	5	..	5½-6
—— 4½ per cent. First Mort. Deb.	100	..	107-109
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-3
—— 5 per cent. Debenture Stock, Red.	100	..	87-92

Name.	Amount paid.		Last price
	£		£
Folkestone Electric Supply, Ord. Nos. 1-10,000	5	..	5½-5⅝
—— 4½ per cent. First Deb. Stock, Red.	100	..	101-104
Havana Electricity, 1-15,000	10	..	9-10
Hove Electric Lighting, Ord., 1-13,000	5	..	8½-8⅝
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk. Red.	100	..	100-103
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	¾-1
Kensington & Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	10¾-11⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock Red.	100	..	101-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10¼
London Electric, Ordinary	3	..	1½-2⅛
—— 6 per cent. Pref.	5	..	4⅜-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-102
Metropolitan Ordinary, 100,001-300,000	5	..	9 10
—— 4½ per cent. First Mortgage Debenture Stock	100	..	109-113
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	..	97-99
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	101-103 p.c.
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,079	5	..	8-8¼
—— do., 57,080-75,000	5	..	8-8⅛
—— 5 per cent. Pref., 1-57,000	5	..	6¼ 6⅜
—— do., 57,080-75,000	5	..	6¼-6⅜
Notting Hill Electric Lighting	10	..	13⅞ 14⅛
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	..	98-100
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	6⅜ 6⅞
—— 4 per cent. Debenture Stock	100	..	100-102
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-103
Smithfield Markets Electric Supply, Ord. 1-12,000	5	..	2-2⅛
—— 4 per cent. Debenture Stock	100	..	76-80
South London, Ordinary	5	..	3 3¼
South Metropolitan Electric Light and Power, Ord.	1	..	13/16-15/16
—— 7 per cent. Cum. Pref.	1	..	1 5/16-1 7/16
—— 4½ per cent. 1st Mort. Deb.	100	..	105-108
—— Ditto, June, 1904	—	..	—
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	12¾-13⅛
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	£8 100
Urban Electric Supply Co., Ordinary, 8-30-007	5	..	4¼-4⅜
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	6-6¼
Westminster, Ordinary	5	..	11½-12¼
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	5¼-6¼
Electric Tramways.—			
Anglo-Argentine, 5½ per cent. Cum. Pref., 1-260,007	5	..	5⅞-6⅛
—— Ord.	5	..	8⅜-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	142-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	105-107
Barcelona Tramways, Ord., 1-20,000	10	..	13¾-14¼
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	..	9½-10
—— 5 per cent. Deb., Red., 1-600	100	..	98-101
—— 4½ per cent. Red. Deb. Stock	100	..	97-102
Bath Elec. Tramways, Ld., Pref. Ord. Shs., 75,001-150,606	1	..	15/16-1
—— 5 per cent. Cum. Pref. Shares, 1-59,394	1	..	15/16-1 1/16
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Brisbane Tramway Invest., Ord., 1-75,000	5	..	1-1⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	95-98
British Columbia Electric Railway Co., Ord. Def.	100	..	119-122
—— Ord. Pref.	100	..	109-113
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	106-109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	103-105 p.c.
—— 4½ per cent. Vancouver Power Deb.	100	..	102-105
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	7¼-8¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	10-11
—— 5 per cent. Perpetual Debenture Stock	100	..	117-119
—— 4½ per cent. 2nd Deb. Stock	100	..	97-99
Buenos Ayres and Belgrano Trams	5	..	3¼-3⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5 11/16-5 15/16
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	..	107-109
—— Prov. Cert., all paid	100	..	102-105
Buenos Ayres Electric Trams., 5 p.c. Deb. Stk., Red.	100	..	98-100
Calcutta Tramways, 1-102,268	5	..	9¼-9⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	107-108
Cape Electric Tramways, Nos. 1-480,000	1	..	⅛ 1⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4¼ 5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3000 (1917)	100	..	100-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	101-103
Cork Electric Tramway and Lighting Co., Ordinary	10	..	14½-15½
—— 6 per cent. Cum. Pref.	10	..	15-16
—— 4 per cent. Debentures	100	..	100-102
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	14½-15½
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per c. Cum. Pref., Nos. 30,001-60,000	5	..	2½-2⅝
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	85-88
Kidderminster and District Lighting and Traction, Pref.	5	..	8-8¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	10-10¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	100 103
Madras Elec. Trams. (1904), 5 per cent. Deb. Stk., Rd.	100	..	103-105
Metropolitan Elec. Trams., Defd., 1,000,001-1,314,016	1	..	7/32-9/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	..	1-1 1/16
—— 4½ per cent. Deb. Stock, Red.	100	..	106-108
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Cons. Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	..	104-107
Montreal Street Rail., Sterling 5 per cent. (Mort.) Deb., 1908, 1-600	100	..	101-104
—— Sterling 4½ per cent. Deb., 1922, 601-2,000	100	..	102-104
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	..	½-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	12
—— 5 per cent. Cum. Pref.	10	..	9⅜-9⅞
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Sk.	100	..	101-104
Potteries Electric Traction, Ordinary, 20,001-40,000	10	..	8⅜-9½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9⅜-10½
—— 4½ per cent. Debenture Stock	100	..	102-105
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £101,132 6 per cent. Preference	1	..	1
—— £597,170 4½ per cent. Debenture Stock	100 p.c.	..	100 p.c
Electric Railways.—			
Central London, Ordinary	100	—	93-96
—— 4 per cent. Pref.	100	—	101-103
—— " deferred	100	—	85-88
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	111-113

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Name.	Amount paid.	Last price.
	£	£
City and South London, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	105-108
—— 5 per cent. Pref. Stock '91	100	119-121
—— ,, ,, ,, '95	100	117-120
—— ,, ,, ,, '01	100	114-116
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent Mortgage Debentures, Red., 1-1,700.,	—	97-98 xd
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	93½-97¼
Waterloo and City, Ordinary	100	94-97

Name.	Amount paid.	Last price
Telephones.—	£	£
National Telephone, Preferred	100	110½-111½
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	5⅝-5¾
—— 3½ per cent. Deb. Stock, Red.	100	98-100
—— 4 per cent. Deb. Stock, Red.	100	104-105
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1¼-1⅜

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1905.	1904.	Week.	Current year.	1905.	1904.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 23	1,235	1,154	+ 90	+ 1,148	25½	20¾	May 31	64,071	15,530,351	1,379,723	0·98	11·14	2,512	6·45
Ayr Corporation	,, 23	186	177	+ 9	—	8	8	,, 15	14,328	3,316,380	353,945	1	9 71	1,830	5·16
Barking Corporation	—	—	—	—	—	1·33	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 24	1,102	1,026	+ 76	— 593	23 53	23½	March 31	55,025	11,145,531	1,309,903	1·18	10·08	2,338b	6·03
Birmingham Corporation	,, 23	435	384	+ 72	—	2	2	,, 31	17,133	4,709,738	265,525	·86	14·5	8,866	—
Blackburn Corporation	,, 20	873	778	+ 94	—	24	24	,, 25	48,875	8,661,720	986,953	1·35	11 89	2,036	7·44
Blackpool Corporation	Nov. 2	340	350	- 10	—	17½	17½	,, 31	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Dec. 23	187	182	+ 5	— 1,103	16½	16½	Dec. 31	31,846	2,325,677	579,264	3 28	13·19	—	7·27
Bolton Corporation	,, 24	1,875	1,626	+ 249	—	40	38	March 31	95,766	20,205,196	2,161,130	1·13	10·63	2,394	6·14
Bournemouth Corporation	,, 20	1,223	857	+ 366	—	16 82	16 82	,, 31	55,276	10,058,288	1,121,623	1·32	11·83	3,226	7·19
Bradford Corporation	,, 16	4,184	3,729	+ 354	—	96	77	,, 31	230,085	47,108,000	5,033,392	1·172	10·927	2,396	—
Brighton Corporation	,, 24	877	852	+ 25	+ 479	9	9	,, 31	50,339	11,321,160	1 152,828	1·06	10·48	2,914·8	8·014
Bristol Tramway Company	,, 22	5,109	5,076	+ 33	—	51½	51½	Dec. 31	259,799	45,312,373	6,127,135	—	—	—	—
Burnley Corporation	,, 23	1,121	982	+ 139	—	10 60	10·60	March 31	—	—	—	1·32	10·56	2,768	8·18
Burton Corporation	,, 24	322	262	+ 60	- 1,378	8¼	8¼	,, 31	17,950	3,878,269	454,082	1·07	9 21	2,068	6·76
Cardiff Corporation	,, 16	1,803	1 831	— 78	— 32	26†	—	,, 31	112,209	24,134,363	2,770,049	1 12	9·72	3,782	9·44
Carlisle Tramways Company	,, 23	180	174	+ 6	— 661	8·5	8·5	Dec. 31	10,713	2,935,003	359,756	—	7·14	—	5·18
Central London Railway	,, 23	7,398	7,744	— 346	— 922	6	6	,, 31	347,538	44,875,547	1,281,214	1·86	65·10	57,931	35·80
City and South London Railway.	,, 24	3,044	3,767	— 723	— 130	6¼	6¼	,, 31	—	—	—	—	—	—	—
Colchester Corporation	—	—	—	—	—	7	7	—	—	—	—	—	—	—	—
Cork E. T and L Company	,, 21	443	446	— 3	+ 638	15½	15½	,, 31	24,895	5,814,376	882,256	1·01	6·64	—	4·69
Darwen Corporation	—	—	—	—	—	7·23	7·23	March 31	—	—	—	—	—	—	—
Dover Corporation	,, 16	168	180	- 12	—	4½	4½	,, 31	11,250	2,853,200	284,343	·94	9·49	2,500	—
Dublin and Lucan Electric Ry.	,, 22	107	105	+ 2	- 23	6¾	6¾	Dec. 3	6,358	402,511	110,738	3·79	13·78	942	7·33
Dublin U. T.	,, 22	5,099	4,932	+ 117	— 3	47	46	,, 31	267,489	50,050,949	7,077,372	1·23	9 07	5,691	5 55
Dundee City Tramways	,, 20	939	815	+ 124	—	23	23	May 15	44,695	11,641,525	933,006	·90	11·49	1,943	7 13
East Ham Corporation	,, 16	729	618	+ 111	—	23	23	March 31	36,652	13,689,658	863,816	·64	10·18	2,994	6·79
Glasgow Corporation	,, 23	15,837	14,066	+ 1,771	+ 26,701h	144¾	143	May 31	756,480	195,767,519	17,915,595	—	10·12	—	—
Gloucester Corporation	—	—	—	—	—	9	5½	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	35½	33	March 31	74,019	17,849,642	1,540,707	—	11·53	2,085	8·56
Huddersfield Corporation	,, 16	1,200	1,171	+ 129	+ 2,024	35	35	,, 31	69,938	12,838,150	1,666,262	1·24	9·71	1,923	—
Hull Corporation	,, 23	2,408	2,291	+ 116	+ 976	27	26	,, 31	112,651	27,102,921	2,910,693	1	9 29	—	5·42
Ilford Corporation	—	—	—	—	—	—	10½	,, 31	—	—	—	—	—	—	—
Ilkeston Corporation	,, 20	102	87	+ 15	— 761	—	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	12,201	3,632,855	432,336	·775	6·519	—	7·649
Leeds Corporation	,, 16	5,848	5,411	+ 437	+ 5,832	89	89	March 25	298,233	64,223,656	7,121,038	1·10	10·02	3,351	—
Leicester Corporation	,, 23	2,209	1,781	+ 423	—	42	—	Dec. 31	26,011	12,039,252	1,229,507	1	9·79	—	4·82
Liverpool Corporation	,, 16	10 337	10,121	+ 116	+10,662	103	103	,, 31	547,625	116,642,663	12,166,419	—	—	—	—
Liverpool Overhead Railway	,, 24	1,479	1,495	— 16	— 1,656h	6·57	6·57	June 30	81,302	11,171,865	1,024,275	—	—	—	—
London County Council	,, 19	13 830	11,920	+1,9 0	+7,155	—	—	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 9	129	133	— 4	—	6	5½	Sept. 30	14,511	3,128,867	359,435	1·08	9·68	2,638	6·48
Maidstone Corporation	,, 21	84	94	— 8	—	2½	2	—	4,740	850,121	112,227	1·33	10·13	2,370	—
Manchester Corporation	,, 23	13 439	11,003	+2,436	+ 21,257	149	131½	March 31	631,956	126,900,875	14,123,124	1·19	10·73	4,299	6·99
Metropolitan District Railway	,, 24	8,328	7,585	+ 753	+ 4 580	24	—	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 24	18,845	18,336	+ 509	+ 3,152	70½*	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 23	131	103	+ 23	+ 517	—	2¾	,, 31	6,159	1,972,647	206,358	·82	7·14	2,239	—
Newcastle-on-Tyne Corporation	,, 23	4,067	3,736	+ 331	+ 3,699	50	45	,, 31	197,849	43,069,934	4,326,152	1·07	10·98	3,957	7·01
Newport (Mon.) Corporation	—	—	—	—	—	32	32	—	—	—	—	—	—	—	—
Oldham Corporation	,, 24	1 666	1,258	+ 407	—	—	34	,, 25	65,553	13,466,245	1,504,740	1·16	10·45	1,886	—
Portsmouth Corporation	,, 9	1,449	1,333	+ 116	—	—	29	,, 31	95,702	19,625,329	197,499	1·17	11·63	—	—
Reading Corporation	,, 7	555	542	+ 14	— 481	—	33½	,, 31	—	—	—	—	—	—	—
Rochdale Corporation	,, 23	868	814	+ 454	—	6½	4¼	,, 31	14,881	2,837,110	386,547	1·24	9·24	1,102	7·92
Rotherham Corporation	Nov. 9	514	497	+ 37	—	9½	7¼	,, 31	23,569	5,251,472	593,054	1·07	9 53	2,612	7·49
Salford Corporation	Dec. 18	4,098	3,817	+ 281	—	70¾	—	,, 31	214,111	39,213,560	4,884,590	1·28	10·29	—	—
Scarborough Tramways Co.	—	—	—	—	—	—	4½	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 24	5,290	4,465	+ 825	+10,183	65¾	52½	,, 25	240,565	63,952,283	6,049 899	·903	9·543	3,653	6·477
Southampton Corporation	,, 20	873	895	— 22	— 333	—	18	,, 31	49,365	9,294,771	1,108,369	1·27	11·02	—	7·83
Southend-on-Sea Corporation	—	—	—	—	—	—	9	,, 31	—	—	—	—	—	—	—
Stockport Corporation	,, 15	807	398	+ 409	—	—	10½	,, 31	—	—	—	—	—	—	—
Sunderland Corporation	,, 24	1,328	1,203	+ 125	+ 1,805	20	20	,, 31	64,858	15,364,463	1,495,685	1·004	10·36	—	6·37
Swindon Corporation	,, 20	163	150	+ 13	—	—	4½	,, 31	4,937	1,315,757	102,751	0·87	11·53	1,371	—
Wallasey U.D C.	,, 23	757	633	+ 124	+ 1,085	11·85	10 5	,, 31	38,768	7,412,881	778,851	1·30	11·94	3,271	7·54
Warrington Corporation	—	—	—	—	—	7½	—	,, 31	17,057	4,418,225	403,363	—	9·85	—	6·33
West Ham Corporation	,, 14	1,773	1,014	+ 759	—	46	8 62	,, 31	—	15,773,742	1,237,165	—	—	—	
Wolverhampton Corporation	,, 20	760	—	—	—	—	7½	,, 31	36,757	7,666,786	809,508	—	10·898		

* Including steam trains. † And 98 mile of interlacing track. a Train mile. Per mile of single track. h Half-year's figures.

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Supplement to "The Electrical Engineer,"

JULY 7, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

794. Describe the method of arranging the stator windings of two or three phase motors with a view to speed regulation. Is it possible to arrange a 12-pole winding so as to reduce to eight poles?—OMEGA.

ANSWERS.

Question No. 786.—At a hydro-electric installation some surplus power is available. State the best method of obtaining a record of the same with a view to installing another turbine 12 months hence. Fall, 11ft., subject to frequent floods.

Answer to No. 786 (*awarded* 5*s.*).—It is evident from the question that only an approximate record of the surplus horse-power available is required, say to within 5 or 10 per cent., on account of the very varying nature of the conditions under which the water is supplied and fed to the installation. It would, however, be a very wise plan, indeed, if two sets of records were taken—one when the fall of the water *is* subject to the flood, and the other when it *is not*. In the very nature of things the two records would be entirely different. In order to obtain a record or records, certain data are required. In the first place, we require to know the quantity of water which is passing over the weir—presuming the existence of such—during unit time, say one minute, when the fall is working under either normal or abnormal conditions according to the record which is required. If the velocity of the water and the depth of the water passing over the crest of the weir can be observed or computed, then the quantity of water passing over the weir can readily be calculated. The velocity of the water may be made in various ways. The simplest, and certainly the least expensive way, is to observe the velocity of some floating body in the middle of stream (as, for example, a moderately-sized piece of wood or other similar body). Let this velocity be denoted by V, then the approximate mean velocity, v, is equal to

$$\frac{7{\cdot}7 + V}{\frac{10{\cdot}3}{V} + 1}.$$

Having found the above quantities, we can then calculate the weight of water passing over the fall per second.

Let W = weight of water, in pounds, passing per second;
v = velocity of water per second;
d = depth of water over crest of weir in feet;
b = breadth of weir in feet.

Then $W = 62{\cdot}3\ b\ d\ v\ c$, where c = coefficient of discharge of the water passing over the weir, and may be taken to have the average value of ·64.

$$\therefore\ W = 40{\cdot}9\ b\ d\ v.$$

The horse-power of the fall

$$= \frac{(40{\cdot}9\ b\ d\ v)\ (60 \times 11)}{33{,}000} = 8{\cdot}2\ b\ d\ v.$$

Subtracting from this the horse-power of the turbines already at work in the station, we get as a result the horse-power available for utilisation in connection with the proposed turbine. It would be well, however, not to depend to any appreciable extent upon the result thus obtained, but to take about 80 per cent. of it as the *actual* horse-power available at the turbine. This takes into account losses neglected in obtaining the first result.

From the wording of the question it is assumed that some permanent record of the available horse-power is required. If such is the case, then the above data should be obtained, and the above computation made every week or every month—according to circumstances and facilities—between the present time and 12 months hence, when the projected scheme will be carried out. The results can then very conveniently be plotted on a sheet of squared paper, the abscissæ representing time and the ordinates power. By this means a permanent and direct record can be obtained, and at a glance the average state of things can be seen. This will help the querist considerably in drawing up specifications as regards the power of the turbine.—G. W. BURLEY.

Question No. 787.—Has Reuleaux's diagram been adapted to the analysis of the Corliss valve motion? If it has, explain the method and show how by its use problems relating to a double eccentric gear may be solved.

Best Answer to No. 785 (*awarded* 10*s.*).—The Reuleaux diagram can, to a certain extent, be applied to some forms of Corliss valve gear, but in so doing it loses its principal recommendation of simplicity. Modern Corliss gears are generally of the double eccentric variety, and this will be the only type considered. Fig. 1 shows diagrammatically

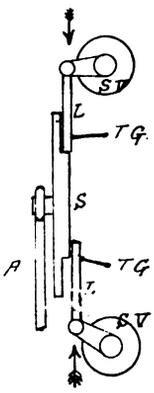

FIG. 1.

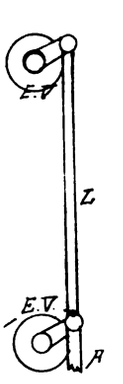

FIG. 2.

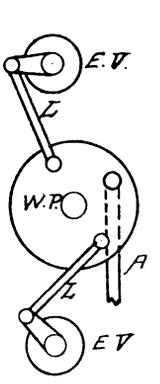

FIG. 3.

FIGS. 1, 2, AND 3.—A, Driving Link; S, Slider; L, Link-Operating Valve Lever; S V, Steam Valve; E V, Exhaust Valve; T G, Tripping Gear; W P, Wrist Plate. The arrows indicate the direction of the dash-pot action in Fig. 1.

a type of steam admission gear which, in principle at least, is fairly common. Figs. 2 and 3 represent two of the more usual forms of exhaust-valve motion. Considering the steam admission valve, the most radical departure from the ordinary Reuleaux diagram occurs in the travel of the slider. To enable the catch gear to engage without a violent jar, the throw of the eccentric is reduced to approximately half that necessary with an ordinary slide valve giving the same port opening and admitting steam during the whole of the piston stroke. This introduces what may seem an anomalous state of affairs; retaining the lead, the steam lap and the angle of advance become negative. To draw the diagram. Set out the sector W V Z (Fig. 4), representing to scale the movement of the valve lever and also that of the valve. Draw T S, representing the line of motion of the slider in its relative position. Drop perpendiculars from the arc V W to T S at the ends of the stroke of valve and also from the point

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at which the valve opens. Then if C = the distance the slider must move before the valve opens, O = the port opening (referred to slider), and c = the clearance necessary to allow the trip gear to engage, then the slider

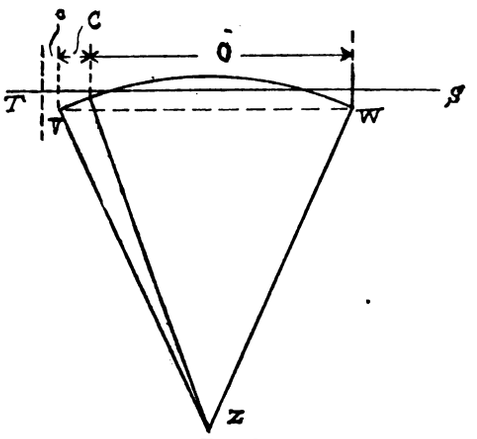


FIG. 4.

travel = O + C + c = T. Draw the circle A C B D (Fig. 5), representing to scale the travel, T, and let this also represent the crank-pin circle. Draw a diameter A B for the line of dead centres, also a diameter C D at

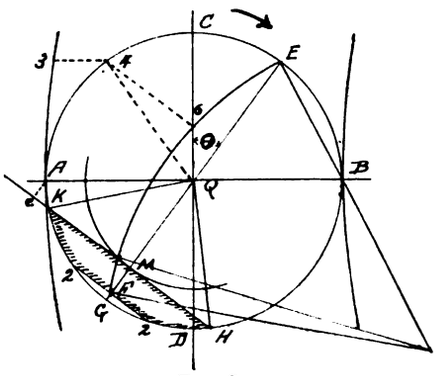


FIG. 5.

right angles. From the centre, Q, draw Q K, making A Q K = the angle of admission. From Q with radius = O − $\frac{T}{2}$—that is = the negative lap—describe an arc. From K draw K M H tangent to this arc and meeting the

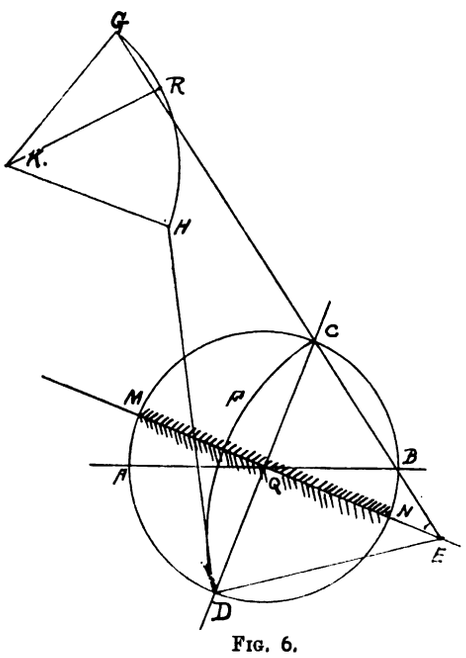
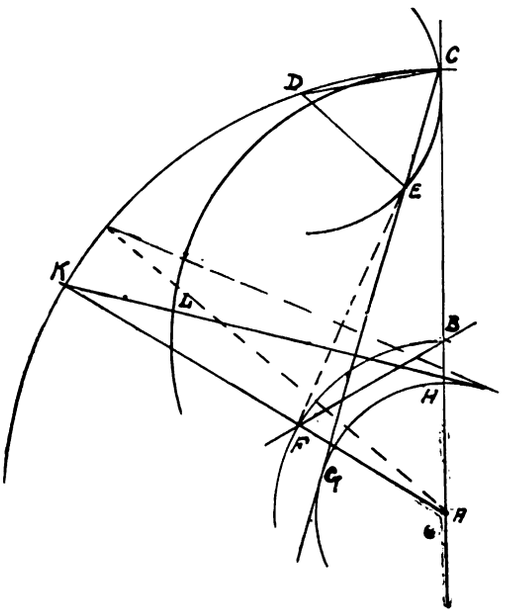


FIG. 6.

circle again at H. Draw 2 F 2 parallel to K H at a distance = C (Fig. 4). Through Q draw M Q E at right angles to K H. To E F apply a figure constructed similarly to Fig. 4. Draw the connecting-rod arcs. Then A e is the lead, Q E is the crank position for maximum port opening. H is the point at which valve would close if for any reason the trip gear did not disengage. The arc 2 G 2 represents the period allowed the trip gear in which to engage, and C Q E = θ = angle of advance. The port opening for any part of the piston stroke can be found as shown at 3-4 and 4-6. The only other point worthy of note is that the latest possible cut-off with the gear shown occurs at E; any attempt to carry the steam further would result in the trip gear not acting at all, and the valve would not close until H.

Of the two exhaust gears shown, that of Fig. 2 presents no difficulty, and a figure may be constructed on similar lines to Fig. 5. The wrist-plate motion (Fig. 6) introduces more complications. However, if the circle A C B D be taken to represent to different scales the crank-pin circle and the eccentric circle, the arc C F D the radii of the wrist-plate pins, and the arc G H the movement of both the valve lever and the valve, the number of lines necessary is reduced to a minimum. It is, of course, inconvenient to work to so many different scales, but if convenient scales are selected for the crank-pin circle and the valve movement, the others will not cause much trouble. The opening and closing of the valve is represented on the lower part of the figure by the line M N and on the valve arc by R. There should be no difficulty in setting out diagrams for Corliss gear. The points of opening and closing, of maximum opening, etc., follow the same laws as an ordinary slide valve. The only difference is in the amount, and this depends entirely on the linkwork employed.—B. O. S.

Answer to No. 787 (*awarded* 5*s.*).—There is no reason why "G. H. H." should not use the Rouleaux diagram for solving problems involving Corliss valve gear. The valves being separately adjustable, it is advisable to keep the diagram of each valve independent of the others. The steam admission valves are generally worked by a trip motion with a variable cut-off. This diagram should give no difficulty, the only points of importance being the lead and the point of maximum port opening which regulates



the latest point of cut-off permissible. Taking the exhaust valves, to the type in which valves for each end are connected by a straight link, the Rouleaux diagram can be applied in the ordinary way. The case in which the valves are worked by a wrist-plate involves more work, but presents no difficulty, if Muller's circles be applied as adapted for a case in which the axial line of the cylinder does not meet that of the crankshaft. Set out the valve motion to scale, as shown at A B F and C D E. Draw the Muller circles for a crank, A B, and connecting rod, B C. Join C E and produce it past A. Draw an arc, G H, tangent to C E produced. Produce A F to meet the outer circle at K. Then the distance, K L, measured on a line tangent to the arc, G H, will give the valve movement within a close degree of accuracy. In the same way the position of the valve for any position of the wrist-plate may be found.

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The ordinary Reuleaux diagram can be then applied to the line F B, making F and B the points of extreme motion of the valve, and working from them.—N. C. T.

Question No. 788.—A three-phase 3-h.p. induction motor with squirrel-cage rotor takes 20 amperes at starting on no load. When the speed has got up to normal the current is two amperes. With the idea of decreasing starting current, a choker is connected in circuit. This choker consists of three separate superimposed windings, one in each phase. On again starting motor, the initial current is now 14 amperes, and running current scarcely readable. What is the reason for this apparent increase of power factor?

Best Answer to No. 788 (*awarded* 10*s.*).—It is evident that the presence of the choker has a considerable influence on the E.M.F. available at the motor terminals, and, therefore, that the choker absorbs a considerable portion of the E.M.F. in each phase. Now, the sum of the currents in all the mains of a monophase, two-phase, or polyphase supply must be zero—that is to say, at any particular instant the sum of all the currents in one direction must be exactly equal to the sum of all the currents in the reverse direction, and, therefore, since the three windings of the choker are superposed, and one winding is in each of the three phases, no choking action will result if all the coils are wound in the same sense. There is, however, evidently a considerable choking effect, for it is out of the question to suppose that the reduction of potential is due to ohmic drop, and, therefore, we must conclude that the three coils are not all connected in the same sense, but that one of them is reversed. The result of this is easily seen on reference to the vector diagrams (Figs. 1 and 2). The vectors

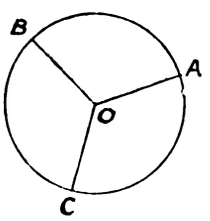

FIG. 1.

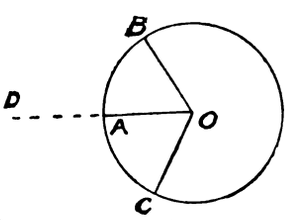

FIG. 2.

O A, O B, and O C represent the three currents. In Fig. 1 the sum of the three is zero, whereas in Fig. 2, in which O A has been reversed, the sum of the three vectors is the vector O D, which is in phase with O A, but twice as great. Since there is under these conditions a resultant current in the choker, there will be developed there a back E.M.F. or choking action, but this E.M.F. will be equal in all three windings at any instant, as they are superposed; therefore, if in Fig. 3 the triangle A B C is the

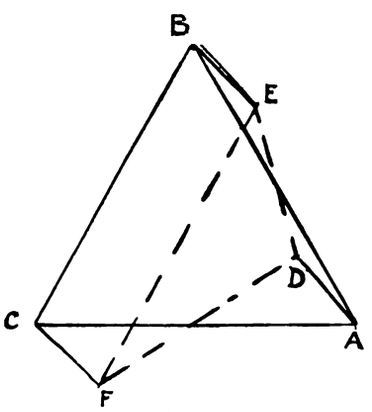

FIG. 3

vector diagram for the voltage existing between the mains before the choker is reached, the voltage after the choker may be represented by the vectors forming the three sides of the triangle D E F, where A D, B E, and C F are all equal and in phase, and represent the induced E.M.F.'s in the choker, the vector A D being in the reverse direction to the other two, on account of the winding in that main being reversed. It will be seen that not only is the voltage reduced by the choker, but that the system is no longer symmetrical, for if the original voltage vectors formed an equilateral triangle, the second triangle cannot possibly be equilateral. It is possible that the ammeter on which the current for the motor was observed was connected in the main in which the current was most reduced, for, of course, the currents in the mains will no longer be equal if equal before; but quite apart from this one would expect the no-load current of an induction motor to be reduced by a reduction of the applied voltage, as will be seen from the following reasoning:

The torque in an induction motor is proportional to the product of the magnetic flux, the induced current in the rotor, and the cosine of the angle of phase displacement between them. Now, the induced E.M.F. in the rotor $\propto$ flux $\times$ slip and the induced current

$$= \frac{\text{induced E.M.F.}}{\sqrt{R^2 + p^2 L^2}},$$

where R is the resistance of the rotor windings; L is the induction of the rotor; and p is a constant depending upon the slip. Therefore

$$\text{the induced current} \propto \frac{\text{flux} \times p}{\sqrt{R^2 \times p^2 L^2}},$$

and the cosine of the angle of lag between the induced current and the flux which induces it is given by the expression

$$\frac{R}{\sqrt{R^2 + p^2 L^2}}.$$

$$\text{Hence the torque} \propto \frac{\text{flux}^2 \times p \times R}{R^2 + p^2 L^2}.$$

Now the torque required to drive the unloaded motor will be practically a constant quantity. Therefore

$$\text{Flux}^2 \propto \frac{R}{p} + p\frac{L}{R}$$

and we see, therefore, that there is one particular value of the slip for which the flux is a minimum. This will be the case when $\frac{R}{p} = p\frac{L}{R}$, since R is a constant, and L is sufficiently near a constant to be considered such, especially over a small range of flux density. The fact that the flux is a minimum when $\frac{R}{p} = p\frac{L}{R}$ can be easily shown by taking a few values of p and plotting the corresponding values of the flux.

Curves showing this connection are given in Fig. 4 It will be seen that for one particular slip the flux for each torque is a minimum. Now, the flux is proportional to the impressed E.M.F. at these light loads, and although the point of minimum induced current does not coincide with

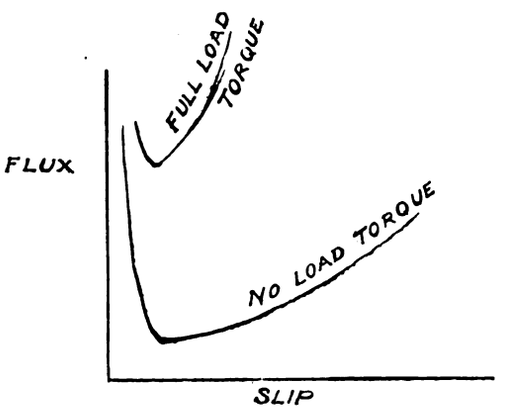

FIG. 4.

the minimum flux, because the current is also influenced by the slip, yet it is very near to it, and, obviously, if we can get both the impressed E.M.F. and the induced current down to nearly minimum values at the same time, while the power required to drive the rotor remains practically a constant, the power factor will then take on its largest value, especially as the losses in the stator will be also at a minimum, and also since the magnetising current required for the stator is least when the flux is least.

The conclusion is, therefore, that the best power factor is obtained when working with minimum flux; but, of course, the minimum flux has a different value for every torque, and for no load will be much less than for full

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load, the normal voltage being arranged, of course, to suit the maximum torque.—SUPERHEAT.

Answer to No. 788 (*awarded* 7*s.* 6*d.*).—The insertion of the choking coil reduces the volts at the motor terminals below the supply volts, and this is the cause of the apparent improvement noticed. At starting, a reduced terminal voltage causes the current to fall practically proportionally (in this case from 20 amperes to 14 amperes), but, at the same time, the starting torque falls off even more rapidly than the starting current, because the torque is proportional to the product of current by useful flux in phase with the current, and the choking coil reduces both these factors. On this account, the time taken by the motor to get up to full speed from rest will be considerably greater with the choking coil in use than without it. The reduction in running current is also due to the reduced terminal voltage produced by the choking coil. This reduced voltage means a proportionately reduced flux, and therefore a proportionately reduced magnetising current and a more than proportionately reduced iron loss. Now the current taken by an ordinary induction motor when running light at full speed is the resultant of the magnetising current and the current representing the friction and iron losses, the loss current being usually almost negligible in comparison with the magnetising current. A reduction in terminal voltage consequently means an almost exactly proportionate reduction in no-load current.

Assuming that the motor has a power factor of, say, ·4 when starting—*i.e*, on short-circuit—so that the lag of the current behind the terminal volts is about 66deg, the phase relations of the current, the terminal volts, the choking-coil volts, and the supply volts may be represented

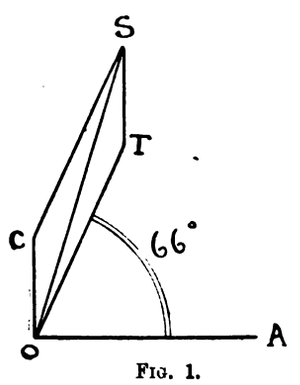


FIG. 1.

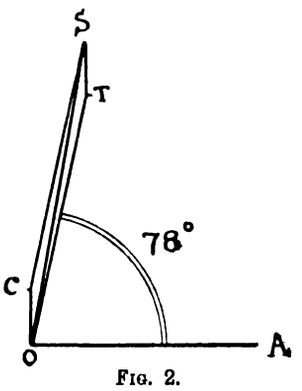


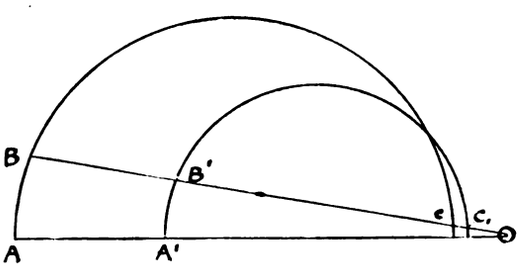
FIG. 2.

as in Fig. 1. O A represents the phase of the current, O T the terminal volts at 66deg. to O A, O C the volts over the choking coil at 90deg to O A, and of such an amount that O S, the resultant of the choking-coil volts and the terminal volts (which resultant is the total supply voltage), is equal to $\frac{20}{14}$ of O T, for the terminal volts at starting with the choking coil are only $\frac{14}{20}$ of the terminal volts before the choking coil is inserted. The value of O C to satisfy this condition scales off as about ·33 of O S. When running light at full speed the power factor of a normal motor would be about ·2, representing an angle of lag of current behind terminal voltage of about 78deg. The value of the choking-coil voltage in this case is doubtful, because if the coil has an air core or an iron core which is quite unsaturated when 14 amperes is passing, the choking-coil volts will fall in proportion to the amperes, whilst if the coil has an iron core which is highly saturated at 14 amperes, the choking coil volts might hardly fall at all when the current changes from 14 amperes to one or two amperes. Suppose that the choking-coil voltage when running at full speed falls to half the value it had at 14 amperes—*i.e*, suppose it is equal to ·165 of the supply voltage, O S. Then the diagram for full speed would be as in Fig. 2, where O A again represents the phase of the current, O T the terminal volts at 78deg to O A, O C the choking-coil volts (= ·165 O S) at right angles to O A. The resultant of O C and O T (= O S) must equal the same supply volts as O C in Fig. 1, and this corresponds to a value of O T equal to ·85 of O S—*i e*, the terminal volts when running light at full speed with the choking coil are only ·85 of the terminal volts without the choking coil. This small fall in terminal voltage would only produce an approximately proportional change in running current, and this would be hardly appreciable. If, therefore, a marked reduction in running current actually takes place when the choking coil is in use it would probably be due to the peculiar construction of the coil with superimposed windings. This arrangement would produce interactions between the windings of the different phases, which would make the three currents unequal, and a measurement of only one phase, such as was probably made in this case, would give a misleading result.—Q.

Answer to No. 788 (*awarded* 7*s.* 6*d.*).—Before this question can be answered, a clearer idea of the arrangement of the choker used in the motor circuit is needed. If the three coils, one of which we presume is placed in each leg of the system, were wound in the same direction—say, all clockwise from one end on the same core—so that each has the same magnetic circuit, as is apparently implied by the word "superimposed," the algebraic sum of the currents at any instant is known to be zero, so that the only reason for a reduction in the current at starting and running light would be due to the ohmic resistance of the "choker." But let us now assume that the arrangement of the choker is such that a true choking effect is obtained. We can easily see the reason for the reduction of the currents, and at the same time we can show that it is not due to any increase in the power factor, as "P. D." presumes.

Let $I_c = \sqrt{p^2 L_c^2 + R_c^2}$ be the impedance of the choker per circuit, where $p = 2\pi \times$ frequency, and let I_m be the corresponding value of the impedance of the motor. Then at any current C per phase we shall get a drop in voltage across the choker $= C \times I_c$. In fact, the voltage across the terminals of the motor will be reduced in the ratio $\frac{I_m}{I_m + I_c}$

From this at once follows that the back voltage to be pro-



duced by the motor is therefore reduced, so that the flux, and therefore the magnetising current, will be reduced in the same ratio. The running light current is the vector resultant of the magnetising current and the current supplying the running light losses, which latter are small in proportion to the former, so that we see that the running light current is also reduced. If we apply the Heyland diagram to the case, we see that both the starting and the running light current are reduced by the ratio $\frac{I_m}{I_m + I_c}$ given above.

In the accompanying diagrams, both of which have been drawn from the same origin, O, we have O B and O C, the starting and running light currents respectively on full voltage, while O B^1, O C^1 are the corresponding values with the choker in circuit. The power factor running light will be practically unaltered, though, of course, it will be altered slightly owing to the decreased iron losses on the reduced voltage. As regards the magnitude of the running light current, it will be seen from the diagram to be about $\frac{14}{20} = 2 \times 1{\cdot}4$ amperes. In all probability the ammeter used was not suitable for measuring small currents, in which case a current up to 1½ amperes would not be readable. If, however, "P. D." will try an instrument for lower values, he will probably find the current will be very near the figure given above.—W. J. P.

[Other replies to Question No. 788 will be given in our next issue.—ED. *E. E.*]

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JULY 14, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

795. It is required to transmit overhead 1,000 kw. at a pressure of 50,000 volts for 40 miles. Three-phase alternating current will be used. What is the best method of calculating the sectional area of cable to use? State clearly the losses in the line, and how they are calculated.—H. G.

796. Is it necessary to clean the tubes of the superheaters of Babcock water-tube boilers? If so, what is the best method of doing so, and how long may such superheaters be run without cleaning?—PERPLEX.

ANSWERS.

Question No. 788.—A three-phase 3-h.p. induction motor with squirrel-cage rotor takes 20 amperes at starting on no load. When the speed has got up to normal the current is two amperes. With the idea of decreasing starting current, a choker is connected in circuit. This choker consists of three separate superimposed windings, one in each phase. On again starting motor, the initial current is now 14 amperes, and running current scarcely readable. What is the reason for this apparent increase of power factor?

Answer to No. 788 (*awarded* 5*s.*).—The explanation of the decrease in current readings noticed lies in the fact that, by putting the choking coil in circuit, the motor terminal voltage has been reduced, and the lower the P.D. at the terminals the less is the value of the current drawn from the mains for a given current taken by the motor, and the greater the power factor.

The most economical design for a choking coil for this purpose is such that the voltage applied to the motor at starting just overcomes the bearing friction. Suppose this value to be 33 per cent. of the line voltage and that the motor under this condition requires 2·0 times full-load current. The line current at starting = ·33 × 2·0 = ·66 full-load current. The actual value of the starting voltage can be determined in every case. Oudin, in his "Standard Polyphase Apparatus," gives the following values as representing the starting performances of modern motors when the starting voltage has the percentage values given:

Motor volts in per cent. of line volts	40	60	80	100
Line-starting current in per cent. of full-load current	112	250	450	700
Motor-starting current in per cent. of full-load current	280	420	560	700
Starting torque in per cent. of full-load torque..	32	72	128	200

Having details of line voltage and resistance of motor, and having determined by the use of non-inductive resistance the lowest permissible starting voltage, the most suitable value for the self-induction of the choking coil may be calculated. It must be remembered, however, that the value of the P.D. across the coil

$$= \sqrt{(\text{line voltage})^2 - (\text{motor voltage})^2},$$

and *not* (line voltage) − (motor voltage), for the P.D. of the choking coil is in *quadrature* with the current.—A. M. L.

Question No. 789.—How may extra high electric pressures be measured by a low-reading electrostatic voltmeter and two condensers? Express the multiplying power of the arrangement in terms of the capacities, and state the conditions necessary for its constancy.

Answer to No. 789 (*awarded* 7*s.* 6*d.*).—There are several ways of fulfilling the requirements of the above question, each of which is applicable, more or less, to any case which may arise, depending entirely upon the precise circumstances of working, so far as they include the working pressure of the system and the pressure of the voltmeter, the conditions under which the application is to be made, and the degree of accuracy which is is deemed advisable to work to. The method which is described below is *the* one which, in the opinion of the writer, is the best for extra high-tension work, because the multiplying power of the arrangement can be increased or decreased by altering the capacity of one of the condensers, and, also, a fairly high multiplying power can be obtained by the use of condensers of moderate capacities. Also, if proper care is taken in the arranging of the condensers, this method is the most accurate of all methods.

In Fig. 1 we have a diagrammatic representation of the voltmeter and condenser circuit. A and B are two mains between which the extra high potential difference is maintained; V is the low-reading electrostatic voltmeter, to which there is connected, as a shunt, a condenser, C_2. Another condenser, C_3, completes the circuit, this latter condenser being connected in series with the compound voltmeter and condenser circuit.

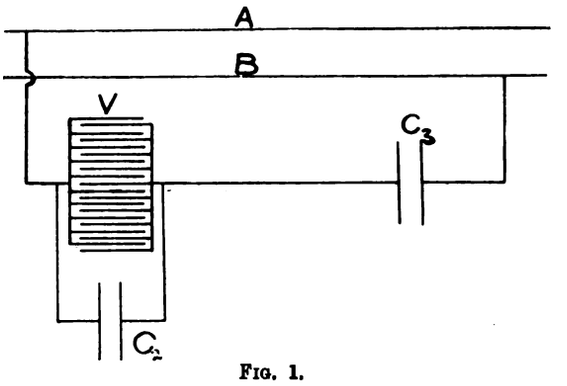

FIG. 1.

Let E = the potential difference between A and B, in all probability reaching the magnitude of 10,000 volts or more;

E_1 = the maximum potential difference that the voltmeter will indicate;

C_1 = the capacity of instrument (that is, voltmeter) in absolute units;

C_2 = the capacity of the condenser, C_2, in absolute units;

C_3 = the capacity of the condenser, C_3, in absolute units.

Then $$\frac{E}{E_1} = 1 + \frac{C_2}{C_3} + \frac{C_1}{C_3} = \frac{C_1 + C_2 + C_3}{C_3}.$$

Of these three capacities, however, whilst C_2 and C_3 can be determined, or are known already, it is more difficult to determine C_1, the capacity of the voltmeter, because of its varying magnitude. In order to make the multiplying power as large as possible, it is clear that C_3 should be as small as possible, whilst C_2 should be large. If C_2 is very large compared with C_1, then we may neglect the latter, the multiplying power becoming $\frac{C_2 + C_3}{C_3}$. But should this not be the case, then it would be necessary to determine C_1. This capacity should be determined for different positions of the movable vane or vanes corresponding to certain voltages, and the results plotted as shown in Fig. 2. Then, for any voltage indicated by the

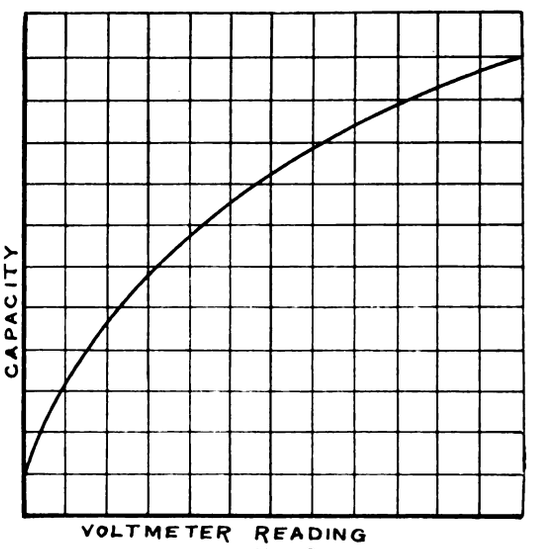

FIG. 2.

voltmeter, C_1 has a certain value, and this can be introduced into the original expression of the multiplying power. Of course, the result will be precisely the same if the capacities are in practical and not theoretical units, because the multiplying power is a ratio, and not an absolute quantity.

The original expression is constant so long as C_1 is constant, provided that C_2 and C_3 are maintained constant, and in the case of an electrostatic voltmeter with large deflections this is not so, although where very small deflections are the rule the assumption that C_1 is constant

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can be made without any very great error. Also, the multiplying power given above will remain constant if there is no inductance in the voltmeter or the voltmeter circuit; if there is, however, then the reactance will vary with changes of working conditions, and so affect the multiplying power, especially if the frequency of the system should change. The capacity of the voltmeter circuit should be such as not to produce the dangerous condition of electrical resonance.—G. W. BURLEY.

Answer to No. 789 (*awarded* 7*s.* 6*d.*).—When two or more condensers are put in series across an alternating voltage the volts across the different condensers are inversely proportional to their capacities, for the same quantity of electricity must flow into each condenser in a given time, and, since quantity = capacity × voltage, the voltage must divide up across the different condensers in inverse proportion to their capacities. By placing two condensers of widely different capacities, C_1 and C_2, across the voltage to be measured a small definite fraction of this voltage will, therefore, be obtained across the condenser with the larger capacity, and by measuring this fraction by means of a low-reading electrostatic voltmeter or electrometer connected across this condenser the value of the total voltage can be arrived at (Fig. 1).

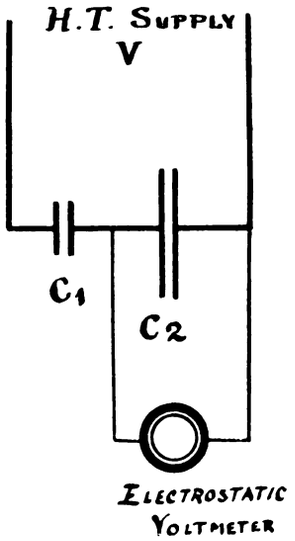


FIG 1.

The multiplying power of the arrangement is obtained thus:

Voltage over C_1 + voltage over C_2 = total voltage = V, and $\frac{\text{voltage over } C_1}{\text{voltage over } C_2} = \frac{C_2}{C_1}$, or voltage over $C_1 = \frac{C_2}{C_1}$ × voltage over C_2.

$$\therefore \frac{C_2}{C_1} \times \text{voltage over } C_2 + \text{voltage over } C_2 = V,$$

or,
$$V = \text{voltage over } C_2 \left(1 + \frac{C_2}{C_1}\right).$$

The multiplying power—*i.e.*, the figure by which the voltage actually measured over the larger capacity, C_2, has to be multiplied in order to obtain the total voltage, V—is $1 + \frac{C_2}{C_1}$. Thus, supposing the capacity of C_2 is made nine times as great as that of C_1, the total voltage, V, would be $1 + 9 = 10$ times as great as the voltage measured over the larger capacity, C_2, and the voltmeter can, of course, be made direct reading by marking the scale to read 10 times the voltage actually applied to the instrument's terminals. Where possible it would be preferable to calibrate the instrument when actually measuring the high voltage by means of its own condensers, as accurate comparisons of condensers are somewhat troublesome to make.

The absolute values of the condenser capacities are not of much importance provided that both capacities are large enough to render the capacity of the electrostatic voltmeter itself negligible in comparison. This is not difficult, however, for even a 200-volt Kelvin multicellular voltmeter has a capacity of only about one ten-thousandth of a microfarad, and the ordinary single quadrant instrument would have considerably less. Quite small capacities such as one-tenth of a microfarad, or even less, would, therefore, be quite allowable.

In order to make the multiplying power of the arrangement independent of changes in periodicity, the two condensers should be identical as regards method of construction, and the dielectric should be of the same quality and thickness in both, for it is only under these conditions that the power factors of the two condensers will be exactly alike, and that the two voltages will be exactly in phase and will allow the equation

Voltage over C_1 + voltage over C_2 = total voltage V

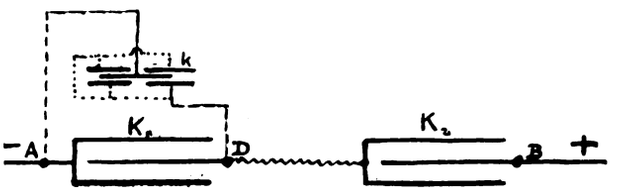
to hold good at all voltages and periodicities. Of course, the power factor of a good condenser is in any case so nearly zero that this precaution would only be necessary for very accurate work and for very wide changes of periodicity. As regards the constancy of the multiplying power of the arrangement, this would depend solely on the constancy of the relative capacities of the two condensers, and in order to ensure constancy in this the condensers should have a solid dielectric—preferably mica—and be kept under constant compression so as to prevent the plates flaking out and reducing the capacity.

It may be mentioned that attempts have occasionally been made to reduce the volts at the terminals of an electrostatic voltmeter by placing a single small condenser in series with the voltmeter across the high-tension supply, but this method has decided disadvantages as compared with the above described parallel arrangement.—Q.

Answer to No. 789 (*awarded* 5*s.*).—The two condensers are arranged in series whilst the electrometer is in shunt with one.

Let v be the highest reading of the electrometer, K;
V = the highest of the new range of readings;
c = capacity of K;
C_1 = capacity of the condenser in shunt with K;
C_2 = capacity of the other condenser, K_2.

The total E.M.F. is applied to the terminals, A and B, of the condensers in series. The E.M.F. at the electrometer



terminals is the same as that between A and D, and is a certain fraction of the whole, depending upon the capacities of the various parts. The quantity of negative electricity on K_2 is equal to its positive charge, and also to the total positive charge on K_1 and K, and, therefore, to the two negative charges on the two latter. Let Q be the quantity on one plate of K_2. Since charge on one plate = capacity × (E.M.F.),

$$Q = C_2 (V - v) = (C_1 + c)\, v.$$

$$\therefore \frac{V - v}{v} = \frac{C_1 + c}{C_2}, \text{ or } \frac{V}{v} = \frac{C_1 + C_2 + c}{C_2}.$$

Neglecting the capacity of K—*i.e.*, c—as must be done, since it is variable (getting greater as the paddles move between the fixed vanes), the following relation holds:

$$V = \left(\frac{C_1 + C^2}{C_2}\right) . v. \quad i.e., \frac{C_1 + C_2}{C_2}$$

is the multiplying factor to be applied to the readings of the electrometer, and applies equally to direct and alternating current. It will be seen that for high voltages either C_1 must increase or C_2 decrease. The capacity of c which has to be neglected determines the minimum size of C_1—*e.g.*, C_1 might be taken equal to 1,000 c. The working current will determine the maximum size. Let C_s = capacity (in series) of the system. Since

$$V = (V - v) + v = \frac{Q}{C_s} = \frac{Q}{C_1} + \frac{Q}{C_2}$$

$$\therefore C_s = \frac{C_1 C_2}{C_1 + C_2}.$$

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As there is no resistance, the working current, A,

$$A = 2\pi \sim C, V = \frac{2\pi C_1 C_2 V}{C_1 + C_2}.$$

The condensers must be of constant dimensions, and, therefore, mechanically strong. Since the ratio $\frac{Q}{V} = ie$, capacity—has been assumed constant, air must be used for the dielectric. The condensers should, therefore, be of the standard air-condenser type. Mica might be used for a laboratory experiment, but paraffin-waxed paper condensers should be avoided.—E. S.

Answer to No. 789 (*awarded* 5*s.*).—If condensers of capacities, C_1, C_2, etc., be connected in series, and a voltage, V, be applied across the ends, each condenser receives a charge, Q, equal to that of the end condenser. Hence the voltages across the terminals of each are

$$V_1 = \frac{Q}{C_1}, V_2 = \frac{Q}{C_2}, \text{ etc.},$$

$$\text{and } V = V_1 + V_2 +, \text{ etc.}, = Q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} +, \text{ etc.}\right).$$

But if the capacity of the combination be C,

$$V = Q\left(\frac{1}{C}\right), \text{ whence } \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} +, \text{ etc.}$$

The relation between the capacity of any condenser and the voltage across it is then

$$\frac{V_1}{V} = \frac{C}{C_1}, \quad \frac{V_2}{V} = \frac{C}{C_2}, \text{ etc.}$$

and so an extremely high value of V (up to 40,000 volts) may be measured by the reading of an electrostatic voltmeter of moderate range. Unless correction is applied for the latter's capacity—and this is impracticable, owing to variation at different deflections—the condenser across which the voltmeter is shunted should be of relatively large capacity. This is easily attained, as the average capacity of a voltmeter is of the order 10^{-5} of a microfarad. The chief drawback of this method in measuring a continuous voltage is leakage, which unequally affects the ratios; the measurement of an alternating E.M.F. is free from this, but is subject to error with variation in frequency unless each condenser has the same dielectric, owing to inequality of absorption. Obviously the condensers must be of such pattern in any case as to be unaffected by adjacent bodies. With due attention to these points the ratios may be relied on. For further applications of and remarks upon this method, the Institution's *Journal* No. 167 (Edgcumbe and Punga on "Direct-Readin g Measuring Instruments," and discussion) and British Association Report, 1903 (Marchant and Worrall), may be consulted.—ZERO.

Question No 790.—**Make a sketch and describe a mains-charging device suitable for a 1,000-kw. three-core power cable working at 10,000 volts. Explain fully why this apparatus is used on high-pressure alternating circuits.**

Answer to No. 790 (*awarded* 10*s.*).—The cable charger shown diagrammatically in Fig. 1 has been successfully used on extra high-tension systems. It consists essentially of a three-phase transformer with an adjustable water resistance in each secondary. The leads from the primaries terminate in plugs which are very efficiently insulated. The whole apparatus is mounted on wheels. To use the charger proceed as follows: Bring the charger up to the switch you want to close. See that all the secondaries of the charger transformer are open, and then connect the primaries across the open switch (as shown in Fig. 1) by plugging into the holes, made for the purpose, in the terminals of the oil-break switch. Now cut out the water resistance in the secondaries gradually, until the cup of mercury (*c* in Fig. 1) is reached. Close the switch and open the secondaries of the transformer, and unplug the primaries. The charger can then be run on to charge any other cable by repeating the above operations.

Before explaining the principle on which this charger works, it will be as well to show why a charger is used on high-pressure alternating circuits. In a "dead" cable, say, two or three miles in length, with transformers or other apparatus fed from it, there is a large amount of "room," or capacity, which the electricity tries to "fill" as soon as the circuit is completed. The cable and its apparatus, therefore, act like a large condenser. The circuit will also contain resistance and inductance. Now, the impressed E.M.F. of such a circuit may be regarded as being made up of three components—viz.: (1) the resistance component = R C; (2) the inductance component = $2\pi n$ L C; and (3) the potential difference across the condenser terminals = $\frac{C}{2\pi n K}$, where C = current, n = periodicity, L = henry, K = capacity, R = resistance. If these three components be drawn out in the form of a vector diagram, as in Fig. 2, and the capacity is very large as compared with the resistance and inductance of the circuit, it is obvious that, as in Fig. 2, the potential difference across the condenser (A F in Fig 2) is much greater than the impressed voltage, represented by the resultant vector, A H. (The current is here assumed to obey the simple harmonic law, but, as a matter of fact, the first wave would be distorted very much indeed, and this distortion would be less with each succeeding wave until the current wave became normal for the particular circuit.

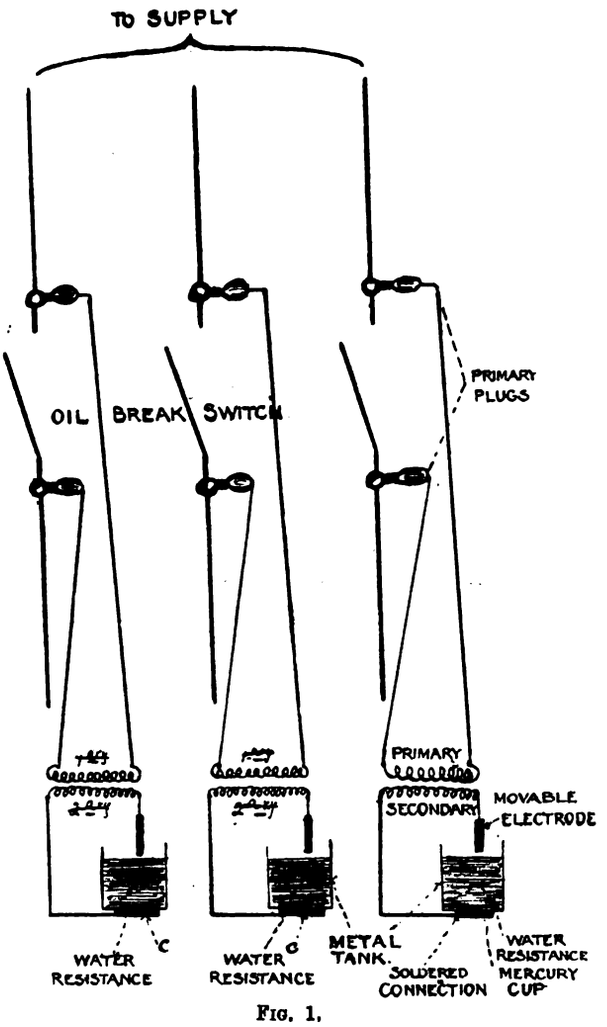

FIG. 1.

We know that the "initial capacity" of a circuit, such as a length of feeder, is very large, indeed, as compared with its resistance and inductance, because it has been observed that at the moment of switching on a large excess current passes into the main. This amount becomes less with each cycle, as mentioned before. If we take the Diagram Fig. 2 as representing an actual case, at the instant of switching on we see that the potential difference across the main which has just been switched on is practically double the working voltage of the system. In practice it has been found that even higher rises take place. This very high pressure may have two immediate and very injurious effects on the circuit: (1) it may, if high enough, instantly puncture the insulation; (2) the very large current may burn the insulation of the cables, and may burn out any apparatus which may be in circuit. If neither of these two things happen, and the circuit is continually switched in directly, the

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insulation will surely be severely strained and much weakened on each occasion, and will sooner or later break down with disastrous results to the system. But this excessive pressure can be prevented by introducing a large resistance into the circuit. The charger shown in Fig. 1 prevents the objectionable rise by utilising the large primary back E.M.F. of an unloaded transformer, and gradually "charges" the main by loading the transformer. When the secondaries are shorted, only a low back E.M.F. exists in the primary, and practically the full

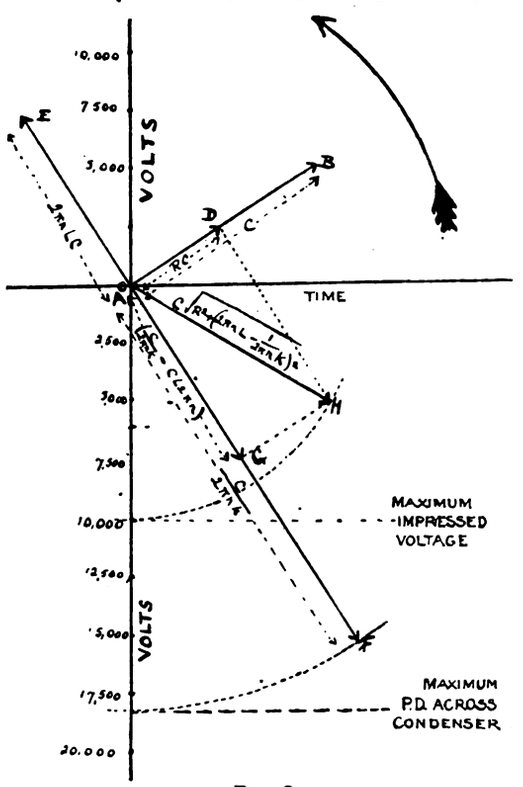
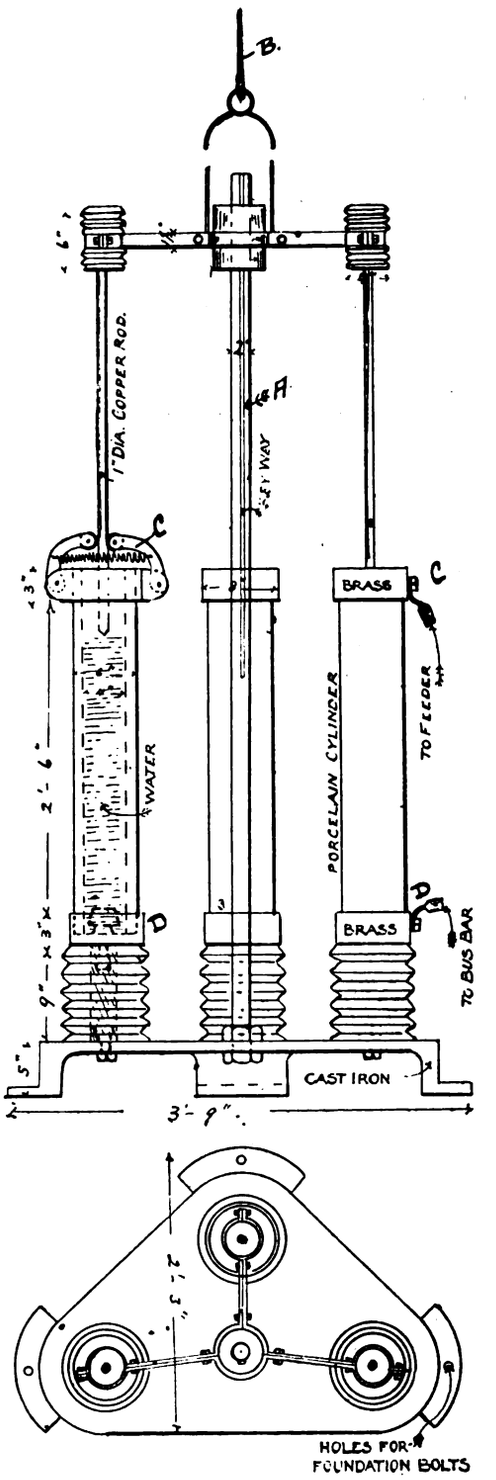


FIG. 2.

pressure of the system is sending current out into the main. The oil switch can then be closed without fear of any damage being done to the system.—H. A. CARNEY.

Answer to No. 790 (*awarded 7s. 6d.*).—The question of the advisability of providing cable-charging gear has been often discussed, but no definite conclusion either for or against the use of such apparatus has been arrived at. American practice is decidedly opposed to the instalment of this apparatus, and there are very few power-houses in the States so equipped. As other instances of the non-use of this apparatus may be mentioned the Central London and Glasgow equipments with high-tension feeders four or five miles in length. The object in using these gears is to prevent sudden and abnormal rises in the pressure which are said to occur under certain conditions when a feeder is switched directly on to the 'bus bars.

Cable-charging gear may be roughly divided into three divisions: (A) water resistance; (B) separate motor-generator, forming the cable charger; (C) the Partridge arrangement, involving the employment of a three-phase transformer, the primaries being connected in series with the three-core cable, and the secondaries connected up to a non-inductive resistance. Type A being the one that is probably most used, we will now consider the construction of one suitable for a 1,000-kw. three-core cable working at 10,000 volts. As shown in the sketch, this consists of a cast-iron frame, supporting three porcelain cylinder cemented to insulators (size of insulators 9in. by 8in.), the insulators being bolted to the cast-iron framework. The cylinders are 2ft. 11in. long, external diameter 6in., internal diameter 4in. To the bottom ends of the cylinders are cemented brass caps, these caps in turn being fastened to the insulators by means of a bolt and sulphur cement. To the upper ends of the cylinder are clamped brass sleeves, forming cable connectors and guides to the contact rods. These rods are mounted by means of insulators on a movable iron framework, free to slide up or down the central spindle, A, there being a keyway on the spindle to guide the framework in a straight line. The rods are raised or lowered as required by means of a thin wire rope, B, the other end of the rope going to a winch placed on the switchboard, the usual arrangement being that the charging gear is placed under the switchboard gallery and the elevating gear on the switchboard platform. The action of the apparatus is as follows: The feeder before being switched on to the 'bus bars is connected to the sleeve and guides at C by



means of a switch, the bottom contact at D being connected to the 'bus bars direct. Then when the rods are gradually lowered by means of the lowering gear, the voltage on the feeder will gradually rise as the rods approach the bottom contacts. When this occurs the main switch belonging to that feeder may be closed and the cable-charging gear disconnected.—A. V. ANDERSON.

[Other replies to Question No. 790 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
JULY 21, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

797.—With gas at 2s. 6d. per 1,000 cubic feet and electricity at 1½d. per unit. can the electric arc system show an advantage for street-lighting over the high-pressure gas system in (*a*) initial outlay, (*b*) running costs, (*c*) distribution of light?—S. P.

ANSWERS.

Question No. 790.—Make a sketch and describe a mains-charging device suitable for a 1,000-kw. three-core power cable working at 10,000 volts. Explain fully why this apparatus is used on high-pressure alternating circuits.

Answer to No. 790 (*awarded* 7*s.* 6*d.*).—In the power station I am connected with there was originally no mains-charging device for use with the extra high-pressure long-distance cables. It was found that the cables repeatedly broke down when switching them on. Consequently a Ferranti type of cable-charging apparatus was tried with complete success. This device is shown in Fig. 1 arranged for a two-phase plant. Needless to say, it can be made suitable for single, two, or three phase working. It is simply a water resistance, the apparatus being specially designed for working at high pressures. The iron

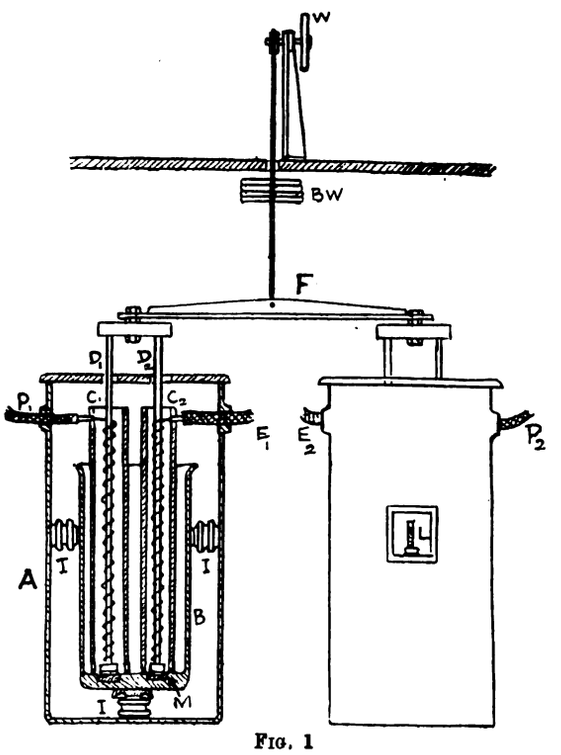

FIG. 1

case, B, contains the water, B is supported by insulators, I, from outer containing case, A, which has a small glass door, shown at L, for inspecting the level of the water. Two long porcelain tubes, C_1 C_2, are fixed vertically in B, resting immediately over two cups at the bottom of the case, containing mercury, M. Two ebonised iron rods, D_1 D_2, have metal caps attached at the bottoms, which dip into the mercury-cups. These metal caps are connected to the cables, P_1 and E_1, by means of flexible copper tapes wound round the iron rods These ebonised iron rods are connected to an insulated block at the top, which is supported by the bar, F. The apparatus is fixed beneath switchboard gallery, and a chain attached to F passes over a chain wheel fixed to a support on floor of gallery, and the weight at F is balanced by balance weight, B W, at the other end of the chain. A handwheel, W, rotates chain wheel and raises or lowers rods, D_1 D_2. The connections to the cable are shown roughly in Fig. 2. A two-way switch, S_1, in No. 1 position connects 'bus bars to cable-charging apparatus, which is connected to feeder, F. The rod, D, is gradually lowered into the liquid, thus gradually raising the pressure of the cable, F, until it is at the same pressure as the 'bus bars. The switch, S, is then put into position No. 2, connecting feeder directly to 'bus bars. To discharge the feeder see that the rod, D, is as far down as possible, put switch, S, in No. 2 position, gradually raise D to top position, and switch off. In a single-phase 2,000-volt system I had some experience with it was the rule to lower the 'bus-bar volts before switching in a feeder the fuse for which had blown. If this was not done, the low-tension volts shown by the pilot voltmeter rose considerably above the normal. At Manchester a separate motor-generator is used for charging the high-tension mains. This motor-generator is switched on to the feeder and the high-tension volts raised to the pressure of the 'bus bars, and then the feeder is synchronised and paralleled. With this method some time is taken in getting a feeder switched on the 'bus.

Another method is the Cowan-Still cable-charging system. A special transformer is used similar to the boosting transformer recently described in the *Electrical Engineer*. Messrs. Cowan and Andrews, in a paper on control of long-distance transmission lines read before the local section of the Institution at Manchester, go very fully into the question of abnormal pressure rises in cables and methods of charging them. Their explanation of the rise in pressure due to switching on a long high-tension cable is as follows: "When the switch is closed, the electrostatic energy stored in the cable may be equal to or greater than the electromagnetic energy stored in the ether surrounding the cable by the current flowing to charge it. This latter energy will be converted into electrostatic when the impressed E.M.F. of the circuit equals the back E.M.F. of the condenser, and the final pressure may consequently double the normal.

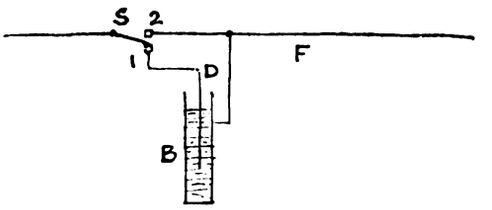

FIG. 2.

In the same way, opening an unloaded circuit may result in a rise of E.M.F. double the normal pressure. One is forced to the conclusion on reviewing the whole question, that circuits having appreciable capacity and self-induction should not be switched on or off, whether loaded or unloaded, suddenly." The system of cable charging first described is a very rapid and good method to use. In the rather unlikely event of anything going wrong with the apparatus, the generator should be run up on the cable.—RESEARCH.

Answer to No. 790 (*awarded* 7*s.* 6*d.*).—This matter of mains charging was fairly fully dealt with by Messrs. Cowan and Andrews in their paper read before the Institution of Electrical Engineers at Manchester two years ago, and I propose quoting from this source fairly fully. Speaking of abnormal rises of pressure in alternating-current circuits occasioned by the sudden opening of a loaded circuit, they go on to say: "While the opening of a circuit under load is the worst condition for causing rises of pressure, rises will also occur when an unloaded line is opened or closed. According to many authorities on this subject, the rise cannot exceed double the normal pressure under these conditions. When the switch on a dead circuit is closed, the electrostatic energy stored in the cable may be equal to or greater than the electromagnetic energy stored in the ether surrounding the cable by the current flowing to charge it. This latter energy will be converted into electrostatic when the impressed E.M.F. of the circuit equals the back E.M.F. of the condenser, the result being that a double quantity of electricity can be forced into the condenser, and the final pressure may consequently be double the normal. In the same way, opening an unloaded circuit may result in a rise of E.M.F. double the normal pressure As a matter of fact, however, a higher pressure than double the normal has been recorded when closing the switch of an unloaded line of 44 miles in length. This

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increased rise is probably due to some coincidence between the crests of the impressed waves of E.M.F. and the crests of the waves of E.M.F. of high frequency, which accompany the natural oscillations in the cable." The above is the reason for the use of these cable-charging devices, so as at first to only apply a small E.M.F. to the cable on making it alive, and then increasing this until the full voltage and finally closing the main switch.

The first device of this kind I will describe is the Cowan-Still cable-charging system. This consists of a variable induction transformer, which is wound somewhat similarly to an induction motor, with the stator winding also wound half on the movable part; this may be termed the secondary

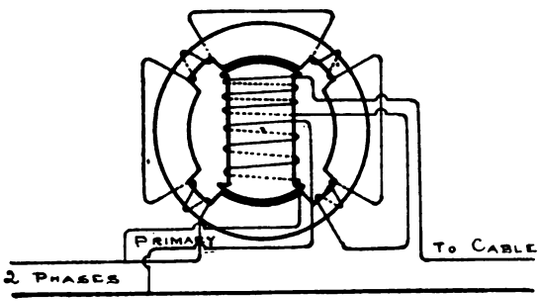

FIG. 1.

of the transformer, one terminal being connected to one 'bus bar, and the other to the cable being charged. The primary or rotor winding is on the movable portion, and is connected across two phases. The idea is that according to the position of the rotor, the pressure applied to the cable will vary from nothing to full voltage, when the cable may be switched in directly. In a certain position the flux due to the primary winding will tend to induce an E.M.F. in one direction in the secondary winding on the rotor, and an E.M.F. of similar magnitude in the other half wound on the stator, the resultant being equal to nothing, and so no charging current will enter the cable. As the rotor is slowly turned through 90deg. the magnitude of the E.M.F. induced in the half of the secondary wound on the stator falls, owing to the primary winding being in a different position relative to it, the E.M.F. induced in the half on the rotor always remaining the same. The resultant secondary E.M.F. applied to the cable hence rises. Similarly, when turned from 90deg. to 180deg., it will be seen that the two E.M.F.'s induced in the two halves of the secondary are now in the same direction, and at 180deg. the resultant is a maximum and is equal to the full supply F M.F. The cable now is switched straight on.

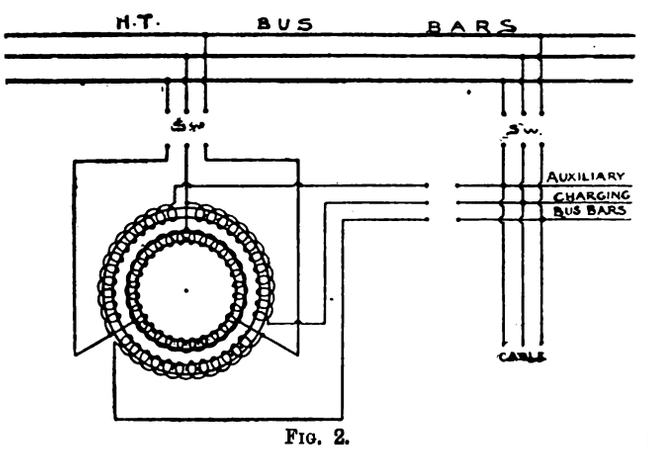

FIG. 2.

Fig. 1 is a sketch showing the idea of this arrangement for just one phase, and Fig. 2 is a diagram of connections for charging the three-phase cable mentioned. It will be seen that the cable is first connected to three auxiliary charging 'bus bars, and then when the full voltage has been applied the main switch is closed. It will likewise be seen that a device of this kind can be used for disconnecting a cable, by slowly decreasing the potential applied to it.

Another cable-charging device, due to Messrs. Ferranti, consists of a water resistance. The cable is first connected to the 'bus bars through long columns of water in tubes, about 3ft. long, in each phase. The length of this water column is then reduced by hand till the contacts at the bottoms and tops of the tubes are touching, when the main switch is closed. This may also be used for disconnecting a cable, as will readily be seen.

In a system with which I am connected, transmitting at 6,000 volts, no such cable-charging devices are in use, but each feeder is fitted with spark gaps which are connected to earth. These seem to be very satisfactory, and it is only necessary to switch the cable straight on. Any abnormal rise of pressure is dealt with by these arresters sparking to earth. They consist of a series of roughened metal cylinders placed one above another, and separated by a narrow air-gap. The top is connected to the cable and the bottom to earth.—E. R. ALEXANDER.

Question No. 791.—Between the rails of a tramway system and the adjacent water-mains pressures up to ·25 of a volt are obtained when the generating plant is shut down. What do you consider is the cause of these potentials? There is an independent combined three-wire and alternating-current supply in the town.

Best Answer to No. 791 (*awarded* 10*s.*).—Differences of potential can be found in most subterranean iron pipes, rails, etc. The currents flowing under these differences of potential are due to one or two causes, and will be found with most lighting and tramway systems with earthed conductors—in fact, since the adoption of earthed conductors made compulsory in some instances by the Board of Trade and universally used on tramways in this country, the earth can hardly be said to be entirely free of stray currents. On the tramway system I superintend, even with traffic suspended there are differences of potential of nearly two volts between the rails and water-pipes. Observations show that the currents are from a neighbouring tramway system, because when this system is shut down the readings drop to ·5 volt, the current flowing from water-pipes to rail. When this neighbouring system starts up the current is reversed—*i.e.*, flowing from rail to water-pipes. When both systems are running the pressures tend to neutralise, and readings only 25 to 50 millivolts are obtained, varying first positive and then negative from rails to water-pipes. The neighbouring system has its rails joined to ours with its fishplates, but not bonded. The difference of potential of ·5 volt obtained when both systems are suspended is probably due to our three-wire lighting system, or it may be due to battery action, which I will explain later. The readings mentioned in the question may be from the local lighting system due to a faulty cable which may be in close proximity to a water-pipe, the leakage current probably attacking the pipe on its return to the station earth-plate if the system has an earthed conductor at the station, thus raising the potential of the water-pipe, or in this case it may be due to battery action.

I have mentioned battery action above, and I will now explain more fully. If two plates of iron are buried in fairly moist earth a short distance apart, differences of potential can be read with a millivoltmeter. I have frequently taken readings of ·25 of a volt with this experiment. The same results can also be obtained between water-pipes and gas-pipes. This is termed an earth battery, and the action is somewhat similar to the ordinary primary battery. If the plates are left long enough in the ground, the action is rather peculiar. When the current leaves a metallic surface buried in the ground, it does not carry with it the decomposed metals, as in a plating bath, and deposit them on the cathode. On the contrary, the products lie adjacent to the surface acted upon, and when the metal is iron they generally form oxides. With a lead service pipe connected to an iron pipe there are two metals which, when buried in the earth, form an earth battery which will cause a current to flow between them when their ends are connected together, as in the case when a cast-iron pipe and a brass nipple are tapped together and attached to a service pipe of iron or lead. With some metals corrosion sets in early and forms a high-resistance contact, and readings cannot easily be obtained, the high resistance breaking up these local earth currents. It was found that the caulking of water or gas pipes sets up galvanic action if the lead touched the iron in any place. I found on an old horse tramway system without a local lighting supply, and miles from any other tramway system, that ·25 of a volt could be obtained between iron pipes and tramway rails, which

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was undoubtedly due to battery action of the buried iron. Mr. A. B. Herrick, in his paper on "Electrolysis and Earth Returns," read before the New York Electrical Society in April, 1900, and D. H. Maury, in a similar paper read before the American Waterworks Association, May, 1900, experimented and found this battery action to be correct.—I. N. W.

Answer to No. 791 (*awarded* 5*s*).—It is evident, from considerations of the above question, that the pressures which are set up between the rails of the tramway system and the adjacent water-pipes are not caused by any other pressures acting at that time in the system, because the system is not working when the observations of these pressures are taken. Nor is it likely—though it is possible—that the continuous currents of the independent combined system are the direct cause, for faults and excessive leakage are, as far as possible, avoided. The real cause, however, appears to be a sequential cause—that is, a cause composed of a number of causes each acting in turn. When the tramway system is working, there is a drop of potential in the rails not exceeding the Board of Trade limit—the exact magnitude of the drop, however, is of little consequence here. There is, however, an equal drop in the earth from end to end of the system, and this gives rise to earth currents. Now these earth currents will take the path of least resistance, and consequently pass from the rails of the system to the *adjacent* water-pipes. If the intervening medium between the rails and the pipes is moist or wet, perhaps containing acid of some kind, then we have a very crude secondary battery, with the water-pipes and the rails constituting the two poles. This crude secondary battery will, during the running and working period, be getting charged up, perhaps not to more than one volt, and possibly to less than this. When running and working have ceased, this battery has then an opportunity of discharging itself, and hence there is an *active* difference of potential between the water-pipes and the rails. Thus the initial cause acts during the period that the generating plant is at work, and the final cause during the period of rest or "shut down."—G. W. BURLEY.

Answer to No. 791 (*awarded* 5*s*).—The difference in voltage between the tramrails and water-mains is most likely due to an earth in the middle wire of the three-wire network when that system is not in balance, or an earth on one of the outers Suppose that there is an earth on the middle wire at A (Fig. 1), and that the middle-wire current is in the direction indicated, then, as tramrails will be earthed at the station end (indirectly, being connected to earth-plate through earth-current ammeter), and as water-main will be making a more or less good earth at different points along

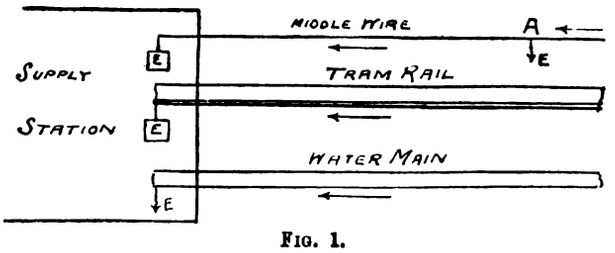


FIG. 1.

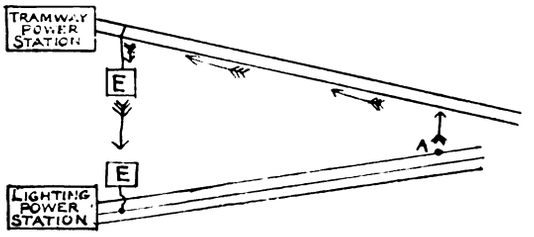
its length, it will be seen that between A and the supply station there will be three paths in parallel, along which the middle-wire current may flow to the station, the respective amounts varying inversely with the resistance to earth at each end of each circuit, together with the resistance of each circuit itself. Then, leaving out of consideration the amount of middle-wire current which returns to the station by the proper path—viz, the middle wire itself—it is more likely that more current will return by the tramrail than by the water-main, since the tramrail is making a good earth at the station end, and the water-main probably only a poor one comparatively.

Now, the potential at the same end of each circuit will be the same—*i.e*, there will be the same fall of potential in each circuit—and, as the tramrail makes perfect earth at the station end, all the fall of potential in that circuit will be due to the resistance of the rail itself, and will be uniform if all bonds are good; but since the resistance of the earth which the water-main makes at the station end probably forms a considerable portion of the total resistance of that circuit, the fall of potential along the water-main itself, although uniform, will not be so rapid as the fall of potential along the tramrail. Hence the difference of potential between these two at any point intermediate between A and the station. If the water-pipe makes good earth, then by following out a similar reasoning bad rail bonds may be shown to be a cause of differences of potential.—G. N. W.

Answer to No. 791 (*awarded* 5*s*.).—This is really the old "earth battery" effect, but under more modern circumstances. The old earth battery consisted of a plate of copper and a plate of zinc buried in the earth. A wire was attached to each, and a feeble current was obtained, generally for driving an electric clock. The E M.F. was very low, but varied with the earth in which the plates happened to be buried—*e g*., if both plates were in clean sandy soil, the E M F. would be very low, but if any acid refuse happened to find its way to the zinc plate, then, of course, the E M.F. would be increased.

In the conditions of the question we have a still more feeble E.M.F., because each "plate" of the battery is iron, one being the tramrails and the other the water-mains; but these are under different circumstances, for the water-mains are buried deep down in clean soil, whereas the tramrails are laid in a busy road soaked with the acid filth of animals, etc., which would easily attack them. There is still a further reason why the tramrails should act the part of positive plate to the water-mains, and that is due to the electrolytic action caused by the electricity used in driving the trams, for this current would, of course, flow from one part of the rail to another on its way back to the dynamo, therefore, one part of the rail would show a positive potential to another part, and, therefore, one part—viz, the negative—would be cleaned by the electric (working) current. This clean part may, for our present purpose, be considered simply pure iron, and being on the surface of the road in contact with the above-named acid filth would, when joined by a wire and galvanometer to the oxidised water-mains, naturally show a slight positive potential for a considerable time after the dynamo had been disconnected. All iron pipes are covered with a thin skin of oxide of iron before they leave the makers. It is very durable, and is not attacked by anything usually found in earth a few feet below the surface.—F. G. A.

Answer to No. 791 (*awarded* 5*s*.).—The difference of pressure observed in the question is undoubtedly due to a leakage current from the three-wire alternating-current supply. In the diagram I have endeavoured to show the



state of things. The power stations will probably be in close proximity, and the tramway rails will be connected to an earth-plate at the power station, as also will be the middle wire of the lighting supply. Now, the tramway rails will provide for the leakage current a path of lower resistance than the earth. In the diagram I have assumed the leak to be at the point A. The current will pass from A to the tramway rails, along which it will flow to the earth-plate at the tramway power station. From here it will pass to the lighting station earth-plate up to the middle-wire 'bus bar. Now, of course, as we have a current flowing between the tramway rails and earth, it follows that there must be a difference of potential between the rails and earth. The water-mains may, of course, be considered as dead earth, and, therefore, when tested with a voltmeter the differences of potential noted are obtained. Apparently the leak is rather a large one, and it is probable that the 25 volt may be measured somewhere near the leak, thus giving a large

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proportion of the total drop. I mean that ·25 volt probably represents about the total pressure drop along the tramrails of the leakage current.—ERNEST P. HOLLIS.

Answer to No. 791 (*awarded* 5*s.*).—The solution of the problem I should look for in a leakage on one of the outers of the three-wire supply system, to which the tramrails are acting as a large collector, and conveying the current through to the point at which it has least resistance to the passage of the current to the water-pipes, and so by this means back to the middle wire of your lighting supply. It stands to reason that the rails, bonded as they are, will have a lower resistance to the passage of the current than the water-mains, some of the joints of which are of higher resistance. Again, the rails are not earthed right up to the station, an insulated return being run back on to the bond; on the other hand, the water-pipes enter the station itself, hence they would have a lower resistance than the rails between the point where the negative return leaves the rails and the station itself. So that the water-pipes being at earth potential and the rails slightly above would give us the reading the questioner finds to be the case in this particular instance. To determine whether this is the case or not, if your middle wire is earthed at the station only and you now connect your voltmeter between the water-pipes and the rails, on switching off your middle-wire earth at the station your voltmeter will cease to register.—W. T. S.

Question No. 792.—In the Crompton automatic cut-out for automatically placing in circuit a substitutional resistance equivalent to the resistance of the arc, and which is used with 10-ampere, open-type, continuous-current street arc lamps, 10 in series on 460 volts, there are just two coils—one thick wire and one thin wire. The latter coil is in circuit the whole of the time, and apparently does all the work. Explain clearly the necessity for the use of the thick-wire coil, and also the functions which in this particular case it performs.

Answer to No. 792 (*awarded* 7*s.* 6*d.*).—In considering the above query a brief explanation of the precise working of the cut-out will not be out of place. In the accompanying

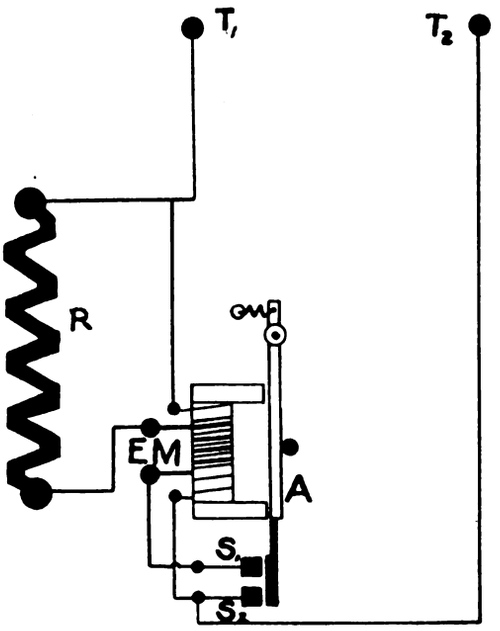
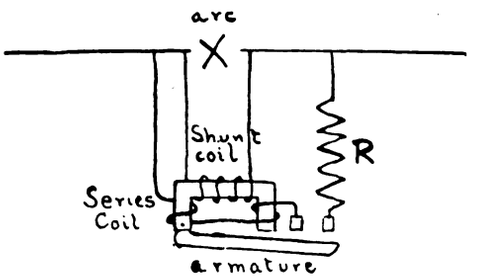


figure we have a diagrammatic sketch of the cut-out. T_1 and T_2 are the two terminals of the arc lamp, the internal mechanism of which has not been included in the sketch. E M is an electromagnet wound with the two windings—one of thick wire and the other of thin wire. These two windings act with one another and *not* against. S_1 and S_2 are two contact studs. A is the armature which, when actuated, bridges the space between S_1 and S_2. R is the substitutional resistance. When, by any means whatever, the two carbons become separated to such an extent that the arc cannot be maintained, then immediately there is an increase in the current passing round the thin wire of the electromagnet, E M. This occurs because, whereas before, when the lamp was working under normal conditions, the thin-wire winding of E M was in parallel with the carbons, now this winding is in series with the main circuit and the full lamp pressure is impressed upon it. This necessarily results in an increase of the current passing through it. This increase in the current results in an increase in the attraction between the electromagnet and its armature, and the spring of the armature holding it back is so adjusted that the armature yields to the new attraction between the electromagnet and itself. S_1 and S_2 are thus brought into contact, and the substitutional resistance circuit is closed. In this new circuit the thick-wire winding is placed. Naturally, now, the current passing through the thin wire will have been reduced in magnitude to its original value. Consequently, the attraction between the electromagnet, E M, and the armature, A, will decrease if the thick-wire winding does not help the thin-wire winding. Therefore, the cut-out will work erratically and unreliably if the thick-wire coils are excluded from the cut-out. The *function* of these coils is to augment the attractive power of the thin-wire coils in order to keep A in contact with S_1 and S_2 until the carbons come into contact again. When the carbons of the lamp are brought once more into contact, the current passing through R, and, therefore, round the thick-wire coils, will decrease, and the attraction between the electromagnet and the armature will also fall off, until, when it has reached a certain value, the spring acts and the armature is released. This release opens the substitutional resistance circuit at S_1 and S_2, and the lamp then works normally.—G. W. BURLEY.

Answer to No. 792 (*awarded* 7*s.* 6*d.*).—Where there are a number of arc lamps in series across 460-volt mains, it is important that the failure of one arc lamp should not cause the rest of the lamps in series with the defective arc to go out. To prevent this, an automatic arrangement is fixed in the case of the lamp to cut it out if it becomes faulty. A fine-wire coil is connected across the two carbons, forming a shunt across the arc itself. It is evident that if the carbons became too short in one lamp, the mechanism would be unable to feed the carbons any closer together, and thus the arc would get longer and longer. The potential difference across the arc would rise, more current would pass round this fine-wire coil until it became strong enough to raise the armature and insert the substitutional resistance. There would be the same pressure drop in this resistance as there would have been if the arc had been working; consequently



the other lamp would be unaffected. The potential difference across the terminals of the fine-wire coil will now fall to normal, and the armature would be released if it were not for the thick-wire winding, which is now carrying all the current, and, therefore, keeps the armature up in position. This thick-wire winding is generally dispensed with in constant-potential circuits, as the voltage drop across the substitutional resistance can be arranged high enough to send sufficient current round the shunt winding to keep armature of magnet in position. The series winding is necessary for arc lamps working on constant-current circuits, because in that case no resistance is substituted, but the arc simply short-circuited. The carbons will thus have no potential difference across them, and there will be no current flowing through the shunt, and if it were not for the series turns the armature would fall, switching off all the arcs in series with the faulty one, and as the pressure would no doubt be high, a continuous arc would be set up, burning away the metal contacts.—RESEARCH.

[Other replies to Question No. 792 will be given in our next issue.—ED. *E. E.*]

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JULY 28, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

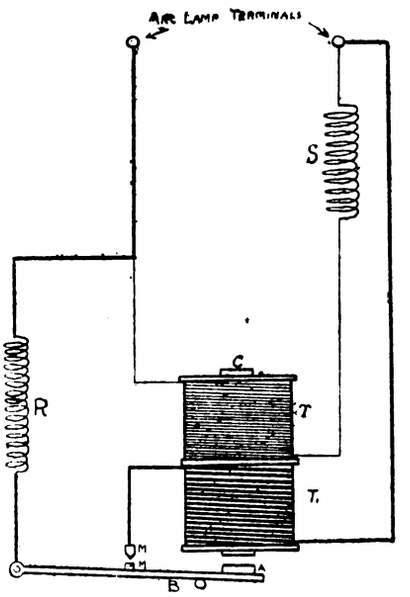
798. A short-circuit occurred across two of the terminals of a 50-h.p. three-phase motor when running at full load. The motor-house is connected to the power-house by an overhead line consisting of three bare copper wires No. 4 S.W.G., placed one above the other, with a spacing of about 10in. between them. The line consists of two short spans, the intermediate support being an iron bracket on the corner of the power-house, which bracket is also situate much higher than the support on the motor-house, this span having an inclination of about 30deg. to the horizontal. Concurrently with the short-circuit on the motor several flashes were seen between the top and middle lines of the motor-house span. The wires were badly burnt and pitted on *both spans*. A distance of several feet, however, on either side of the intermediate support showed no signs of burning. A main 300-ampere fuse in the power-house was blown, while the 120-ampere motor fuse was overheated only. The weather was fine and calm. We have had a similar occurrence before when using a different make of generator, both generators being of the revolving-field type, 330 volts, 42 ~, and of modern construction, motor and generator A wound. Can any of your readers furnish an explanation of the arcing on the line.—F. E. H.

799. An electrostatic extra high-tension voltmeter is continually giving trouble through the metal parts corroding. What is the reason of this?—P. D.

ANSWERS.

Question No. 792.—In the Crompton automatic cut-out for automatically placing in circuit a substitutional resistance equivalent to the resistance of the arc, and which is used with 10-ampere, open-type, continuous-current street arc lamps, 10 in series on 460 volts, there are just two coils—one thick wire and one thin wire. The latter coil is in circuit the whole of the time, and apparently does all the work. Explain clearly the necessity for the use of the thick-wire coil, and also the functions which in this particular case it performs.

Answer to No. 792 (*awarded* 5*s.*).—The accompanying diagram shows the connections for a cut-out used in connection with continuous-current arc lamps connected in series with one another. It will be seen that the thin-wire winding, T, of the cut-out is in series with the shunt winding, S, of the arc lamp, and that both are connected across the arc lamp terminals. When the carbons burn away, or stick apart in any way, the whole of the current, still of the same strength, has to pass through the shunt circuit and would soon destroy it, but the coil T is so adjusted that this increased current passing through it magnetises the core sufficiently to raise the armature, A, and with it the lever, B. This lever, B, carries with it a small contact stud, M, which, when it is raised, comes in contact with another stud, M_1, connected to one end of the thick coil, T_1, on the cut-out. R is a resistance coil equal in value to the resistance of the arc, and when the above action takes place it becomes connected in series with the thick coil, T_1, on the cut-out, and also in series with the other arc lamps in the circuit. This thick coil, T_1, and resistance coil, R, now carry the current which formerly traversed the carbons, so that the shunt circuit again carries only its normal current. The heavy current through the thick coil of the cut-out still keeps the core, C, magnetised sufficiently to keep the lever, B, in position, and thus maintains connection between M and M_1. The insertion of this resistance after any arc lamp has burned out maintains the correct potential drop



across the other arc lamps in the circuit, so that they burn under the same conditions as before.—B. W.

Answer to No. 792 (*awarded* 5*s.*).—The necessity of the thick-wire coil will, I think, be obvious on inspecting Fig. 1. The functions which it performs are as follows: When the lamp is burning steadily the whole current flows from the positive terminal through the series coil, S, then part passes through the carbons and part through the shunt coil, T, which has in circuit the fine-wire coil on the cut-out, C, to the negative terminal. Now, when the main

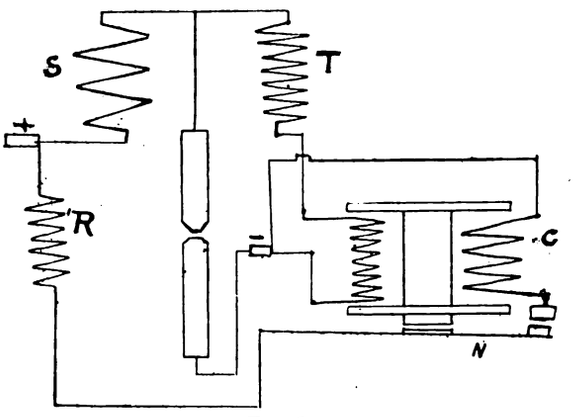


FIG. 1.

circuit is broken, the whole current strength has to pass through the shunt circuit, and might soon destroy it; but the fine-wire coil on C is so adjusted that when this increased current passes through it its core becomes sufficiently magnetised to attract the lever, N, closing the circuit through the substitutional resistance, R, and the thick-wire coil on C, which is wound to assist the fine-wire coil on C; because the latter coil will now have its current diminished, and the circuit would be repeatedly made and broken were it not for the thick-wire coil on C. The current will also be diminished through the series coil, S; the brake will therefore be free, and if only a portion of the carbon has broken off the arc will be re-established, when the current flowing through the thick-wire coil on C will be reduced, and the cut-out circuit disconnected.—H. M.

Question No. 793.—A battery working in conjunction with a reversible booster on a traction load has recently been overhauled and all sediment removed from bottoms of cells. Since then it has been

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noticed that large lead trees have been forming on a lot of the negative plates, causing a lot of trouble by short-circuiting cells. Would the fact of using acid out of an old battery, that has been idle for months, to top up the cells after overhaul cause the trouble, and could some reader give a remedy for same; also explain the cause of trees forming?

Answer to No. 793 (*awarded 7s. 6d.*).—It seems curious that many engineers find so much mystery surrounding the cause of defects which develop in storage batteries. It seems pretty certain to the writer that most troubles can be traced to the failure of battery attendants neglecting to give the battery the treatment which is generally acknowledged to be essential for its proper maintenance. One of the most important conditions for satisfactory results, and one which probably receives the least attention, is that the electrolyte must be pure. "A. B. C." should have the acid tested, and if it is found to contain impurities, then the acid should not be used. There are two main causes which the writer believes will bring about the formation of so-called lead trees: (1) impure electrolyte, (2) battery being worked at too low an efficiency.

1. Let us examine No. 1 cause. It is well known that impurities in the electrolyte causes clogging of the pores in the active material, and in some cases this takes place in patches. In other words, this clogging may be said to be analogical to corrosion in a boiler, inasmuch as sometimes corrosion is general and sometimes local, the local corrosion being generally distinguished from the general corrosion by being called "pitting"; so, too, the clogging of the pores in the active material of a battery is sometimes general and sometimes local, or in patches. Now examine the effect of these patches. They vary in size from that of a threepenny to a sixpenny piece. They are composed of impurities which have been deposited on the plates, and which produce with the active material on which they become deposited, a couple, which causes local action. The result of this local action is that the active material in close proximity becomes n time disintegrated. As the paste gradually becomes loosened in powder form it falls from the sides and bottom of the patch to the bottom of the cell, but that from the top of the patch comes in contact with the impurities, and is held there; this increases the action, and so the process continues until the loosened paste and impurities accumulate, and so form a ledge, or what is sometimes incorrectly called a growth. As soon as this so-called growth or lead tree assumes appreciable size, they increase in size rapidly. The distance, and consequently the resistance between the plates at this point is reduced, and this again increases the amount of current passing until local or internal discharge results. If allowed to remain, these lead trees soon bridge across the plates and causes short-circuiting. All so-called growths should be removed by means of a thin piece of wood as soon as possible.

2. If the efficiency of a battery be kept low, it follows that the amount of current put into a battery is much more than the amount given out. During charge the current flows from the so-called positive to negative plates, and the direction of current causes the impurities to be deposited on the plate to which the current flows. That is to say, the impurities during charge would be in contact with the negative plates, and during discharge in contact with the positive plates. When, therefore, the efficiency of a battery working in conjunction with a reversible booster is kept low, it usually infers a greater time is taken for charges than discharges. It will, therefore, be seen that under such conditions the impurities will be against the negative plates for longer periods than they would be against the positive plates, and, consequently, they are more likely to become permanently deposited on the negative plate, and this is one reason why so-called growths or lead trees are almost invariably found on the negative plates.

From the above it will be obvious that a combination of 1 and 2 would have a very serious effect on a battery. Another cause which might partly arise out of No. 2 is imperfect circulation. Hence these lead trees are frequently found quite close to the glass separators where the electrolyte is, in some cases, somewhat stagnant.—C.

Answer to No. 793 (*awarded 7s. 6d.*).—It is probable that "A. B. C.'s" trouble is caused, as surmised, by using the acid from an old battery to top up the cells. After standing so long unused this acid probably contains some lead sulphate, or possibly also nitrate, and oxides in solution or suspension. The sulphate, although insoluble in pure water, is slightly soluble in sulphuric acid, while the oxide is slightly soluble in even pure water when air is present. Possibly also dust settling in the disused cells has caused the formation of small quantities of other soluble organic salts of lead, such as the acetate. Similar troubles are caused by ordinary impure commercial sulphuric acid, which often contains lead sulphate, nitrate, or other salts in solution. The action of the lead trees forming is probably purely an electrolytic one. The efficiency of a battery being below unity (perhaps 70 per cent.) it will receive more charging than discharging: therefore, the balance of current will be through the liquid to the negative plates, and the lead will, therefore, be deposited from the salts in solution on these plates, forming the lead trees. So long as any lead *remains* in solution in the acid there does not appear to be any remedy for the trouble. If "A. B. C." wishes to save the acid, he might try *with caution* the addition of a small quantity of sodium sulphate (Na_2SO_4), or, better still, of sodium carbonate (common washing soda), not exceeding one ounce to the gallon of acid solution. Both of these have been used as a cure for "sulphating" in cells, but in the present case their action would be to precipitate as insoluble sulphate or carbonate any soluble lead salts in solution. If practicable, it is preferable that the cells should be cut out one or more at a time (care being taken not to "short" them), the acid siphoned off, and the sodium salt completely dissolved in it before pouring it back into the cell. This should be done in a reasonably short time, to prevent the spongy lead negative plates oxidising much in the air, although some time should be allowed for precipitate formed (if any) to settle to the bottom of the acid before it is returned to the cells. If "A. B. C." can arrange for a supply of sulphuretted hydrogen gas and can put up with the "stink," he can test for the presence of any serious quantity of lead in solution by passing this through the acid, and can remove the lead as a black precipitate of lead sulphide, which should be allowed to settle before returning the acid to the cells.—X. Y. Z.

Answer to No. 793 (*awarded 5s.*).—It was quite a wise and proper thing to remove the sediment and to clean the battery cells, and if the acid from the idle battery was in good order no objection could be urged against using it. The first thing to consider now is whether the acid is of the proper strength—viz., 1,200deg.—when the battery is fully charged. If not, make it so, and push down all the "lead trees" by means of a wooden or ebonite lath. Then continue the charging for half an hour after all the plates give off gas in order that any nitric acid and any hydrochloric acid in the electrolyte may be decomposed and eliminated as gas. These two acids, if present, would make soluble salts of lead, and so enable the lead trees to form when the battery is charging and also when standing idle. Repeat this treatment three or four times, each time pushing down all the "lead trees" and making certain that no cell is short-circuited. I have known this simple treatment quite successful. The lead trees may be formed by some impurity in the lead plates, and, if so, they are difficult to get rid of; but this is not probable, because all makers know that impurities in the plates are fatal to the efficiency of the battery, and, again, it is not easy to see how the trees could form without some soluble salt of lead actually dissolved in the electrolyte. The only remedy for this would be to discharge the battery slowly and to throw away the whole of the electrolyte as useless. The plates should be well washed with clean cold water, brushed, rinsed, and replaced in the cells. Best brimstone sulphuric acid should then be carefully poured into clean rain, or, better still, cold distilled water, with great care and constant stirring. This must then be left for some hours until quite cold, when its specific gravity should be adjusted to 1,190deg., and it may be poured into the cells and charging started, which will bring the gravity of the electrolyte up to 1,200deg., and no more trouble would be likely, because during discharge any metal soluble in the electrolyte, such as zinc or iron, would be removed from the grey plates

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and dissolved by the electrolyte, and this would have been thrown away. I, however, omitted to mention above that possibly, though improbably, the electrolyte of the recently cleaned cells might be very much too strong. If so, its gravity would be greater than 1,200deg., and it would require water adding, but it would have to be much too strong, probably 1,700deg., to cause "lead trees." Lead is slightly soluble in very strong oil of vitriol. The "trees" are formed by electrolytic action, which may be in the charging current or it may be due to local action on the plates, caused by some such metal as zinc or iron acting in the presence of some soluble salt of lead, as the nitrate or chloride dissolved in the liquid. Common oil of vitriol often contains nitric and nitrous acids as impurities, but they would be decomposed by the hydrogen set free during charging and discharging. However, it is always best to use the purest brimstone sulphuric acid for accumulator work. It gives the best results, and often saves a lot of trouble. The cost is not great, and it is only once—*i.e.*, at starting.—F. G. A.

Answer to No. 793 (*awarded* 5*s.*).—It would be advisable to carefully examine the cells before taking extreme measures; when cells have been overhauled it is quite a common occurrence for them to scale badly for a time, therefore the trouble may not be very serious. Going round the cells and pushing a slip of wood between the plates should remove the abnormal growths; if simply due to fresh setting up, the trouble will soon disappear. In case the growths should persist, the cause may be attributable to faulty electrolyte. Should sulphuric acid used for accumulators contain chlorides, the chlorine is almost certain to be given off during the time the cells are in use, and will inevitably show itself by growths on the plates. There are, however, several other causes that may be looked for. Have the cells been thoroughly charged before being put on discharge? Cells that are charged very slowly, particularly when nearly run down, are apt to throw off shoots between the plates. On the other hand, the battery may have been subject to sudden and heavy demands for current, this may have caused the paste to swell and fall out. This is a frequent source of trouble with an old battery. The remedy appears to be, make sure that the conditions of working are all right, and, if this is so, test the electrolyte. Faulty working can easily be remedied if the electrolyte is unsatisfactory; the only thing to do is to refill the cells. Doctoring accumulators generally ends in the resulting "cure" being worse than the disease.—M. M.

Answer to No. 793 (*awarded* 5*s.*).—The lead trees are due to a chemical lead compound which the acid liquor now contains in solution in sufficient quantity to give trouble. On charging the battery this soluble lead compound is decomposed by electrolysis, and the lead is deposited on the negative plate as lead trees. The bottom edges of the plates, or along the edges of the separators, are the surfaces where deposition generally occurs. This is probably because there is a more rapid circulation of the liquor along those parts, but wherever deposition begins it continues at that point instead of coating the plate evenly, and eventually produces a "short." The acid from an old unused battery, if otherwise normal, could not do any harm. The pure acid of our accuumulators—that is, acid free from injurious impurities—always contains a small quantity of lead in solution, and this is deposited on the negative plate during charging, but it is a fine uniform deposit, only noticeable after long periods of work. It gives no trouble, but is rather an advantage. One cannot say how the soluble lead compound has got into the liquor without knowing all the facts relating to the removal of the sediment, but it is probably a "salt" of some mineral acid, such as hydrochloric. Soluble chlorides of lead would eventually be formed if either acid or plates came in contact with common salt, sal-ammoniac, soldering solution, urine, or any other substance containing a chloride. Perhaps the compound may be nitrate of lead, which would result from contact with nitre or any other nitrate or from nitric acid.

As to the remedy. I know no other than the regular working of the battery. If the compound be a chloride then the characteristic smell of chlorine may possibly be detected, especially on beginning to charge the battery after discharge. Fortunately, the compounds sulphuric acid and a peroxide (necessary for generating chlorine gas from a chloride) occur in the battery, and it will be found that the combined effect of electrolysis and chemical action will be to clear the liquor of any chlorides it may contain by expelling the chlorine as a gas. In the same way the liquor will be cleared of nitrates, the nitrogen being expelled as a gaseous oxide, so that unless the amount of impurity is so great as to render working impossible through "shorts" there is hope for the battery.

It may not be out of place to draw attention to evidence given at the enquiry into the A 8 submarine catastrophe. The battery of a sister boat was flooded with sea-water and chlorine gas was given off as a result of it. Possibly the "lead trees" are not lead, but some other metal, such as iron or zinc, which has been dissolved from galvanised-iron pails or other iron articles. If this be the case, the shorts may gradually disappear, probably from the deposited particles which are shoved off the plate and fall to the bottom amongst the mud from the positive plates, becoming oxidised to Fe_2O_3, in which case the battery acid would have no further action on them.

In justice to the person responsible for the battery, the battery-room ought to be locked or well guarded. It is quire easy for a viciously-disposed person to introduce in two minutes a common substance which would spoil the battery.—F. P. S.

Question No. 794.—Describe the method of arranging the stator windings of two or three phase motors with a view to speed regulation. Is it possible to arrange a 12-pole winding so as to reduce to eight poles?

Best Answer to No. 794 (*awarded* 10*s.*).—The principal methods adopted for varying the speed of polyphase induction motors may be classed under three heads—viz.: (1) by the insertion of non-inductive resistances in the rotor circuit; (2) by changing the number of poles; and (3) by tandem control, or, as it is sometimes termed, the "cascade connection." The first method may be suitable where the speed is only to be varied within small limits, but even then the regulation is obtained only by a sacrifice in the efficiency. This method is equivalent in principle to varying the speed of a shunt motor by inserting resistance in the armature circuit. The third method involves the use of two separate motors, and is similar in principle to the series-parallel control of continuous-current motors. It possesses many advantages for traction work, but up to the present has not found much use for stationary work.

The second method is one which is the most practicable for workshop and stationary work, and is dealt with below, polyphase motors only being considered. The synchronous speed of an induction motor is given by

$$s = \frac{\sim}{p} \times 120;$$

where s = synchronous speed in revolutions per minute
$\sim$ = frequency of supply; and
p = number of stator poles.

Thus, by reducing the number of poles by one-half, the synchronous speed is doubled. We will briefly investigate the relations existing in an induction motor before discussing the stator connections for pole changing. The relation existing between voltage and flux is (for a three-phase motor) given by

$$E = 4{\cdot}2\ T\ N\ M \times 10$$

where E is the "internal" E.M.F. per phase, T the number of turns in series per phase, M the flux per pole linked with the turns, T, and N the frequency in cycles per second.

Consider the case of an ordinary three-phase induction motor with squirrel-cage rotor, and suppose the motor is wound for four poles. We will investigate briefly the alterations required in order to enable motor to run with four and with two poles. We will suppose, for the purpose of this investigation, that the motor is wound for 200 volts and 50 ~. The stator has 36 slots, and there are 22 conductors per slot, the connection of phases being Y. Thus from the above formula we find the flux per pole, M, to be ·407 megaline. Now, in converting this motor into one with two poles it is desirable to keep the gap density the

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same, and consequently the flux, M, will have twice the value found for the case with four poles. Therefore, since the voltage is the same, the number of turns in series per phase must be one-half of that for the four-pole motor. Thus this motor can very simply be converted from four to two poles by taking a tapping from a point midway in the winding of each of the phases. These three additional leads are connected on to the line in place of the three original terminals, which are now connected together, and we have a two-pole motor. Fig. 1 will serve to make this point clear. When the double-throw switch is thrown "down" the motor has four poles, and when thrown "up" the motor has two poles, the connections made by the switch being shown by the small sketches to the right in the diagram.

It will be observed that the turns in *series* per phase are, for the two-pole connection, one half of that for the four-pole connection. Let us now investigate the operation of the motor for each of these cases. The magnetising current of an induction motor may be obtained from the expression,*

$$i_e = \frac{B \cdot 1{\cdot}6\,\Delta}{t\sqrt{2}};$$

where i_e is the magnetising current, Δ is the radial depth of air-gap in centimetres, and t is the number of turns in series per pole per phase. A brief inspection of this equation will show that the magnetising current is the same for both the four-pole and two-pole connection. It should, however, be pointed out that the magnetising current will be probably greater with the two-pole connection than with the four-pole. This difference will be

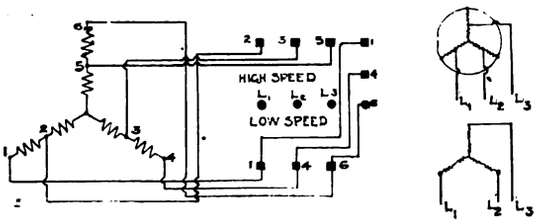

FIG. 1.

marked if the motor is originally designed for four poles, as with the two-pole connection the density in the iron at the back of the slots will be increased considerably, and incidently it may be mentioned that the core loss may be increased so much as to lead to excessive heating.

Adopting Behrend's expression for the leakage factor,†

$$\sigma = \frac{c\,\Delta}{\tau},$$

where σ is the leakage factor, τ the pole-pitch in centimetres, Δ the depth of air-gap in centimetres, and c a factor which, according to Behrend, is "dependent on the shape and size of the slots and upon a great many other conditions of which we are still profoundly ignorant." Now, for the motor under consideration, c and Δ are constant, and τ is increased for the two-pole connection to double its value for the four-pole connection. Now, σ is defined as the ratio of

$$\frac{\text{magnetising current}}{(\text{ideal short-circuit current} - \text{magnetising current})},$$

and as the diameter of the circle in Heyland's diagram is given by (ideal short-circuit current – magnetising current), we see that for the two-pole connection the circle has twice the diameter of that for the four-pole connection. As the diameter of the circle is proportional to the output from the motor, it is apparent that the output of the motor will be doubled when connections are changed from four to two poles.

Fig. 2 and 3 show further diagrams of connections for changeable pole motors similar to the one discussed above.

* "The Induction Motor," B. A. Behrend, p. 15.
† "The Induction Motor," B. A. Behrend, p. 36.

Fig. 2 is a somewhat modified form of connection to that shown in Fig. 1, while Fig. 3 shows the connection when the stator windings are delta connected. In Figs. 2 and 3 the motor runs on the "low speed"—*i.e.*, with the larger number of poles—when the double-throw switch is thrown "up." Throwing this switch "down" connects the stator windings (as shown in the small sketch to the right) and the motor runs on the "high speed."

In connection with speed regulation of induction motors, attention must be drawn to the work done by Mr. C. Wüss (of the firm of Wüst and Co., Seebach-Zurich) in developing what he terms a "multi-speed" induction motor. The motor was described in an article on "The Speed

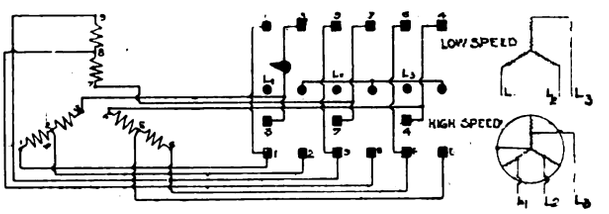

FIG. 2.

Regulation of Three-Phase Motors," which appeared in the *Electrical Engineer* for Nov. 13, 1903. This article should be read by all those interested in the polyphase induction motor, as not only is a description given of this multi-speed motor, but numerous curves showing the operation of induction motors for changeable pole work are included, which in themselves are worth studying.

It may be mentioned that the multi-speed motor consists of a number of stators—two, three, or four, according to speed variation required—arranged in one common housing. Rotors corresponding to these stators are arranged along a common shaft. As an example, we may take the case of what is termed a "three-step" motor. One of the stators is wound, say, for four poles, another for six poles, and another for eight poles, the rotors being wound to correspond. By means of a suitable controller one or other stator is put into circuit, and also various combinations of the individual stators can be made enabling a great variety of speeds to be obtained. In the above-mentioned article some interesting data are given of a three-step, 3-h.p., 50 ~ motor, having the individual stators (or elements) wound for four, six, and eight poles. With various combinations of the elements, speeds from 670 r.p.m. to 1,500 r.p.m. were obtained, the maximum output at the lowest speed (670 r.p.m.) being 6·7 h.p. This multi-speed motor possesses many advantages

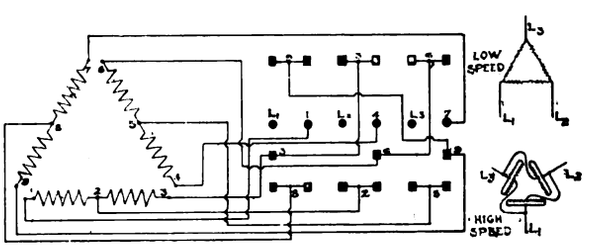

FIG. 3.

(especially where a greater horse-power is required at the lowest speed), and the power factor and efficiency is maintained high at all speeds.

The point raised in the question, *re* arranging a 12-pole winding to reduce to eight poles, would be impracticable in the ordinary form of induction motor on account of the great number of connections that would have to be brought out from the winding. Assuming that the stator has the "rectangular" type of winding, and that for eight poles this winding is arranged with 100 per cent. pitch, then to convert this into a 12-pole winding the coils would have to be reconnected to give a pitch of 66·6 per cent., which would be impracticable.—MONOPHASE.

[Other replies to Question No. 794 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
AUGUST 4, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

800. Will a Kelvin multicellular voltmeter give the R.M.S. volts when connected across the secondary of a pressure transformer? The high-tension pressure is 2,000, and the transformer ratio 20 : 1.—H. C. H.

801. Show how to calculate the ampere-turns needed to balance the armature reaction of a polyphase alternator working at power factor cos ϕ.—X. X.

ANSWERS.

Question No. 794.—Describe the method of arranging the stator windings of two or three phase motors with a view to speed regulation. Is it possible to arrange a 12-pole winding so as to reduce to eight poles?

Answer to No. 794 (*awarded* 7*s.* 6*d.*).—The method of speed regulation by pole changing has often been employed where continuous running at two or more speeds is involved. Owing to the complication of the switchgear, as well as to the unsatisfactory conditions under which the machine would be running at the lowest speed, more than two speeds are seldom attempted by this method, and these speeds are usually in the ratio of 1 : 2. The rotors of such motors would generally be of the squirrel-cage type, as these are equally suitable for all numbers of poles. If, however, a wound rotor is essential from torque considerations, two independent windings would have to be put on it—one for each number of poles. In most cases these two windings would not involve any additional slip-rings, as both could be connected to the usual three slip-rings, one or the other winding alone being active according to the number of stator poles in use. With this rotor arrangement the starting current is increased owing to the partial short-circuiting of the active winding by the inactive one; but, unless a comparatively large starting torque is required, this is not of much importance. When running normally, the rings are in any case short-circuited so that the running conditions would not be affected.

With regard to the stator, the same plan of two independent windings can, of course, be employed, and though this involves the use of slots of practically twice the normal size, the switchgear is simple (merely a three-pole main throw-over switch putting one or the other winding into circuit), and the working conditions are better than if a single winding is recoupled to suit both speeds. For the sake of economy in material and space, however, the latter arrangement of a single stator winding is usually employed. This winding is arranged exactly as in a standard motor, except that additional ends must be brought out to enable alternate coils to be reversed. The span of the coils and the width of the coil side would usually be those corresponding to the larger number of poles—*i.e.*, they would be exactly the same as in a normal motor wound for the larger number of poles alone. In some cases, however, especially when the machine is intended to run most of the time with the smaller number of poles, it will be more satisfactory to make the span of the coils and the width of the coil sides something between those corresponding to the larger and those corresponding to the smaller number of poles—*e.g.*, a span of $1\frac{1}{3}$ times the normal span corresponding to the larger number of poles. The case of a four-to-two pole, three-phase, star-connected stator winding with one coil per phase per pair of poles (of the larger number of poles) is represented in Figs. 1 and 2.

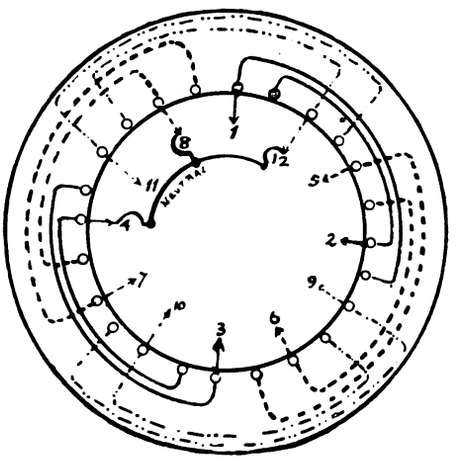

FIG. 1.

Fig. 1 shows the arrangement of the coils, and the ends are numbered to correspond with the diagram of connections and switchgear given in Fig 2. It will be seen that nine leads are required between the stator and the change-over switch in this three-phase case. When the switch is on one side the coils form four poles (alternately north and south), whilst on the other side the reversal of one coil per phase is accomplished, and the motor becomes a two-pole one. In the latter case there are twice as many magnetising turns looped with each magnetic circuit than in the former case, and since the total flux per pole remains unchanged (provided the terminal voltage and the total turns per phase in series remain unchanged) the magnetising current becomes approximately halved. The leakage flux per ampere is much the same in the two cases, so that

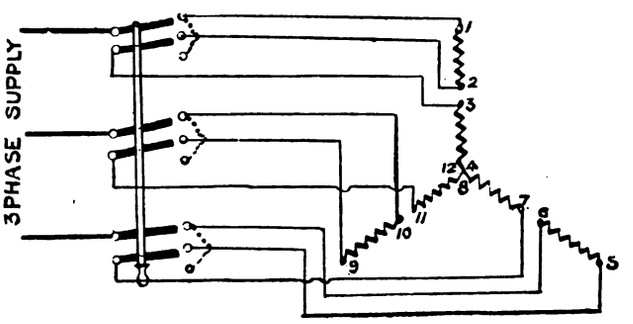

FIG. 2.

the short-circuit or standstill current remains about the same whichever number of poles is in use. This short-circuit current is a measure of the maximum possible horse-power which the machine can develop, so that this maximum horse-power remains unchanged, and since maximum torque $\propto \frac{\text{maximum horse-power}}{\text{speed}}$, the maximum torque is about double as great with the low-speed connection than with the high-speed one. If the larger torque is required also at the high speed, it will be necessary to couple the two sets of coils per phase in parallel at this speed so as to double the flux. This will, however, usually involve an increase in the iron section at the back of the slots, both on the rotor and the stator. When the stator winding is arranged with as many coils per phase as poles (which is unusual in three-phase motors, but general with two-phase ones), it becomes necessary to reverse each alternate *pair* of coils per phase in order to change from the full number of poles to half that number. The change from 12 poles to eight poles mentioned at the end of the question can

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only be carried out by having two quite independent stator windings—one for each number of poles—arranged either in the same slots or in separate ones.—Q.

Question No. 795.—It is required to transmit overhead 1,000 kw. at a pressure of 50,000 volts for 40 miles. Three-phase alternating current will be used. What is the best method of calculating the sectional area of cable to use? State clearly the losses in the line, and how they are calculated.

Answer to No. 795 (*awarded* 7*s.* 6*d.*).—The problem presented here is similar to one which has been previously discussed in these columns—*i e*, in Question 753, Jan. 27, 1905. The real problem is to design the most economical transmission line operating under the given conditions. Now, in any transmission line we have two factors which bear upon the design of the line. If we have the conductor of a large cross-sectional area, the heating losses will be low, but the capital expenditure will be high. Conversely, if the cross-sectional area of the conductor be small, the heating losses will be high and the capital cost low. It is obvious that we must effect a compromise between these opposing factors. This has been done by Lord Kelvin, who enunciated the law that the total cost of a transmission line and wasted energy per annum is a minimum when the cost of the wasted energy per annum is equal to the interest on and the depreciation of the cable. I have proved this law by the aid of the calculus in the answer which I submitted to Question 753, and therefore I do not think it is necessary to repeat it here.

The current per phase in the transmission line $= \frac{1,000 \times 1,000}{50,000 \times \sqrt{3}} = 11{\cdot}6$ amperes. This, of course, is very small, and it is obvious that the cross-sectional area of the conductor will be small. Let A be the cross-sectional area of the cable in square inches. We can now obtain the resistance of the cable, R, in terms of A. We know that $R = K\frac{L}{A}$, where L = the length of the cable in inches, and K = the specific resistance of copper (assuming copper to be the conductor used) in microhms per cubic inch; K can be taken as $\cdot 66 \times 10^{-6}$ ohms.

I would, however, point out that the current is an alternating one, and the well-known skin effect of the alternating current might enter in if the conductors were thick ones or if the frequency (which is not mentioned) were high. This, of course, would have the effect of increasing K and R. As neither of the two above conditions have any prospect of being fulfilled, we may safely take K at the value given.

$$\therefore R = \frac{\cdot 66}{10^6} \times \frac{40 \times 1,760 \times 36}{A} = \frac{1{\cdot}673}{A} \text{ ohms.}$$

Now, the watts wasted in heating W are given by $W = C^2 R$, where C is the current in amperes.

$$W = \frac{(11{\cdot}6)^2 \times 1{\cdot}673}{A} = \frac{225{\cdot}12}{A}.$$

This is, of course, the waste of energy by heating per phase, and we shall obtain the total by multiplying by 3—*i e*, $\frac{675{\cdot}4}{A}$ watts.

The cost of the waste of energy has now to be determined. We do not know anything about the cost of the power generated. Only a small amount, 1,000 kw., is being transmitted; this may or may not be the whole of the power generated. However, we will take the price of the power as ·5d. per unit. Therefore, the cost of the waste of energy per hour

$$= \frac{675{\cdot}4 \times \cdot 5}{A \times 1,000} = \frac{\cdot 3377}{A} \text{ £,}$$

and the cost per year

$$= \frac{\cdot 3377 \times 168 \times 52}{A \times 240} \text{ £} = \frac{12{\cdot}3}{A} \text{ £.}$$

Now we have the cost of the energy wasted per year we have to obtain the capital cost of the line. Overhead lines, especially in this country, are in their infancy, and very little practical data as regards their cost are available. It must be remembered that the cost of the copper in an overhead line of this description is only a small proportion—may be 10 per cent.—of the total cost of the line, the numerous poles, both ordinary and corner poles, and the insulators taking a large amount of capital. The most recent data on this subject are given in a paper on "The Value of Overhead Mains for Electrical Distribution," by Mr. G. L. Addenbrooke, read before the Institution of Electrical Engineers on Feb. 9, 1905. In this paper is included a table giving the capital cost of a complete transmission line at different voltages. It is found that the cost of the line increases only very slightly with the voltage, which increase is probably due to the increase in size of the insulators and height of the poles. Table A gives particulars of four standard conductors, the capital cost of the transmission line at 50,000 volts. These capital costs are based on those given by Mr. Addenbrooke, and which I may say are not theoretical costs, but are the results of tenders for high-class work. The interest on the capital cost and depreciation, which are taken as 8 per cent. of the total capital cost, are shown, and also the cost of the waste of energy.

TABLE A.

Number and size of cables.	Number, and section of cables in square inches.	Cost of line per mile at 50,000 volts.	Total cost of 40 miles.	Interest and depreciation per annum.	Cost of waste of energy per year given by formula £ $\frac{12{\cdot}3}{A}$.
3	3	£	£	£	£
$^7/_{18}$	·01292	300	12,000	960	945
$^7/_{16}$	·02299	340	13,600	1,088	470
$^7/_{14}$	·03588	390	15 600	1,248	435
$^{19}/_{16}$	·06247	490	19,600	1,568	313

Now, as I have said before, we must choose the cable according to Lord Kelvin's rule. It will be seen that the first cable in the table satisfies the rule nearest—*i e.*, the interest and depreciation per annum equal the cost of waste of energy per annum. In the case of the first cable the equality is very close, indeed, and, therefore, we must choose this cable—*i e.*, three cables of $^7/_{18}$ each—as the one for our transmission line. Of course, we must choose a standard gauge.

As regards the second part of the question, which asks for the losses in the line and their calculation, the chief and only losses of any magnitude are, of course, heating losses. There may be a small amount of leakage, which, of course, will be larger in wet weather. We can easily calculate the heating losses from the formula we have obtained—*i e.*,

$$W = \frac{3 \times 225{\cdot}12}{A} = \frac{225{\cdot}12 \times 3}{\cdot 01292}$$

$$= 52{,}200 \text{ watts.}$$

$$= 52{\cdot}2 \text{ kw.}$$

This is 5 22 per cent. of the total energy (1,000 kw.) transmitted.—ERNEST P. HOLLIS.

Answer to No. 795 (*awarded* 7*s.* 6*d.*).—The quantity that fixes the sectional area of the conductors in a transmission scheme is the amount of power that may be lost in the line. By increasing the sectional area of the conductors we increase the weight of copper employed, but at the same time we decrease the line losses. To find the amount of the line losses that will give a minimum yearly cost, we proceed as follows:

Let T = hours per year during which power is supplied;

x_1 = cost per watt-hour at generating station (pence);
W = line losses;
W_1 = power output from station;
W_2 = power supplied at end of line;
V_1 = voltage at generator end;
V_2 = voltage at receiving end;
C = current in each lead;
q = sectional area of each lead;
R = resistance of each lead;
L = length of transmission;
ρ = specific resistance of copper.

It is found that the cost per mile of installing a transmission line is approximately a linear function of the

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sectional—*i.e.*, cost = $(a + b\,q)\,L$, where a and b are constants obtained by plotting values for the particular type of construction to be employed. If we allow p per cent. on this principal for interest, depreciation, and upkeep, we have the yearly cost of the line = $(a + b\,q)\,L\,p$. The yearly cost of the line losses will be $W\,T\,x_1$. Hence the total yearly cost of transmission in pence will be $W\,T\,x_1 + (a + b\,q)\,L\,p$.

$$\text{But} \quad W = \frac{C^2 \times 2\,L\,\rho}{q} \quad \text{and} \quad C = \frac{W_1}{V_1} = \frac{W_2 + W}{V_1}.$$

$$\therefore\ q = \frac{(W_2 + W)^2}{V_1^2} \times \frac{2\,L\,\rho}{W}.$$

That is, total yearly cost

$$= T\,x_1\,W + a\,L\,p + 2\,b\,L^2\,p\,\rho\,\frac{(W_2 + W)^2}{W\,V_1^2} = K.$$

Differentiating and equating to zero to find the minimum value of K we get

$$0 = T\,x_1 + 2\,b\,L^2\,p\,\rho\left[\frac{V_1^2\,W2\,(W_2 + W) - (W_2 - W)^2\,V_1^2}{(W\,V_1^2)^2}\right]$$

$$T\,x_1 = -\frac{2\,b\,L^2\,p\,\rho\,W_2^2}{V_1^2\,W^2} - \frac{2\,b\,L^2\,\rho\,p}{V_1^2}$$

whence

$$T\,x_1 = \frac{2\,b\,L^2\,p\,\rho}{V_1^2}\left[\frac{W_2^2}{W_2} - 1\right]$$

$$\therefore\ \frac{T\,x_1\,V_1^2}{2\,b\,L^2\,p\,\rho} + 1 = \frac{W_2^2}{W^2} \quad \therefore\ W = W_2\sqrt{\frac{2\,b\,L^2\,p\,\rho}{2\,L^2\,b\,p\,\rho + T\,x_1\,V_1^2}}.$$

Using this equation we can find the value of the line losses that will give us a minimum yearly cost of transmission. As in the question sufficient data are not given to determine W, we must assume a value to complete the calculation; let W = 5 per cent. of the total power transmitted.

To find the power lost in a three-phase system we proceed as follows: We have power output of line = $C\,V_2\,\sqrt{3}\cos\phi$ watts. As no power factor is stated, we will assume an arbitary value, say ·9. Then in this case

$$C \times 50{,}000 \times 1{\cdot}73 \times {\cdot}9 = 1{,}000 \times 1{,}000,$$

whence

$$C = 12{\cdot}8 \text{ amperes.}$$

Then loss in one lead = $C^2\,R$, but $R = \frac{L\,\rho}{q}$ Hence loss in one lead

$$= \frac{C^2\,L\,\rho}{q} = \frac{12{\cdot}8 \times 12{\cdot}8 \times 40 \times 5{,}280 \times 12 \times {\cdot}00000066}{q}$$

$$= \frac{50 \times 1{,}000}{3},$$

whence

$$q = {\cdot}0165 \text{ square inch.}$$

No. 9 S.W.G. has a sectional area ·01629, which would probably do.—H. E. H.

Answer to No. 795 (*awarded* 7*s.* 6*d.*).—Several factors have to be considered in the calculation of overhead transmission lines, the most important of which are the pressure loss and the financial point of view. If the conductors are small the cost of copper will be small, but the loss of power due to the heating of the wires will be great. The reverse will take place with large conductors. There is a *most economical conductor* for which the sum of the annual cost of generating the lost energy and the charge of interest and depreciation on the copper is a medium. However, it frequently happens, in polyphase systems especially, that the most economical conductor would give too great a pressure loss, and the size of the wire is then determined by this last factor. The usual pressure losses are: for light, 2 to 4 per cent., and more; for power, 5 to 7 per cent, and more. In this particular case it seems as though the most economical conductor would give a moderate pressure loss, as will be shown later.

If we call R the resistance of one conductor in ohms, C the current in each conductor in amperes, the *pressure loss* in volts will be 2 C R. For hard-drawn copper, the resistance in ohms at 60deg. F. will be

$$R = {\cdot}04317 \times \frac{\text{length in miles}}{\text{area in square inches}}$$

So that

$$\text{pressure loss} = {\cdot}08634\,\frac{C \times L}{A},$$

or,

$$A = {\cdot}08634\,\frac{C \times L}{\text{pressure loss}}.$$

This equation will give us the section of the wire if we assume the pressure loss. In our case L = 40, and if we suppose the power factor to be 1, C = 11·55 amperes.

The *energy loss* in the three wires will be in watts 3 C^2 R.

The relation between pressure loss and energy loss is: energy loss = 1·5 × C × pressure loss.

Table B gives the cross-sectional area of each conductor, the energy loss, and approximate weight of copper for different pressure losses, worked out for this particular case. The losses are given in per cent. of the total voltage and output.

TABLE B.

Pressure loss. Per cent.	Energy loss. Per cent.	Cross-section. Square inches.	Weight of copper in tons.
1	·87	·07980	87·1
2	1·74	·03990	43·6
3	2·60	·02660	29·0
4	3 47	·01995	21·8
5	4·33	·01596	17·4
6	5·20	·01330	14·5
7	6·06	·01140	12·4
8	6·93	·00998	10·9
9	7 80	·00887	9·7
10	8·66	·00798	8·7

Financial Considerations.—It is difficult to determine the most economical conductor with accuracy, as it depends on many factors which cannot be known exactly before the undertaking has been running for some time, such as the cost of generating one unit, the load factor, etc. Each case must be dealt with separately, according to circumstances. The output is proportional to the current, and the lost energy to the square of the current. It follows, therefore, that the lost energy will be proportional to the square of the load factor. With an energy loss of 5 per cent., for instance (50 kw. in our case), the total number of Board of Trade units lost per year would be: 8,760 × 50 = 438,000 kilowatt-hours if the full load was maintained without intermission. If we assume an average annual load factor of 30 per cent., this number will be reduced to 438,000 × ·09 = 39,420 kilowatt-hours.

Let us further assume that the cost of generating one unit is 1d., the interest and depreciation on copper 10 per cent., and its price £65 per ton. We obtain the result in Table C.

TABLE C.

Energy loss. Per cent.	Annual cost of lost energy. £	Annual cost of copper. £	Total. £
·87	28	566	594
1·74	57	283	340
2·60	85	188	273
3 47	114	142	256
4·33	143	113	256
5·20	171	94	265
6·06	199	81	280
6 93	228	71	299
7 80	256	63	319
8·96	285	57	342

With the above assumptions it will be seen that the total cost is practically constant, and a minimum for pressure losses of 4 to 6 per cent., so that the most economical conductor would be quite compatible with a moderate pressure loss.

Other Losses of Energy.—At such a high voltage as 50,000 volts a silent discharge will take place between the wires, and unless these are placed very far apart, the loss due to this fact may become important. There will also be some leakage over the insulators, specially in wet weather. These losses are independent of the size of wire used, but as the pressure drop will be increased by them they might have to be taken into account in determining the cross-sectional area.—ALTERNATOR.

Answer to No. 795 (*awarded* 5*s.*).—The best section of conductor is the one which, taking everything into account, will give the best results financially, this test being the

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ultimate one for the solution of all engineering problems. In the above case, since the power to be transmitted is a fixed quantity, the revenue is also presumably a constant, so that the best section is that on which the total average annual expenditure is least.

The annual expenditure can be divided into two main sections: (1) the amount paid in interest on capital, repairs, depreciation; and (2) the cost of the energy wasted in the conductor; and we can prove mathematically that when costs under heading (1) equal those under (2) the total is a minimum. Under heading (1) the capital expenditure depends entirely on the weight of copper, since the small differences in section permissible would not affect the size of insulators, posts, or labour, and as long as the section is a reasonable one depreciation and repairs will also be constant for a given weight of copper. Hence the weight of copper is the only variable. Under heading (2) the loss in the line depending on the sectional area ($C^2 R$) is all that is practically affected by any variation in its size, but, of course, the generating plant is involved, since if the line loss were unduly large the capacity of the generating plant would have to be increased to give the same power at the far end, thus requiring extra capital at the station, extra labour, extra repairs, etc. The simplest and fairest way to deal with this is to find or estimate the *total* cost of a unit to the producer and charge the energy wasted in the line at this rate.

Before the annual energy loss can be even approximated it is necessary to assume a load factor, and, of course, to do this moderately accurately a knowledge of the local conditions such as number and nature of the probable consumers. It will be seen from the above that a number of points in each individual case must be carefully considered before any calculations can be done. To show the methods the following figures and assumptions are given. Power to be transmitted = 1,000 kw.; voltage (assumed at distant end of line), 50,000 volts virtual; power factor (dependent on plant installed), assumed, 80 per cent. Let C = amperes required

$$= \frac{1{,}000 \times 1{,}000}{50{,}000 \times \sqrt{3}} \times \frac{100}{80} = 14\,5 \text{ virtual amperes.}$$

Now take a trial section of wire, say No. 9 S.W.G., = ·0163 square inch. Let R = resistance of 40 miles. (tables)

$$= 1{\cdot}502 \times 40 \times \frac{1{,}760}{1{,}000} = 106 \text{ ohms approximately.}$$

Loss in the line $= 3\ C^2 R = 3 \times 14{\cdot}5^2 \times 106 = 67{,}000$ watts.

Assume load factor 25 per cent. Units wasted per annum

$$= 67 \times 24 \times 365 \times \frac{25}{100} = 144{,}000 \text{ approximately.}$$

Assume cost of unit = ·75d. Annual loss heading (2)

$$= \frac{144{,}000}{240} \times {\cdot}75 = £450.$$

Weight of 120 miles of No. 9 S.W.G.

$$= 188 \times 120 \times \frac{1{,}760}{1{,}000} = 39{,}800 \text{lb.}$$

Take cost of copper at 10d. per lb. Capital expended on copper

$$= 144{,}000 \times \frac{10}{240} = £1{,}650.$$

Assume that interest, depreciation, and repairs on copper = 10 per cent. per annum. Costs under heading (1)

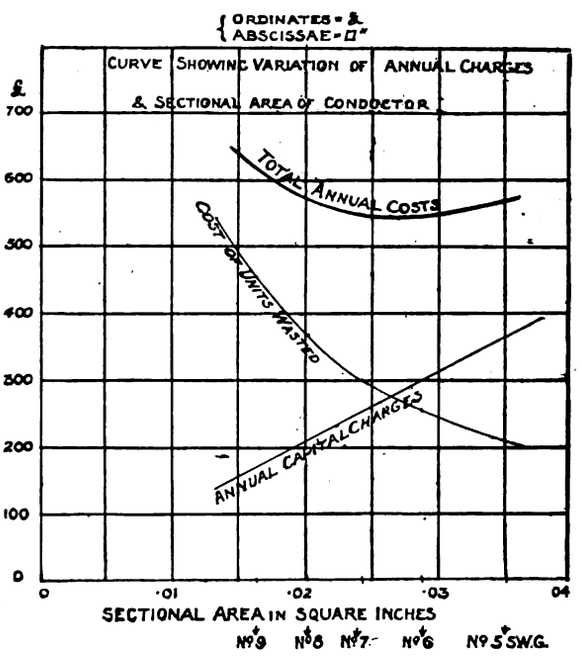
$$= 1{,}650 \times \frac{10}{100} = £165.$$

We see, therefore, that loss under head (2) is much larger than that under (1), so that the sectional area is too small.

On trying another size, No. 6 S.W.G. = ·0289 square inch, the costs work out: heading (1) £292, and heading (2) £252. In this case the total cost per annum only = £544, against £165 + 450 = £615 in the former case.

The curves given show very clearly how the costs vary. The capital charges follow a straight line law within limits being proportional to the area, while the power costs follow a curve proportional to the resistance which is proportional to $\frac{1}{\text{area}}$.

In the above examples the voltage at the distant end has been assumed 50,000 volts, so that at the station it must



be higher. Supposing No. 8 S.W.G. to be chosen (this would give a margin for extensions), the total loss in the line is

$$3\ C^2 R = 3 \times 14{\cdot}5^2 \times 59{\cdot}5 = 24{\cdot}9 \text{ kw.}$$

$$\text{This} = \frac{24{\cdot}9 \times 100}{1{,}000} = \text{say } 2{\cdot}5 \text{ per cent. of output.}$$

The lost volts $= C R \sqrt{3} = 14{\cdot}5 \times 59{\cdot}5 \times \sqrt{3} = 1{,}490$, so that the generating end volts must be about 51,500. The capacity current has been covered by the assumption of a power factor, and will depend on the distance the wires are apart, etc.

It will be seen that the best section has a density of only about 500 amperes per square inch, but that a fairly wide variation from this can be made without very seriously affecting the economical working. If the voltage had been 50,000 at the generating end, then the current would have been slightly increased and the losses a little greater, each area would have a slightly different sized current, which could be easily approximated within ½ per cent., and since so many assumptions must be made it is useless to work too accurately. All the necessary calculations can be worked on a 5in. slide rule.—NEWCASTLE.

[Other replies to Question No. 795 will be given in our next issue.—ED. *E. E.*]

Rain and Speed.—A gentleman has been writing to the Press opining that when the horse-drawn conveyance has been entirely superseded by the motor we shall still be without any quicker means of locomotion as soon as the roads become wet. He asks: "Now that the motor has arrived are we not faced with a new traffic problem, associated with new dangers? I refer to the peril of the slide-slip when the wood or asphalt are 'slithery.' After yesterday's rain I noticed that the motor 'buses seemed to be running much slower than usual—in fact, little or no faster than horse-drawn vehicles." This is where the vehicles running on rails comes in. On a slippery road the motor 'bus has to proceed somewhat gingerly, while the electric car remains comparatively unaffected. It is true that rain occasionally exerts the opposite effect, and results in an undue acceleration upon declines, causing the car now and then to become derailed, but improved braking appliances have reduced this risk to a minimum.

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Supplement to "The Electrical Engineer,"
AUGUST 11, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

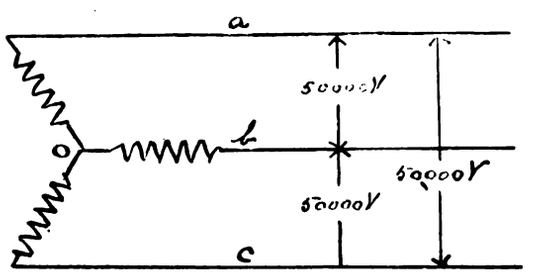
802. Two rotary converters (three phase) are running in parallel on alternate-current side. They are connected on direct-current side with only positive of one and negative of the other closed. Explain how it is possible for a load to be taken off direct-current bus bars.—A. G. H.

803. A Parsons two-phase alternator, 25 kw., is excited from a small exciter carried on an extension of the main shaft. The alternator field is connected directly across the exciter brushes through a Weston type of ammeter placed on the switchboard. There is a switch and regulating resistance in the exciter field. When the machine was started up, the current was in, say, the positive direction round the alternator field, as shown by the ammeter, which read properly. When the exciter field switch was opened and closed again, the current round the alternator field was reversed, as shown by the ammeter reading the wrong way. On testing it was found that every time the exciter switch was opened the current round the alternator field was reversed, the ammeter reading first right, then wrong, and so on apparently indefinitely. What is the cause of this?—TURBO.

ANSWERS.

Question No. 795.—It is required to transmit overhead 1,000 kw. at a pressure of 50 000 volts for 40 miles. Three-phase alternating current will be used. What is the best method of calculating the sectional area of cable to use? State clearly the losses in the line, and how they are calculated.

Answer to No. 795 (*awarded* 5*s.*).—Suppose the system to be star connected, as in sketch, and that *a*, *b*, and *c*



represent the line wires. The voltage between any of the line wires and the neutral point, 0, will be $50{,}000/\sqrt{3}$; if, then, the combination is in a balanced condition, such as would be the case when supplying nothing but motors, the current, C, in any one of these three lines may be obtained from

$$C \times \frac{50{,}000}{\sqrt{3}} = \frac{1{,}000{,}000}{3}$$

$$\therefore C = \frac{1{,}000{,}000}{3} \times \frac{\sqrt{3}}{50{,}000}$$

$$= \frac{20\sqrt{3}}{3} = 11{\cdot}546, \text{ say 12 amperes.}$$

At 1,000 amperes per square inch this would mean a No. 10 gauge wire, but although the wire would be large enough for this current, the loss might, perhaps, be too great. The drop between generator and end of line would be 3,200 volts (approx.). Suppose a No. 3 S.W.G. was employed for the lines, this has a resistance of about ·49 ohm per 1,000 yards. The drop would then be

$$\frac{40 \times 2 \times 1{,}760}{1{,}000} \times \frac{49}{100} \times 12 = 828 \text{ volts (approx.)}$$

As to which size cable for the line would be most suitable, this must be decided by a reference to Kelvin's law. Much would depend on the cost of generation, local conditions, etc. There is a point with regard to the employment of a larger size wire, and that is, that, other things being equal, the losses by atmospheric discharge will be less as the diameter of the wire is increased. Losses due to this discharge are considered to vary directly as the potential, and with such a voltage as 50,000 this would be by no means a small matter. With such a high potential it would be necessary to keep the line wires about 10ft. apart. Good quality of insulators about 12in. in diameter would be required. There is also the permission to be obtained to erect such a line, wayleaves, etc. to be secured. In similar cases, instead of ordinary wooden poles, it has been found advisable to employ steel supports. By suitably running the lines so that, while still the normal distance apart, they formed a sort of cable, mutual induction would be considerably reduced. So far all is fairly easy, but we have yet to tackle a most difficult problem—viz., the effects of capacity and inductance—and not only these phenomena as regards the line itself, but also the various pieces of apparatus the system has to supply with electrical energy. The idle current in the lines must be allowed for, and at the best this idle current can only be approximately calculated. The periodicity of the supply is not stated in the question, and this is a factor to be reckoned with. The charging current will increase with the periodicity; also the higher the periodicity the greater the drop due to impedance. For a complete treatment of this question the querist should study some of the advanced works on the subject, but the whole matter is one little understood and of extreme difficulty.—M. M.

Question No. 796.—Is it necessary to clean the tubes of the superheaters of Babcock water-tube boilers? If so, what is the best method of doing so, and how long may such superheaters be run without cleaning?

Answer to No. 796 (*awarded* 7*s.* 6*d.*).—Internal cleaning of the superheater tubes of Babcock boilers is, so far as the writer's personal experience goes, not necessary. An installation of 12 Babcock boilers with superheaters—the evaporation totalling 200,000lb. per hour at a temperature of 580deg. F.—has been working for over four years, and recent examination shows very little incrustation in the tubes. From each of four superheaters a tube was taken and cut at the bend; the deposit was in no case measurable, although the water used in the boilers was far from good. Deposits from steam would naturally be negligible, and it is the water used in flooding the superheaters that causes what scale is found. As, however, this water is drawn from the steam and water drum of the boiler, it is, perforce, free from most of its scale-forming constituents; being heated to temperatures of the order of 350deg. to 385deg. F., incrustation is thus but slow. The tubes being small, the steam velocity is high, and the superheater, not being subject to the direct impact of the flames, is maintained at a fairly uniform temperature; there is thus little predisposition to deposit at particular points. Probably by the time incrustation serious enough to call for attention results, it would be wiser economy to replace the tubes altogether. The smallness of the tubes, 1½in. diameter, and the U bend will render cleaning thoroughly a costly matter, and it will probably be cheaper to replace the tubes. The manifolds and ends of the tubes should be examined regularly, and it is advisable to, if deposit be suspected, to take out a tube and cut it at the bend. Externally the tubes should be freed from dust, and this is done by the use of steam jets directed through the openings left in the settings for the purpose. Once a week for this operation should suffice.—S. E. T.

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Answer to No. 796 (*awarded* 7*s.* 6*d.*).—The greater part of the steam generated in a Babcock boiler comes up the front headers, comparatively little being generated in the drum. The tee pieces, A A (Fig. 1), which form the head of the down pipes to the superheater, are near the back end of drum. This causes the steam to flow some distance before entering the tee pieces, therefore very little wet steam or solid matter is carried down into the superheater. This being the case, it is practically unnecessary to clean the tubes of the superheater or superheater boxes, although, of course, it is advisable to examine them periodically, say once every four months. Fig. 1 is a diagram of the pipes connecting the superheater to the boiler, looking at the boiler from the back end. I remember coming in contact with the following case: The valves connecting the superheater uptakes and the saturated steam outlet to the steam range were both left open in order to reduce the temperature of the superheated steam. The flooding and draining cock was also partly open to flood. The result was that some of the water from the bottom of the drum flowed down the pipe, B, and up C into the superheater bottom box, and the superheater acted partly as a boiler in parallel with the main tubes and drum.

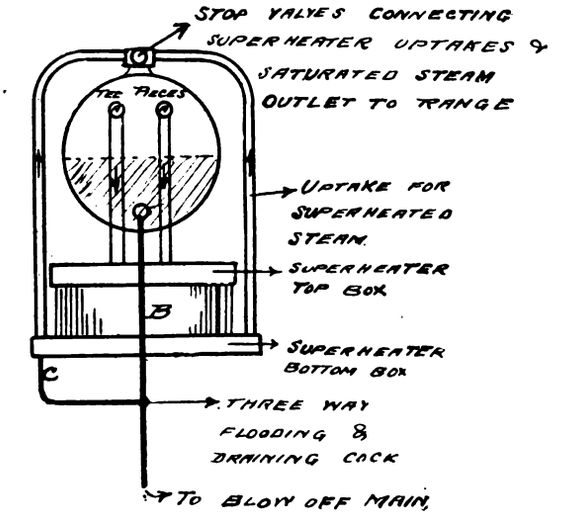

FIG. 1.

Under these conditions and with bad water the superheater bottom box and ends of the tubes were soon choked up: therefore the circulation was stopped, and superheater tubes became red hot and burnt away, and new superheater had to be fitted. Particular care should be taken to blow down thoroughly before putting boiler on range; also keep three-way flooding and draining cock in good repair.—SUPERHEAT.

Answer to No. 796 (*awarded* 5*s.*).—The *exterior* of the tubes of Babcock and Wilcox superheaters should, of course, be cleaned when the boiler is laid off for the periodical cleaning. The writer has never found, during many years' experience of this type of boiler, any necessity for cleaning the interior of the superheater tubes. If the water used be impregnated with much scale-forming matter, and the boiler is only steamed intermittently, and the superheater "flooded" each time the fires are banked (or if the boiler be allowed to stand with slow fires in for long periods), then it would be possible for scale to be formed on the inside of the tubes, as, when steam is being raised, the superheater becomes, in fact, part of the boiler heating surface. It is not a wise plan to fill the boiler with cold water, especially if containing much scale-forming matter when standing at little or no pressure. There is one point in connection with the working of Babcock and Wilcox superheaters—namely, the draining of same before opening boiler to range. It is always advisable to make quite sure that all water is cleared before closing the drain cock—the writer considers the class of cock provided with sight-glass by far the best of the several patterns in use—as any loose sediment, etc., which may be present in the tubes is thus blown out during the draining operation, also the risk of passing water over to range, with its attendant dangers, is minimised by spending half a minute or so longer over the operation. The interior of the superheater manifolds, particularly round the tube joints, should be carefully examined when the boiler is laid off for cleaning. At a large station in the Midlands with which the writer was connected, it was held a strict rule that no boiler superheater (B. and W.) was to be "flooded" unless intended to be shut off the range for not less than 24 hours. In addition, steam was to be passed through the superheater even when the engine-room plant was standing. To effect this a steam-pump would usually be run to fill up a water-storage tank. A special tool, similar to the turbine type, would be necessary for cleaning the interior of B. and W. superheater tubes. This tube cleaner consists of a turbine operated by water power, or air pressure, which works in ball bearings, and to which is attached four arms having steel cutter wheels at their extremities. The water which passes through the turbine has the effect of washing out the tubes.—S. L.

Answer to No. 796 (*awarded* 5*s.*).—It is not usual to clean out the superheater tubes of a Babcock boiler, but this can be done by removing the caps on the header end of the tubes, when you can use a wire brush from the top and bottom headers. Scale is not likely to form on these tubes if your boiler feed water is free from impurities; if this is not the case, it can be treated before entering the boiler. It would have to be in a fairly bad state, however, to affect the tubes, since the tubes are only flooded before getting up steam and drained as soon as the boiler is put on the range. The cock which floods these tubes is taken from the lower half of the boiler, so that impurities which might collect on the surface do not enter the tubes. The writer has been in some four stations using Babcock boilers, and has never had the slightest trouble with the superheaters extending over a period of four years. In some instances these tubes are regularly examined when the boiler is down for cleaning. The method of draining the superheater should remove any loose scale that may form inside the tubes, and even if you use the air-pump discharge water, which may contain oil, this would not interfere with these tubes, as the oil would rise to the surface when the boiler is at rest. The trouble is caused by the circulation of the water in the boiler at high temperatures when at work. The best plan for ascertaining if scale is forming is to remove one of the caps, when this can easily be judged.—W. F. S.

Answer to No. 796 (*awarded* 5*s*).—Considering the fact that in superheated steam there is no water or water vapour, it is not difficult to see that the same actions of corrosion and incrustation of foreign matter in the water on the shell and tubes of the boiler will not occur in the tubes of the superheater. There is, however, just the possibility that the steam as it leaves the boiler, before reaching the superheater, is not *dry saturated* steam, but that it contains a percentage of moisture. Then, of course, water is carried into superheater entrance, and with the water there is probably some of the impurity of the water as originally fed to the boiler. This would lead to a mild incrustation on the inside of the entrance tubes of the superheater, but it would not make very great progress in development. Where pure or purified feed water is used this tendency is diminished considerably. There is, therefore, no necessity whatever, except in extreme and exceptional cases, to clean the tubes of the superheater after the manner in which the tubes of the boiler are cleaned. But, as is the case with every good machine, unless there is a periodical inspection of the internal and external surfaces of the tubes of the superheater, the superheater is liable to become a little erratic at times. The inspection should be made about five times a year, whilst the cleaning will probably not be required more than once a year. All that need be done in the way of cleaning is scraping. Attention should be paid to the fact that the condition of one or two tubes does not afford a reliable criterion of the remainder, therefore *each* separate tube should be inspected. As well as the above, superheaters should, as a general rule, be tested hydraulically at intervals of two or three years, the object of such tests being to find out any mechanical weaknesses in the tubes themselves or their fastenings.—G. W. BURLEY.

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Question No. 797.—With gas at 2s. 6d. per 1,000 cubic feet and electricity at 1½d. per unit, can the electric arc system show an advantage for street-lighting over the high-pressure gas system in (*a*) initial outlay, (*b*) running costs, (*c*) distribution of light?

Answer to No. 797 (*awarded* 10s.).—There are few questions in connection with lighting round which so much controversy has raged as that of gas *versus* electricity for street illumination. When we come to consider the photometric values of the two systems we meet with great difficulties; for instance, where should we find two individuals who would agree as to the candle-power of an arc lamp; and then again, given that the electric arc far outshines its rival, there are many who object to the cold glare and deep shadows of the arc lamp. Let us consider the points as formulated in the query.

(*a*) The initial outlay will be but little different in either case. The ground has to be opened up for pipes as well as for cables, and the cost of the cables themselves will just about balance that of the piping. With regard to posts, lanterns, and lamps, electricity will undoubtedly exceed the cost of gas, although if the gas lamps are of anything like the light-giving power of the arcs, and are mounted on high ornamental columns with good lanterns, the difference will not be so great as might be supposed.

(*b*) If we consider each system per candle-power, the electric arc has a great advantage. A fair average estimate is that an expenditure of 500 watts of electrical energy will give 1,000 c.p.; for such a light with gas we should require about 100 cubic feet per hour. On the basis of 2s. 6d. per 1,000 cubic feet this would mean 3d. per hour, and with electrical energy at 1½d. per unit ·75d. per hour for a lamp giving 1,000 c.p. It must be remembered, however, that the arc will keep its brilliancy unimpaired, while the mantles rapidly fall off in efficiency; therefore, although the arcs will cost more for attendance, carbons, etc., if the gas mantles are kept in good condition no small outlay will be necessary on that account. The running cost per candle-power will be very much less in the case of electricity, but if the running cost per lamp is the basis of calculation, no doubt gas will have the advantage. In several places known to the writer the mantles require changing much more frequently than is the case. Thus we may have the running cost kept down, but at the price of a lowered efficiency.

(*c*) Distribution is a point where the arc lamp is somewhat at a disadvantage. While for main thoroughfares it is pre-eminently suitable, for the general lighting of side streets it can hardly be deemed satisfactory. The arc light is too concentrated for this purpose, and the gas mantle has an advantage over the arc for detailed distribution. Where street-lighting by electricity is in vogue, the Nernst lamp has been found to give satisfaction for side-street work, and now the tantalum lamp running at two watts per candle-power will put a new weapon in the hands of the electrical engineer. For distribution in large open spaces or main roads the elevated electric arc lights its surroundings with a well-diffused illumination unapproached by any gas lamp on the market. That this is a fact is pretty evident from the various powerful gas lamps that have been placed on the market during the last few years. Imitation is the most sincere form of flattery.

Generally, at the prices quoted, electricity should be able to more than hold its own against gas, but, in order to obtain the appreciation it deserves, every care is necessary in its installation. The idea of ground globes for diffusion of the light, so much the fashion some years ago, has not met with general public approval. Clear globes are better appreciated. The average man in the street likes to see the light itself; he is, as a rule, not so much concerned with the illumination. There is also another point that may have to be considered. If a station engineer were to erect arc lamps in one street, inhabitants of less favoured thoroughfares might feel aggrieved. It may be safely affirmed that having once enjoyed the electric light as a street illuminant, the average individual would hardly care to return to gas lighting.—M. M.

Question No 798.—A short-circuit occurred across two of the terminals of a 50-h.p. three-phase motor when running at full load. The motor-house is connected to the power-house by an overhead line consisting of three bare copper wires No. 4 S.W.G., placed one above the other, with a spacing of about 10in. between them. The line consists of two short spans, the intermediate support being an iron bracket on the corner of the power-house, which bracket is also situate much higher than the support on the motor-house, this span having an inclination of about 30deg. to the horizontal. Concurrently with the short-circuit on the motor several flashes were seen between the top and middle lines of the motor-house span. The wires were badly burnt and pitted on *both spans*. A distance of several feet, however, on either side of the intermediate support showed no signs of burning. A main 300-ampere fuse in the power-house was blown, while the 120-ampere motor fuse was overheated only. The weather was fine and calm. We have had a similar occurrence before when using a different make of generator, both generators being of the revolving-field type, 330 volts, 42 ~, and of modern construction, motor and generator A wound. Can any of your readers furnish an explanation of the arcing on the line.

Answer to No. 798 (*awarded* 7*s.* 6*d.*).—The arcing, and consequent trouble, is due to the fact that when bare conductors in fairly close proximity to one another are carrying abnormally heavy currents, as in the case under consideration, attractions and repulsions due to electromagnetic action are set up, which cause swinging and may cause actual contact and welding together of the conductors. A very interesting example of a short between two bare conductors, caused by this swinging, and which finally welded the conductors together, is given in the chapter devoted to "testing of mains" in Mr. C. H. Wordingham's "Central Electric Stations." In the case under consideration most of the damage has been done in and about the motor-house, and for the following reasons. The actual short took place in the motor-house, as did also the flashing and arcing. The motor-house will probably be somewhat confined, and will not give the conductors as good an opportunity of getting rid of the heat generated in them due to the passage of heavy currents as the conductors in the neighbourhood of the intermediate support will probably have, which support, besides being in a less confined situation than that in the motor-house, may possibly be subjected to a current of cold air due to draughts.

The sequence of events will probably be as follows: The conductors are stated to be *about* 10in. apart, and it is very likely that in the motor-house they may be (due to sagging or careless putting up) somewhat nearer together. Now, on the short occurring between the two terminals heavy currents will at once flow in the two leads attached to these terminals, with the result as indicated above—viz, that swinging due to electromagnetic attractions and repulsions has taken place, and once or twice the conductors have swung near enough together to just start an arc, which is, however, at once broken by the conductors swinging away again. This accounts for the flashing seen previous to the main 300-ampere fuse blowing, which has been caused by the conductors at last coming so near together that the resistance to the passage of a current between them is so much diminished that still heavier currents are set up, an arc is started, and the main 300-ampere fuse blows. That this fuse blows while the motor fuse is simply overheated seems to point out that the 300-ampere fuse is in circuit with a conductor feeding several other motors, and that the overload caused by the short on this particular motor, together with the other loads, has blown the fuse. It would, therefore, be advisable to somewhat strengthen the main and weaken the motor fuse, thus ensuring that in case of other similar occurrences the motor will be cut out at once, the main fuse remaining intact and the shut down being confined to the one motor. The obvious course to be taken is to at once effectually insulate the two terminals from each other, and thus prevent other similar disasters.—W. T. W.

Answer to No. 798 (*awarded* 7*s* 6*d.*).—The voltage used on the transmission line mentioned in the question being only 330 volts, it is obvious that the phenomena noted cannot be due in any way to any sudden rises of pressure in the system, also the distance apart of the lines—*i e*, 10in.—is much too great to allow any arcing due to the above cause, even had the line pressure been 10 times as high. The real cause of the arcing across the lines is due, in my opinion, to the sagging of the top wire caused by its superheating with the current supplying the short-circuit across the terminals of the motor. The sag has been so great as to bring it into contact with the second wire which

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is underneath it. It is my purpose to explain why the top wire should sag more than the second wire.

In the first place, it is well known that when a current passes through a wire, the wire is heated according to the law given below.

$$J \cdot H = C^2 R t \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where J = Joule's equivalent;
H = the amount of heat generated;
C = the current strength;
R = the resistance of the wire;
t = the time for which the current passes.

I would ask readers to note particularly that the amount of heat generated varies as the *square* of the current. It is also well known that when a wire is heated it expands in all directions. However, the linear expansion alone concerns us here. The amount of expansion (linear) per inch length is given by the formula

$$L = kT \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where L = the increase in length;
k = the coefficient of expansion;
T = the rise in temperature of the wire.

In Fig. 1, T_1, T_2, and T_3 are intended to represent the terminals of the motor. Their connections to the respective lines are also shown. Now the short-circuit has occurred between T_1 and T_3. From this it will be seen

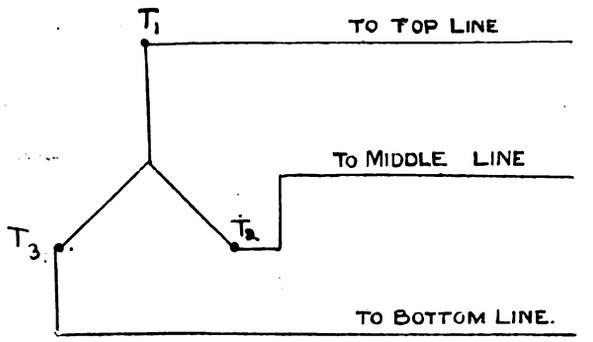


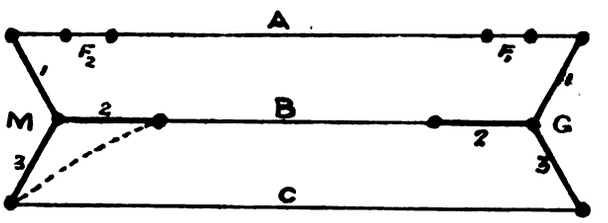
FIG. 1.

that the system is not now in balance, and there will be a very large current flowing in at T_1 and T_3 in order to supply the short-circuit. Thus the top and bottom lines will be carrying a large current and the middle wire very little. In the question it is stated that the motor fuses are overheated only, the fuses being 120 ampere fuses. Now, of course, the fuse would not blow at a sudden rush of current of the above value, and it is quite possible that the value of the short-circuit current will be greater than this. As I have pointed out, since the heating of the wire varies as the square of the current strength, the increase in temperature of the wire, and, therefore, the lateral expansion, will increase correspondingly.

FIG. 2.

In Fig. 2 I have shown a diagram of the wires. The full line shows the normal position of the wires. There will, of course, be a slight sag due to their own weight. This I have not shown. The broken lines indicate the position taken up by the wires during the short-circuit. The inclination of the wires would cause the point of maximum sag to be very near to the lowest point in the wires. The procedure has probably been as follows: The short-circuit has occurred at the terminals of the motor, causing, for the reasons explained, the top and bottom wires to sag very much and the middle wire very little. The current has probably been one of about 120 amperes, and may have been on for rather a long time, or may have been a larger one for a short interval. Anyhow, the current has heated the wires to such an extent that the top one has come into contact with the middle one. The arc has run along the wires, and apparently has not had time to run along to the intermediate support, or it has burnt out before it has got there. This current has been large enough to blow the 600-ampere fuse in the power station. I think that the above probably represents what has occurred in the question.—ERNEST P. HOLLIS

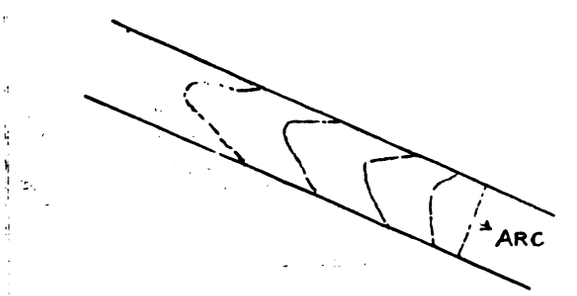
Answer to No. 798 (*awarded* 7*s.* 6*d.*).—There are several probable causes of the arcing or flashing referred to in the



above question, but the writer will only touch upon what he regards as being the cause of it. In the accompanying figure we have a diagrammatic representation of the circuit. G is the star-wound generator, M is the motor, and A, B, and C are the three mains from the generator to the motor. Under ordinary circumstances the currents in A, B, and C are practically equal and of normal value. But suppose that the terminals of the windings 2 and 3 of the motor are connected together so as to produce the condition of short-circuit referred to in the question. Then abnormal currents will traverse the conductors B and C, currents of approximately the same value, and these will traverse the windings 2 and 3 of the generator. This will result in the immediate propagation of a magnetic flux of an enormous value through the windings of the remaining limb of the star. This magnetic flux will be alternating in character, and, hence, it will set up an induced E M F. in the winding 1 of the generator. The magnitude of this E M F. will be many times greater than the normal E M F. of supply; it is, in fact, sufficient to break down the insulation of the large air-space between the two conductors, A and B, and to cause a spark to pass from one conductor to the other.

The explanation of the peculiarity of the larger fuse—*i e*, the 300-ampere fuse—blowing, whilst the smaller fuse was only overheated, appears to the writer to be as follows: Although a greater current has evidently been caused to traverse the coils 1 of the generator and also the wire A, yet all the current has not passed from end to end of A, but some of it has taken a short path—viz, that of the spark or arc. Since, however, the smaller fuse is overheated, it follows that the current through it has been increased, but not to the same extent that the current through the larger fuse has been increased, and certainly not sufficiently to blow it.—G. W. BURLEY.

Answer to No. 798 (*awarded* 5*s.*).—Immediately after the short on the 50-h.p. motor, the voltage of the line would rise and flash across from one wire to the other.



This arcing due to the inclination of the line would gradually rise and run along in an arched form, the wires acting as horns, until it got too long to maintain itself, and so would break, as shown in the figure. Due to this arc, or second short, the voltage would rise and the same arcing occur again, and so on until the main fuse blew. In the case I have in mind no less than seven distinct shorts were observed on the generator meters.—H. E. T.

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Supplement to "The Electrical Engineer,"
AUGUST 18, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

804. I am employed at a paper mill, and frequently receive complaints from the printers about electricity being in the paper. I have tried several experiments with it, but without success. What is the best method of reducing or preventing the effects complained of?—J. W.

805. Show by comparative figures the advantage of using laminated poles compared with solid ones for direct-current machines. Is there any real gain in the use of the former, when air-gap is not less than half the width of slot?—A. G. S.

806. At a power station they use several alternating arc lamps, B.T.H. enclosed type in parallel on a 220-volt circuit, with a choking coil in series. The carbons used are not consumed equally unless one of them is cored and the other solid. What is the reason they do not burn in equal quantities?—H. W. C.

807. In a continuous-current central station it is believed a consumer is using his current to earth. Describe the best method of detecting and locating this consumer.—H. W. N.

ANSWERS.

Question No. 799.—An electrostatic voltmeter is continually giving trouble through the metal parts corroding. What is the reason of this?

Best Answer to No. 799 (*awarded* 10*s.*).—Several electrostatic voltmeters under my care used to give considerable trouble, owing to the corrosion of metal parts, until I discovered the cause of it. A Kelvin electrostatic voltmeter for reading extra high pressure is shown in Fig. 1. The high-pressure terminal 1 is connected through a water fuse to A-phase 'bus bar. Metal cages 3 and 4, completely encased in mica and connected together by wire 2, are connected to the terminal 1. Two aluminium paddles, 5, are free to rotate on knife edges, 6, within cages 3 and 4. The aluminium pointer attached to the spindle of the paddles, 5, has the lower end flattened out and dipping in a metal box, 7, containing oil, thus damping the occasional violent movements of the pointer.

Having already traced the high-pressure connections, I will now trace the connections to earth. The brass stud 10, shown in the other view of the meter, is connected to the back knife edge, and so to the paddles, and is also connected to strip of tinfoil pasted on to the glass front of the meter. The metal-box, 7, is connected to the front knife edge by a wire or piece of tinfoil, and the metal dial, 8, is also connected to the knife edge. So it will be seen that all metal work in the meter is connected to earth, except the metal cages 3 and 4. I found that after the meters had been in use two or three months there was a white deposit on case close to lower edges of cages 11, all brass or copper objects were corroded with a green substance, steelwork (knife edges, etc.) very rusty, and the face of the dial destroyed. The aluminium parts were unaffected. When it was dark I could see tiny sparks passing at points indicated 11, from box 7 to supporting piece 9, made of some compressed insulating material and all round knife edges. I therefore came to the conclusion that nitrous oxide was formed inside the meter case by the passage of these sparks, and this gas attacked the metal work. The nitrous oxide would attack the copper or brass, forming copper nitrate, and thus accounting for the blue colour.

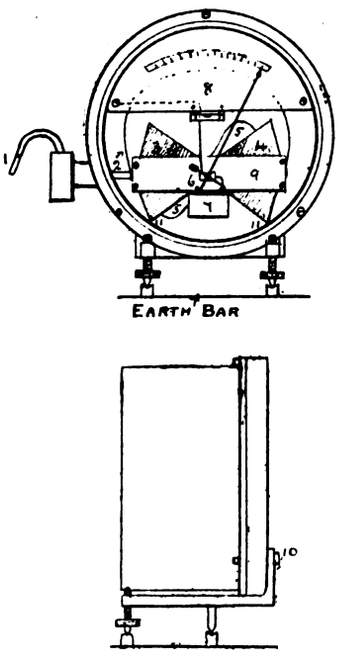

FIG. 1.

The whole bother lies with this sparking, which is apparently caused by different parts of the meter being charged at slightly different potentials, and the remedy is to keep all the earth connections spotlessly cleaned, and ensure that all parts are efficiently earthed. If this is not done, the meter will quickly want many parts renewed, and the needle will occasionally stick, and read inaccurately.—W. A. T.

Answer to No. 799 (*awarded* 7*s.* 6*d.*).—The chief cause of this trouble is moisture settling on the neighbourhood of the terminals and places which get corroded. This moisture holds particles of dust, some of which are partly composed of soluble mineral matter, and it also dissolves the gases such as carbonic and sulphurous acids, often present in the atmosphere of towns and factories. These make a conducting film for the electricity across the surface of the ebonite, etc., plates, and so electrolysis is set up, the result of which is the corrosion of any positively electrified metal, and, of course, if a thin wire is attacked it is soon eaten through, and the instrument fails to act. Any smoke from the furnaces or ashpits getting to the voltmeter would be particularly apt to cause the trouble. If a wire is not actually broken by the corrosion, probably a thin layer of non-conducting matter will be found between the terminal and the ebonite or other base to which it is fastened. If the terminal is brass this non-conducting layer will be green; if lead, then the layer will be white. It is caused by the action of the current, which dissolves a little of the metal of the terminal during the time the current passes, and then carbonic acid gas attacks the metal in solution and forms a salt such as carbonate of copper (green) or carbonate of lead (white). There are also other salts which might be formed, but their action would be to the same effect—*i.e.*, they would force the metallic face of one conductor from another and so insulate, when the instrument would refuse to act.

It is, moreover, just possible that circumstances might admit a more insidious and deceptive fault—viz.: the films

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of moisture, etc., to act as a varying shunt across the terminals of the instrument, and so cause inaccurate readings. The best remedy would be to thoroughly clean and re-lacquer the instrument, and then to put it in a good dust-proof case, and place it in a warm, dry situation. If a dry situation cannot be found then put a saucer holding a few fragments of chloride of calcium in the bottom of the case. All the while these appear dry the air in the case will be dry, as they absorb moisture very rapidly. When they appear very wet or a solution accumulates in the saucer, take it out and put it in an oven to dry. It will then be fit for use again, and may be put in the case as before. The chloride of calcium should not be fused every time it is dried. If, however, it does get fused it should be broken up into rough pieces, so as to expose as much of its surface as possible. It is quite easily broken when cold, and the operation may be repeated many times. Chloride of calcium absorbs moisture when cold, and parts with it when heated.—F. G. A.

Answer to No. 799 (*awarded* 5*s.*).—Due to insufficient wording, it is very difficult to say what precisely is *the* requirement of the questioner. To the writer there appears to be two possible renderings of the questions: first, as regards the reason or cause of the corrosion; and, second, as regards the reason why there should be any trouble consequent upon the corrosion occurring. Also, the information in the question would have been greatly enhanced if the querist had been a little specific as to what he means by "the metal parts"—that is, as to whether this phrase refers to the internal fittings or to the external case. If the former is the case, then it is very difficult to see exactly why corrosion should take place, unless the meter is not hermetically sealed, and it has been placed in a humid atmosphere or an acid-laden atmosphere. Then, if moisture—either water or acid—found its way into the meter, corrosion would, as a consequence, occur. This applies also, of course, to the case of the corrosion of any metal parts that may be fixed on the case, and also of the corrosion of the case itself.

Concerning the question of the trouble which arises, very little can be said, because the question does not state what the trouble is. If it is due to leakage, then it is clear that it is due to the provision of a leakage path or paths by the acid or water settling on or in the instrument. If such is the case, then it is not correct to say that the trouble is due to the corrosion of the metal parts.—G. W. Burley.

Question No. 800.—Will a Kelvin multicellular voltmeter give the R.M.S. volts when connected across the secondary of a pressure transformer? The high-tension pressure is 2,000, and the transformer ratio 20 : 1.

Answer to No. 800 (*awarded* 7*s.* 6*d.*).—For the purposes of deciding this question I will first consider the law of a multicellular voltmeter which is, of course, that of a quadrant electrometer. Let V_1 and V_2 be the potentials of the two parts of quadrants, and V_3 the potential of the needle. Then the deflection of the needle, d, is given by the formula

$$d = k\,(V_1 - V_2)\left(V_3 - \frac{V_1 + V_2}{2}\right). \quad . \quad . \quad (1)$$

k being a constant depending upon the instrument. The above voltages are supposed to be steady. Now, if, as in the question, the current is alternating the voltage at any instant is given by V sin pt where V is the maximum voltage. We can now substitute this value for each of the voltages in equation (1)

$$d = k\,(V_1 \sin pt - V_2 \sin pt)\left(V_3 \sin pt - \frac{V_1 \sin pt + V_2 \sin pt}{2}\right)$$

$$= k \sin^2 pt\,(V_1 - V_2)\left(V_3 - \frac{V_1 + V_2}{2}\right) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now, it will be seen that we may replace, for the purposes of simplification, the last two terms of equation (2) by a term, E^2, since V_1, V_2, and V_3 are constants. This equation now becomes reduced to

$$d = k\,E^2 \sin^2 pt;$$
$$= k\,(E \sin pt)^2 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From the above it will be seen that the needle is being subjected to a succession of impulses, and, of course, it will not vibrate, but will take up a steady position. Now, the real point in this question is to find the voltage which, if produced continuously, would give the same deflection of the needle as the one above, which is alternating. This will be, perhaps, better explained by aid of Fig. 1. The

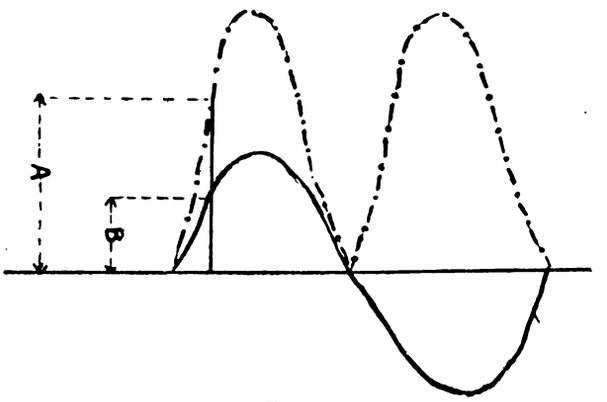

Fig. 1.

full line represents the pressure, and the broken line represents the impulse on the needle, which, as shown above, is proportional to the square of the pressure. Now, the needle will take such a position as if it were actuated by a continuous impulse represented by the mean ordinate of the impulse curve. The height of this ordinate is represented in the diagram by A. Now, this impulse is produced by the voltage represented by B, and it is the voltage that we have to find. To find this we must obtain the area of the impulse curve, and divide it by its length, which will give us the mean ordinate. The area of the curve is given by

$$\int_0^{\frac{\pi}{2}} k\,E^2 \sin^2 pt = k\,E^2\,\frac{\pi}{4}.$$

Its length is $\frac{\pi}{2}$.

Therefore its mean ordinate is $\dfrac{k\,E^2\frac{\pi}{4}}{\frac{\pi}{2}} = \dfrac{k\,E^2}{2}$.

This gives us the mean impulse. The voltage producing the impulse is given by

$$\sqrt{\frac{E^2}{2}} = \frac{E}{\sqrt{2}}.$$

Thus $\frac{E}{\sqrt{2}}$ will easily be recognised as the root mean square of the voltage. I think, therefore, that I have shown that a multicellular voltmeter will give the R.M.S. of the applied voltage.—Ernest P. Hollis.

Answer to No. 800 (*awarded* 7*s.* 6*d.*).—The Kelvin multicellular voltmeter is a perfectly suitable instrument for any alternate-current work, if it be remembered that this type of instrument possesses a very small but definite capacity, and hence forms a condenser. A minute charge and discharge current is set up when connected to an alternating circuit, and if the voltmeter be shunted across some part of a circuit carrying current, this current must be sensibly large compared with the voltmeter current, say ·25 to ·5 ampere, or an error is introduced by the lowering of the P.D. between the points on the circuit to which the voltmeter is connected. This drop in the voltmeter is clearly only worth considering when small readings are taken, but reference to it may be useful if small portions of the secondary winding be tested.

Even if calibrated with direct current, the voltmeter reads correctly the R.M.S. voltage, for since the couple tending to move the suspended vanes is proportional to the square of the P.D. applied the deflection produced by an alternating P.D., the R.M.S. value of which is E, will be the same as that produced by a continuous P.D. of value E, for the mean value of both couples is the same, or

(continuous P.D.)^2 = mean square of alternating P.D.).

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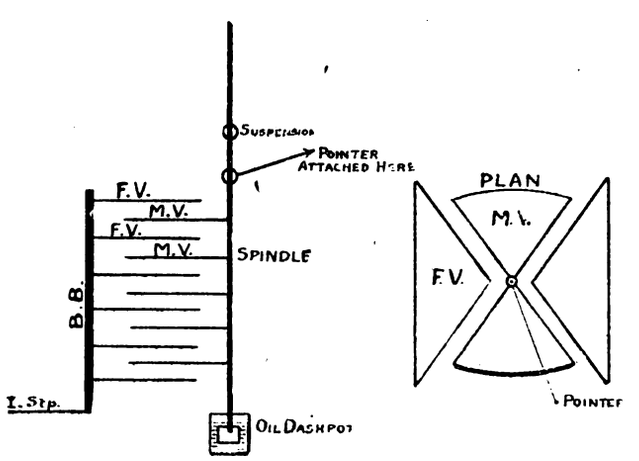
The instrument reads *absolutely correctly* R.M.S. volts, whereas an error of about one-fifth of a volt is introduced with direct current, owing to the fact that the movable part of the instrument is usually of aluminium, and the fixed part brass. As aluminium is electro-positive to brass, if the positive pole be connected to the needle the instrument will read ·2 volt below the correct value, and the same amount too high if the connections be reversed.—A. M. L.

Answer to No. 800 (*awarded* 7*s.* 6*d.*).—The Kelvin electrostatic voltmeters are based upon the well-known elementary fact that two adjacent bodies at different potentials mutually attract one another. The force of attraction is proportional to the square of the potential difference. A short description of the instrument and its working will make it evident that it will give the R.M.S. volts when connected as described, or between any two conductors carrying an alternating or direct current.

The multicellular instrument was designed in order to obtain a sufficiently great attractive force to give a distinct movement of the indicating pointer when measuring comparatively low differences of potential. A number of aluminium vanes are fixed on a vertical spindle horizontally, and are all equidistant from each other, and also metallically connected to one another. The spindle is supported by platinum iridium wire, the spindle also carrying the indicating pointer. There are also a number of fixed conductors, between which the aluminium conductors on the spindle are free to move, but owing to suitably



placed stops the fixed and the moving conductors can never come into actual metallic contact. These fixed conductors consist of triangular brass plates fixed into vertical brass back plates, and these plates, like the moving plates, are fixed equidistant from one another, and are all in metallic contact, but insulated from the outer brass case of the instrument, and are connected to an insulated terminal on the side of the case, the spindle carrying the movable aluminium vanes being connected to the case through the platinum iridium suspending wire. When a difference of potential is set up between the fixed and moving vanes, the attractive force urges the moving vanes to come inside the fixed vanes. A special vane, carried on an extension of the spindle, and immersed in an oil bath, acts as a dashpot, and steadies the movements of the moving vanes. The force of attraction between the fixed and moving vanes varies as the square of the potential difference between them, and thus directly indicates the value of the square root of the mean squares of the potential difference between the plates, or the R.M.S. as generally written; the instrument is also, through being electrostatic, quite free from any self-induction effects, and is thus correct for any periodicity. The accompanying sketch shows diagrammatically the working of the instrument. B B. represents the brass backs, F.V. the fixed and M.V. the moving vanes, whilst I.stp. represents the insulated brass strip connecting B.B and the fixed vanes to the insulated terminal on the outside of the case. The view-marked plan will also give a good idea of the working and construction of the instrument.

There are, it will be noted, two sets of moving and two of fixed vanes, the object being to obtain a fair deflection with ordinary pressures, the original instrument with only one pair of fixed and one pair of moving vanes being unable to give suitable deflections under about 1,500 volts. With the multicellular instrument, by using a small transformer whose primary is connected across the high-tension bars and the secondary to the instrument, as in this case, the voltmeter can be calibrated to give accurate readings of the difference of potential between the high-tension bars, and thus obviate the necessity for carrying high pressures on the instrument itself.—W. T. W.

Answer to No. 800 (*awarded* 5*s.*).—The Kelvin multicellular voltmeter reads R.M.S. volts when connected to an alternating-current circuit. In the case mentioned by "H. C. H." the voltmeter would read 100 volts when connected to the secondary circuit of the potential transformer having a 20 : 1 ratio, the primary volts being 2,000. With an electrostatic voltmeter (such as the one mentioned above) there is, of course, no voltage drop on the secondary of the transformer due to its resistance, since there is no current flowing in the voltmeter. With a well-designed potential transformer there is no appreciable drop on the secondary when a current-consuming voltmeter is connected to it. There is a point to be noted in connection with the Kelvin multicellular voltmeter, and that is the contact potential difference due to the use of different metals in it. The makers state in their pamphlet what this contact P.D. amounts to. In the old type vertical multicellular voltmeter, when one terminal, say A, was connected to the positive main, and the other terminal, B, to the negative main, the voltmeter would read 0·2 volt low. With the connections reversed—*i.e.*, A negative and B positive—the instrument would read 0·2 volt high. On an alternating-current circuit the instrument read correctly. If "H. C. H." is using his instrument with a reflecting mirror these small P.D.'s will be easily readable. If he is making a new scale, a direct-current potentiometer will be necessary, and he will find it convenient to make, say, A positive in the test and mark off his scale. Then the instrument connected with A positive has no error, but with alternating current it will read 0·2 volt high. With A negative the voltmeter would read 0·4 volt high, so that care must be taken to see that the polarity of the instrument is correct, as when first tested with potentiometer.—L. S.

Answer to No. 800 (*awarded* 5*s.*).—The electrostatic voltmeter will give the root mean square value of the volts whether the voltage be represented by a peaky, a flat-topped, or by a sine curve. It is only in the case of the rising and falling E.M.F. taking the form of a sine curve that the apparent volts multiplied by $\sqrt{2}$ gives the maximum voltage. If the potential be taken on the primary side and also on the secondary side of the transformer, the readings, allowing, of course, for ratio of transformation, will give the root mean square of the voltages. Should the voltage curve of the energy supplied to the transformer be peaky, that on the secondary side will be peaky also, if flat-topped the secondary will be flat-topped, or if the primary voltage may be represented by a sine curve the secondary voltage will also take the form of a sine curve. Generally the curve of potential on the secondary side is but a reproduction of that on the primary.

The question as to whether a peaked or a flat-topped curve is the better is, of course, another matter. For arc lighting a flat-topped curve is considered to give the best results, while a sine curve is generally preferred for motors. For a given amount of energy a peaked curve will give a minimum loss in the iron of a transformer. With a peaky curve the insulation must be of a higher order than when the E.M.F. is represented by a curve of the flat-topped variety. "H. C. H." will get the R.M.S. voltage by means of his multicellular voltmeter, but only in the case of a sine curve will this multiplied by $\sqrt{2}$ give the maximum potential. Even supposing the generator supplying the transformer to give a sine curve under normal conditions, the load may be such as to alter its potential very considerably from a simple sine curve. Thus a generator supplying a bank of unloaded transformers will give a different curve to that which it will give when the trans-

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formers are all fully loaded. The form taken by the voltage curve is of considerable importance when machines or transformers are to be coupled up in parallel.—M. M.

Question No. 801.—Show how to calculate the ampere-turns needed to balance the armature reaction of a polyphase alternator working at power factor cos ϕ.

Answer to No. 801 (*awarded 7s. 6d.*).—Before we can make this calculation it is necessary that we should obtain certain data from the polyphase alternator under consideration. To do this two distinct tests have to be made on the machine. The first of these is a no-lead excitation test, which enables us to plot a curve connecting the exciting current with the open-circuit voltage per phase. In making this test, the alternator is belted to a motor of sufficient capacity to run the alternator light, and then run at its normal speed. The open-circuit voltage corresponding to various values of the exciting current is measured, the exciting current being varied between such limits as to give a range of voltage from 0 to 20 per cent. over the full-load voltage of the alternator. From these readings a curve can be plotted similar to that shown in Fig. 1.

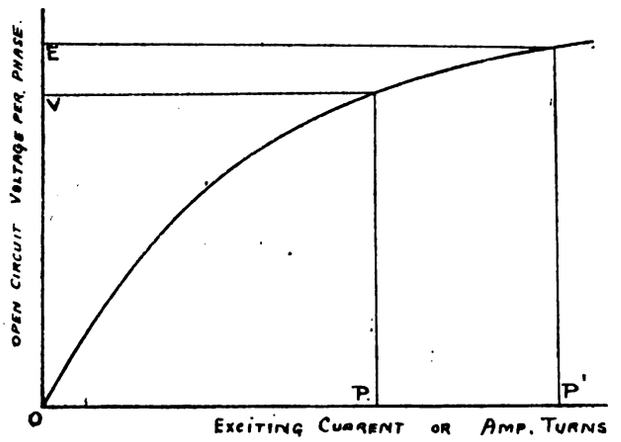

FIG. 1.

The second test is an impedance test, from which we can calculate the armature reactance per phase. As before, the machine is run at its normal speed, but with the phases short-circuited through three ammeters sufficiently large to carry the full-load current. These ammeters are connected either in star or mesh, to correspond with the winding of the alternator. A small exciting current is then put on, and adjusted so as to give the full-load current as indicated by the ammeters. Two or three check readings should be taken with smaller exciting currents, the ammeter readings (which should be equal) corresponding to the different exciting currents being in each case noted. Now, suppose that with an exciting current of *a . amps.* the reading on each of the ammeters was *C*. By a reference to the curve plotted from the no-load excitation test, we find that corresponding to an exciting current of *a . amps.* the open-circuit voltage per phase is *E*.

We can then put

$$C = \frac{E}{\sqrt{R^2 + L^2 p^2}}$$

or

$$L p = \frac{\sqrt{E^2 - R^2 C^2}}{C},$$

where $L p$ = armature reactance per phase,

R = resistance per phase (which can readily be determined).

We are now in a position to make the calculation required. In Fig. 2 a vector diagram is drawn, which shows the state of affairs when the alternator is loaded with a current of *I . amps.* lagging by an angle, ϕ. Here we have

O I = current per phase.

ϕ = angle of lag.

O V = line voltage per phase.

The reactance voltage per phase is found by vectorially compounding O C and O A, where

O C = ohmic drop per phase = I R.

O A = reactance drop per phase = $L p I$ (at 90deg. to O C).

Then O B = reactance voltage per phase.

The resultant of O V and O B gives us O E, which represents the actual voltage which has to be induced in each phase to give us a line voltage of O V, when the alternator is loaded with a lagging current of O I working at a power factor cos ϕ.

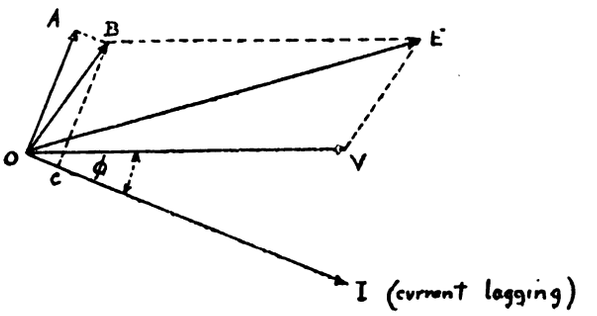

FIG. 2.

From Fig. 1 we find that the ampere-turns (which are equal to the exciting current × total turns on field-magnet system) corresponding to a line voltage O V, are O P, and the number required to give an induced voltage per phase of O E is O P'. The difference O P' − O P = P P' gives the ampere-turns required to balance the armature reaction corresponding to a line current, O I. In the case where the current leads by an angle, ϕ, exactly the same procedure is followed as previous. Fig. 3 represents this case,

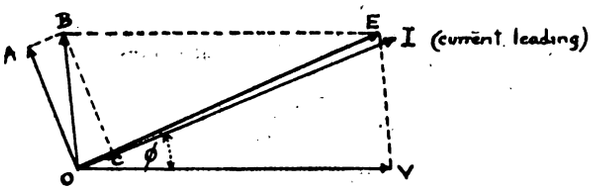

FIG. 3.

exactly the same lettering being used as in Fig. 2, O V representing the line voltage, and O E being the actual induced voltage per phase. By comparing with Fig. 2, it is readily seen that for the same current, O I, O E in Fig. 3 is much less than O E in Fig. 2. This means that the ampere-turns, for this particular power factor, required to balance the armature reaction is less for a leading current than what it is for a lagging current. In fact, with a leading current it is seen that there is a certain value of ϕ which gives O E = O V—*i.e*, for this particular lead the armature reactance has been exactly neutralised.—A. P. YOUNG.

Testing of Rubber-Insulated Wire.—The Wire Inspection Bureau affiliated to the Underwriters' Laboratories of Chicago and New York, recently held a conference for the purpose of devising ways and means of testing all rubber-insulated wire manufactured under the rules of the National Board of Fire Underwriters, and to prevent the introduction into commercial use of any such wire which would prove inferior to the standard demanded by the National Board of Fire Underwriters. It was decided to appoint electrical inspectors, three being considered sufficient at present, who shall from time to time visit the testing laboratories of any factories making rubber-insulated wire, and make, supervise, and verify tests specified by the bureau. The expenses of these inspectors is to be paid by fees collected from the manufacturing companies whose product is tested, each company paying its share in proportion to the amount of wire manufactured. This will be collected as payment for labels for each coil of wire, specifying that the standard tests have been applied.

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Supplement to "The Electrical Engineer,"
AUGUST 25, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

808. Can any of your readers give any information as to the costs of working of petrol or petrol-electric motorcars on rails, either in this country or abroad?—R. G.

809. In a station having water-tube boilers working at 200lb. per square inch, and using salt water for condensing, what is the best and quickest method of detecting small quantities of salt in the feed water? The presence of the salt being due to a leaky condenser. As it is desired to avoid "blowing down" as much as possible, to what density may the water in boilers be allowed to rise to before forming a dangerous scale? What percentage of the feed water should be "blown down" daily to maintain the density at a safe value?—PRACTICAL.

ANSWERS.

Question No. 801.—Show how to calculate the ampere-turns needed to balance the armature reaction of a polyphase alternator working at power factor cos ϕ.

Answer to No. 801 (*awarded* 10*s.*).—The armature reaction in an alternator for a given load is dependent on the power factor of that load. Consider the hypothetical case of an alternator, the armature of which is non-inductive, working on a non-inductive external load. The current in the armature conductors will reach its maximum value at the same instant as the maximum value of the E.M.F. occurs, and the position of the armature coil for this condition is shown in Fig. 1A, where the coil is shown in "mid-pole-face" position. The demagnetising effect of the armature current, when the maximum value of the current corresponds to this position, is evidently a minimum. In modern alternators the maximum value of the armature current, when working on a non-inductive load, occurs somewhat later than the mid-pole-face position, due to the reactance of armature coils.

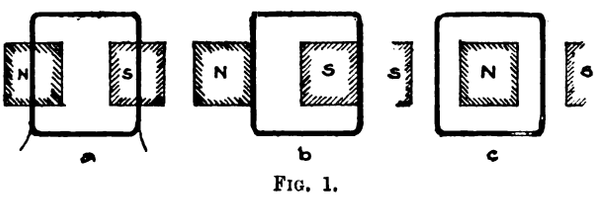

FIG. 1.

If, however, the external load possesses considerable inductance, the maximum value of armature current may occur when the coil is opposite the pole corners, as in Fig. 1B. When the maximum value of the current occurs with the coil in the position shown in Fig. 1C (corresponding to a power factor of 0), the demagnetising effect of the armature is a maximum. From the position shown in Fig. 1A to that in Fig. 1B the demagnetising effect increases very rapidly, and after this position it increases much more slowly, the maximum value occurring for the position shown in Fig. 1C. It is sufficiently accurate for calculations of armature reaction to consider that the demagnetising effect of the armature increases in proportion to the sine of the angle of lag between mid-pole-face position and positon of armature coils when carrying maximum current.

It is customary in designing three-phase alternators to consider the resultant magnetomotive force of the armature winding to be equal to twice the magnetomotive force of one phase. This convenient rule calls for the armature winding to be so arranged that the phase difference of the E.M.F.'s generated in each of the three windings is 60deg. (see Fig. 2A). By reversing the connections of the intermediate phase, the voltages between the terminals become 120deg. apart in phase, as shown in Fig. 2B. From Fig. 2A it will be observed that the resultant of the three vectors shown has a value of 2, each vector being assumed to have a value of unity. It should be noted that the calculations on alternators are generally made on the assumption of the machine giving a sine wave.

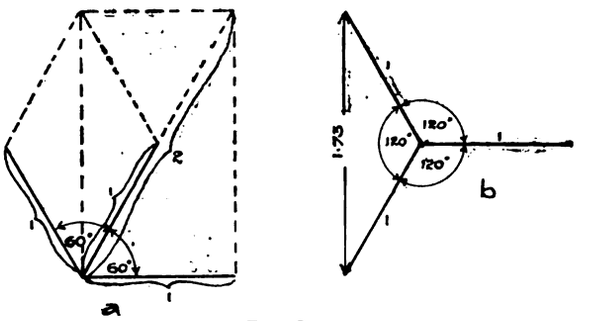

FIG. 2.

A three-phase machine will now be examined, and the armature reaction calculated for various power factors. The example below is taken from a three-phase machine of the revolving-field type, the leading particulars of which are given in the following specification*: rated output, 850 kw.; speed, 94 r.p.m.; periodicity, 25 ~; number of poles, 32; terminal voltage, 5,000 volts; voltage per phase, 2,880 volts; full-load current per phase, 98·5 amperes. The stator has 192 slots of the "open" type, and each slot contains 14 conductors, hence there are 14 turns per pole per phase.

The average value of the reactance for all positions is 9·6 ohms at 25 ~. We will now calculate the ampere-turns necessary to maintain a constant terminal voltage of 5,000 volts with full-load current at various power factors.

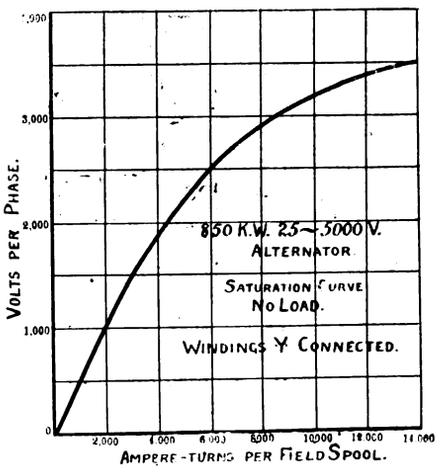

FIG. 3.

1. *Unity Power Factor.*—The reactance voltage at a load of 98·5 amperes = 9·6 × 98·5 = 945 volts per phase. Now, when the external load is non-inductive, the angle of lag of

*A description of this machine is given in "Traction and Transmission," vol. x., p. 28, by Messrs. Parshall and Hobart.

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the maximum value of the armature current behind the mid-pole-face position is given by :

$$\tan^{-1}\frac{\text{reactance voltage per phase}}{\text{terminal voltage per phase}}=\frac{945}{2,880}=\cdot328.$$

$\tan^{-1}\cdot328=18^\circ\ 10'$. $\sin 10^\circ\ 18'=\cdot312$.

Assuming a sine wave current curve, the maximum resultant armature turns per pole at full load are :

$$14\times98\cdot5\times\sqrt{2}\times2=3,900 \text{ ampere-turns.}$$

Hence the demagnetising effect of the armature when working on an external non-inductive load of 98·5 amperes is

$$3,900\times\cdot312=1,215 \text{ ampere-turns.}$$

Therefore, when this machine is working at full load, with a power factor of unity, there is required 1,215 additional ampere-turns above that required at no load, in order to maintain a constant voltage of 5,000 volts between terminals at a constant speed of 94 r.p.m. The no-load saturation curve for this machine is given in Fig. 3, from which the no-load excitation for 2,880 volts per phase (corresponding to 5,000 volts between terminals) is found to be 7,650 ampere-turns per field spool. As the resistance per phase is ·405 ohm, the volts drop at full load = 30 volts per phase, and internal E.M.F. to be generated at full load in order to give 2,880 terminal volts per phase = 2,910 volts. The field excitation to give this voltage at no load is found to be 7,670 ampere-turns. Hence the field excitation when the machine is working at full load and unity power factor is 7,670 + 1,215 = 8,885 ampere-turns per field spool.

2. *Eighty per Cent. Power Factor.*—For a power factor of ·8 in the external circuit, the construction shown in Fig. 4 may be adopted. Lay off the angle $a\ c\ b\ (\theta)=18^\circ\ 10'$, the tangent of which is $\frac{\text{reactance voltage}}{\text{terminal voltage}}$. From a lay off the angle $c\ a\ d\ (\phi)$ to equal $\cos^{-1}\cdot8=37$deg., making $a\ d$ equal to $a\ c$. Join $b\ d$ and draw $d\ e$ at right angles to $a\ c$.

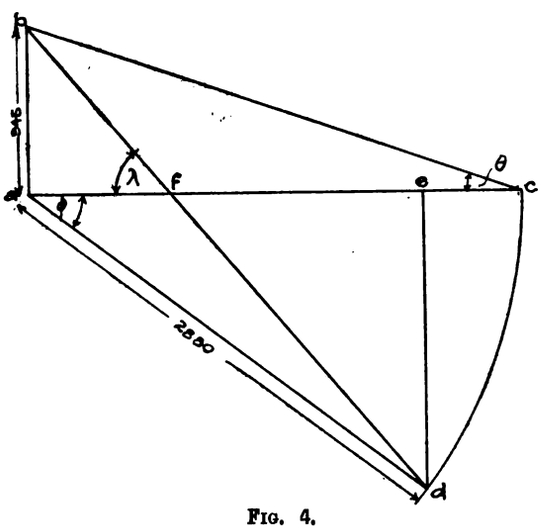

FIG. 4.

The angle of lag between mid-pole-face position and position of maximum current is now given by angle $a\ f\ b\ (\lambda)$.

$$\text{Now, } \tan\lambda=\frac{a\,b}{a\,f}=\frac{a\,b+c\,d}{a\,c}$$

$$=\frac{945+a\,d\sin 37\text{deg.}}{a\,d\cos.\ 37\text{deg.}}$$

$$=\frac{945+(2,880\times\cdot6)}{(2,880\times\cdot8}=1\cdot16.$$

Hence $\lambda=49\cdot2$deg.

and $\sin\lambda=\cdot735$.

Therefore, demagnetising component of total armature strength = 3,900 × ·755 = 2,950 ampere-turns.

Therefore, to maintain 5,000 volts between terminals with a load of 98·5 amperes at a power factor of 80 per cent., an excitation of 7,670 + 2,950 = 10,620 ampere-turns per field spool will be required. A similar construction will give the excitation required for other power factors.

3. *Zero Power Factor.* — In this case the armature demagnetisation will approach it maximum value as the maximum value of the current occurs when the armature coil is in the position shown in Fig. 1C. Hence the armature demagnetising effect is, in this case, equal to 3,900 ampere-turns, and the excitation required to maintain 5,000 terminal volts with a load of 98·5 amperes at a power factor of 0 will be 7,670 + 3,900 = 11,570 ampere-turns per field spool.

TABLE I.

Power factor of external load.	Ampere-turns per field spool required to maintain a constant potential of 5,000 volts between terminals at 94 r.p.m. for various power factors.		
	Full load.	Half load.	Quarter load.
Unity	8,885	7,940	7,735
95%	9,850	8,535	8,030
90%	10,200	8,740	8,145
80%	10,620	9,000	8,285
60%	11,110	9,310	8,460
20%	11,520	9,580	8,615
0	11,570	9,610	8,630

Table I. has been calculated out for three different loads

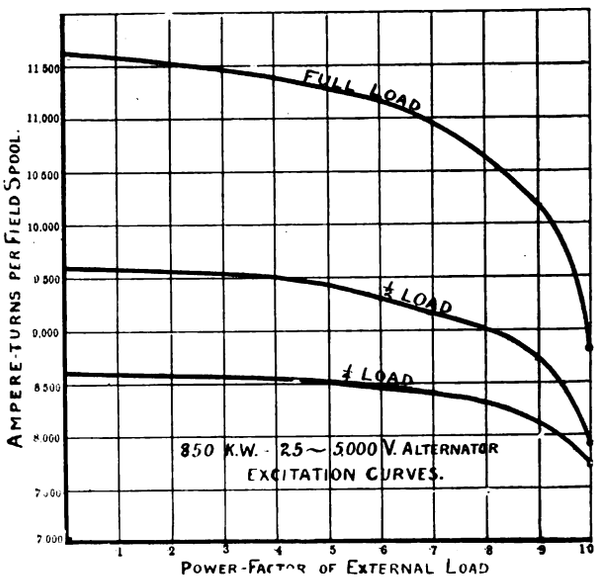

FIG. 5.

and various power factors, the results being plotted in Fig. 5.—MONOPHASE.

Answer to No. 801 (*awarded 7s. 6d.*).—There are four main considerations governing the pressure drop in any alternating-current generator. By pressure drop is meant the rise in voltage that will occur when full load is thrown off the machine and speed and excitation are kept normal. These factors are (1) armature reaction; (2) armature leakage; (3) increasing field leakage with load; (4) ohmic losses in armature and eddy currents in pole-pieces. We are considering the first of these, and, since corrections may afterwards be applied for the rest, we may leave them out of count for the present. In order that we may be in a position to calculate the effect of reactions under all conditions of load and power factor, we need to know both the no-load characteristic and the short-circuit current curves for the machine in question, which we will assume is built. To obtain the first, run the machine at its rated speed and plot the relation between terminal potential difference and field ampere-turns. The second curve is obtained by short-circuiting the terminals of the machine—inserting an ammeter in one phase—and while running it at a convenient speed plotting the relation between field ampere-turns and short-circuit current as given by the ammeter. In cases of original design the designer must rely on his own experience to guide him in constructing hypothetical curves.

Now the resultant reactive ampere-turns of a three-phase armature can be shown to be one and a-half times the maximum value of the current wave (in the case of a three-phase machine) multiplied by the number of turns per phase in the armature winding—k_1, C_a, S_a, where C_a and S_a are armature current and turns per phase respectively, and k_1 is a constant depending on the shape of the E.M.F. wave and the number of phases in the machine—being

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equal to about 2·25 with average three-phase machines, and 1·5 to 1·6 for two-phase machines (see A. C. Eborall's "Polyphase Electric Working"). Let O P (Fig. 1) represent the phase of the current in a short-circuited armature. Now the armature leakage flux being in phase with this,

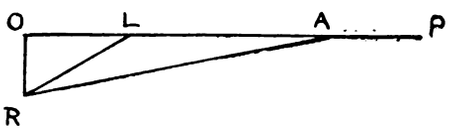

FIG. 1.

may be represented by O L in magnitude. But the E.M.F. generated in the armature by the main flux is in phase with this current, also, since the circuit is made up of the ohmic resistance of the armature. Hence O R will give the magnitude and phase of the armature flux (in quadrature with E.M.F.), R L, the resultant is the field excitation necessary to generate the E M F. The resultant reactive armature ampere-turns being in phase with the current, may be represented by L A, whence the total field ampere-turns are R A. Note that the angle O A R will be small in well-designed machines, so the R A approximately equals A L+O L.

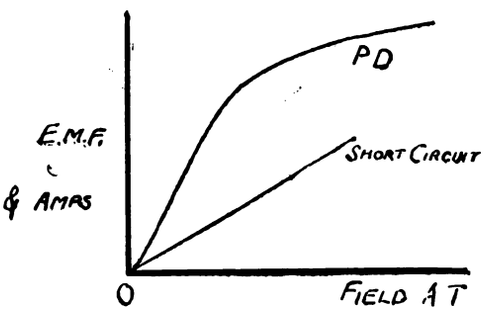

FIG. 2.

Fig. 2 gives the no-load characteristic and short-circuit curves of an alternator. Let E represent the terminal E M F. per phase in a load of C amperes where cos $\phi = 1$. Let O E in Fig. 3 represent the E.M.F. in magnitude and phase. Then O N gives the phase of the main flux produced by the ampere-turns, T_1 (see Fig. 2). Let O T_1 represent these. The reactive ampere-turns of the armature, or rather the field, A T, needed to counteract them, is given from the short-circuit curve as T_s (Fig. 2). These are practically in phase with the load current, O C, as shown above, so that we may represent them by O T_s. Then, T_1 T_s gives the ampere-turns needed on the field to give a load current of C amperes at a terminal pressure of E volts per phase. In cases where cos ϕ is not equal to unity it is merely necessary to plot O T_s, the armature reaction vector making

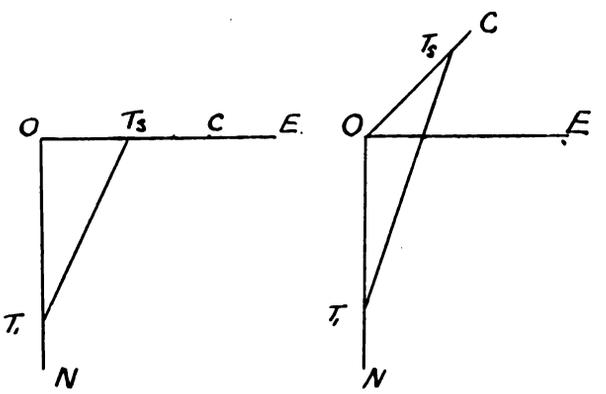

FIG. 3.

an angle ϕ (lag or lead) with O E (as shown in Fig. 3A) where cos $\phi = \cdot 7$, current lagging. A study of the figures will show that a leading current will reduce the pressure drop, while a lagging current has the opposite effect. The explanation of this is as follows: When the power factor is unity, the position of those coils carrying maximum current is such that their axes in each case lie midway between the field poles (the most active conductors lying in the densest field). This results in a *distortion* of the flux, but seeing that the reaction in both north and south poles is equal owing to position, the net *reaction* is nil. Now, a lagging current causes these same active conductors to take a position, relative to the maximum flux, in the rear of the previous one, with the result of a reduced flux in the armature (see

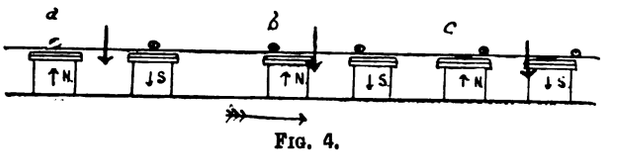

FIG. 4.

Fig. 4). A leading current has, of course, a similar but opposite action.—PERPLEX.

Answer to No. 801 (*awarded 7s. 6d.*).—One of the simplest methods of calculating the armature reaction effect in alternators, and one which at the same time is probably quite as reliable as any of the more elaborate rules, is that based on a consideration of the short-circuit current. When an alternator armature is short-circuited and run at approximately normal speed, there is a certain definite small number of exciting ampere-turns which will cause the normal full-load current to flow in the armature. This number of ampere-turns corresponds to a certain open-circuit terminal voltage, v, and this voltage may, without appreciable error, be taken as equal to the inductive, or armature reaction, drop due to the normal full-load current. When v is known it is easy to arrive at the volts which must be produced at the terminals on open circuit in order to obtain without change of excitation any required voltage at full load with any given power factor. Now v can be predetermined from the fact that, for modern alternators of a given type and number of phases, a fairly fixed relationship exists between the field excitation ampere-turns and the ampere-turns produced in the armature on short-circuit. This relationship can be stated as—

$$\text{Field exciting ampere-turns per pair of poles} = \text{Armature turns per phase per pair of poles} \times \text{Armature current per phase on short-circuit with the given field ampere-turns} \times C \qquad (1)$$

where C has the following approximate values for ordinary slotted alternators with rotating radial pole magnets, alternately north and south:

C = 1·5 for single or two phase alternators;

C = 2·7 for three-phase alternators.

A more exact value for C can always be obtained by making a short-circuit test on an alternator of the same, or nearly the same, type and proportions as the one under consideration. Inserting the correct values in equation (1), the number of field ampere-turns per pair of poles required to produce normal full-load current on short-circuit is obtained. By calculation with the air-gap and iron dimensions of the alternator in the ordinary way, the value of the flux, and, therefore, of the voltage per phase produced by this excitation at normal speed and with no current in the armature, is arrived at = v.

The resultant of this inductive or armature reaction drop, v (which is in quadrature with the armature current), and the required terminal voltage, V (which is at a phase angle ϕ to the armature current), gives the voltage, E, which must be induced in the armature on open circuit if the terminal voltage at full load and with power factor = cos ϕ is to attain the required value, V, assuming armature reaction alone and no resistance drop to be present. It is then only necessary to carry out the ampere-turn calculation (by means of the air-gap and iron dimensions) for the fluxes corresponding to the no-load voltages of V and E respectively, and the difference between these two numbers of ampere-turns is the number of ampere-turns required to compensate for armature reaction. The value of E for a given value of V, and of v on a load of any given cos ϕ, is obtainable by means of the simple vector diagram shown in Fig. 1. Let A C represent the phase of the armature current. Draw A B at an angle ϕ to A C, and of such a

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length as to represent the required full-load voltage, V, to any scale. From B draw B D at right angles to A C and equal to the armature reaction drop, v, to the same scale. Then A D is the resultant of V and v, and is, therefore, equal to E. It will be seen that this method of obtaining the armature reaction ampere-turns simply consists in

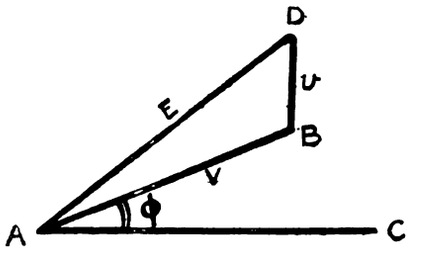


Fig. 1.

finding two points on the no-load characteristic (Curve I., Fig. 2) of the alternator. The first point, V, is the voltage required at full load, and the second point, E, is the no-load voltage produced by the ampere-turns which give the required voltage, V, at full load, and with the given power factor cos ϕ, the effect of resistance drop being omitted. Curve II. (Fig. 2) represents the full-load characteristic (omitting resistance drop) at the given power factor of cos ϕ. The horizontal distance, a, between the two points V and E gives the number of ampere-turns required to compensate for armature reaction.

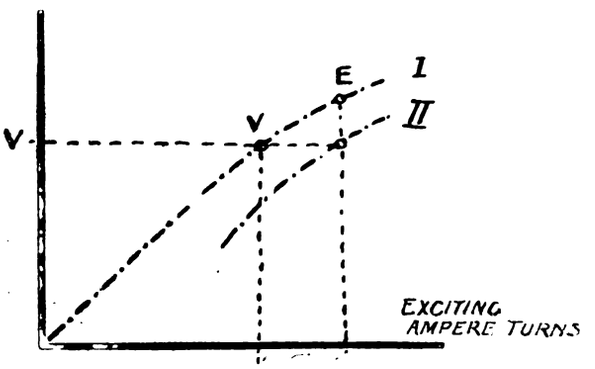


Fig. 2.

It may be mentioned that, owing to some of the assumptions involved, this method is found to give rather more importance to the armature reaction than is usually justified by the test results.—Q.

Answer to No. 801 (*awarded* 5*s.*).—The ampere-turns with which the stator acts on the field of the alternator are given by the expression

$$\text{ampere-turns} = -S \sin \phi,$$

where S = the back ampere-turns of the stator per pair of poles. The angle ϕ is considered positive when the current lags behind the voltage. When ϕ is positive the back ampere-turns have demagnetising effect on the field, and when ϕ is negative they have a magnetising effect on the field. The value of S can be found from the following expression:

$$S = Z\, i\, \frac{k}{m} \sin m \frac{\pi}{2},$$

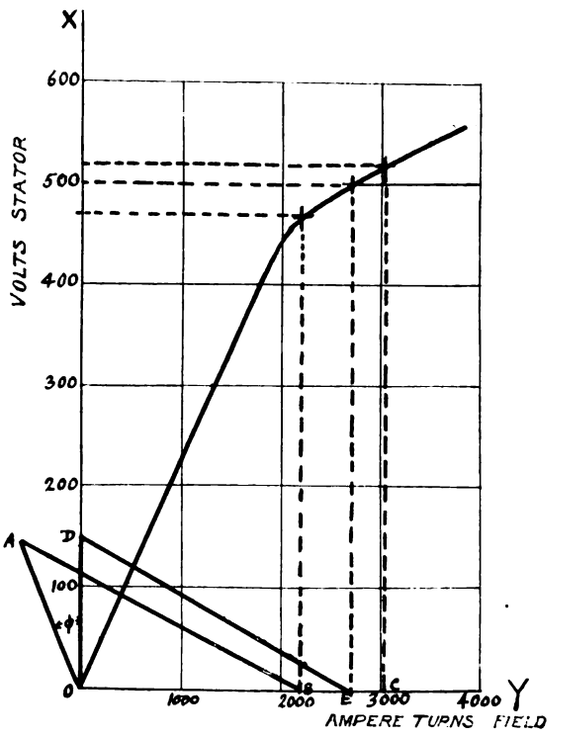
where Z = number of effective conductors per slot × number of slots per pole and phase;

i = current per phase stator;

m = the ratio of pole arc to pole pitch—this should not exceed two-thirds, or 66 per cent.;

k is a constant having the following values: for single-phase, $k = 0.57$; for two-phase, $k = 1.13$; for three-phase, $k = 1.68$.

The ampere-turns required by the other parts of the machine are found in the usual way by getting the densities, length of path, and ampere-turns required at that density per unit of length. Adding the back ampere-turns on to these, we get the total ampere-turns required for any particular load at any particular power factor and voltage. If we have obtained a "saturation curve" of the machine, either by test or calculation, it can be seen graphically what takes place in the machine. The saturation curve is a curve plotted between the volts (line) stator and the ampere-turns field. Referring to the accompanying sketch, it will be seen that at no load and 3,050 effective ampere-turns on the field we get 517 volts on the stator. Now, if $\phi = 0$, then the back ampere-turns of the stator would act along O X. Now, at a certain load let the back ampere-turns be O D, ϕ being O. Supposing that the field ampere-turns have remained the same, then, since the back ampere-turns act at right angles to the field ampere-turns, the resultant ampere-turns must, therefore, be less than O C. We really get a right-angled triangle, of which the hypothenuse is equal to O C. So the effective ampere-turns of the field are now only = $\sqrt{O\,C^2 - O\,D^2}$, or, graphically, from centre, D, and radius, O C, strike an arc, cutting the line O Y at E, then O E equal the effective ampere-turns field, which in this case correspond to 500-volt stator. If ϕ has some value, then the back ampere-turn stator must be drawn at an angle ϕ from O X, like A O, ϕ being taken as positive. Again, assuming that the field excitation



still remains the same, and striking an arc of radius equal to O C from centre A, we get the point B, so that our effective ampere-turns of the field are now only O B, which correspond to a voltage of 470 volts. Here the voltage drop due to the resistance and self-induction of the stator winding has been neglected.—F. L.

Large Turbines.—In our issue of the 11th inst. we referred to the order which the New York Edison Company had placed with the American Westinghouse Company for two 7,500-kw. turbo-generator units. It appears that simultaneously with this the New York Edison Company placed an order with the General Electric Company of Schenectady for two Curtis vertical turbines of the like capacity, from which it is evident that they intend making an all-round trial with this form of large prime mover. It may be mentioned that an aggregate of 500,000 kw. in Curtis turbines has been supplied or is on order in America and Europe, which, considering the comparatively short period they have been in the market, is a notable record.

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Supplement to "The Electrical Engineer,"
SEPTEMBER 1, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

QUESTIONS.

810. Discuss means of speed regulation of alternating-current low-voltage motors, and state why the cost of variable-speed alternating-current motors exceeds that of constant-speed motors by a relatively high amount. What would be the best method for obtaining electrically a speed variation of 25 per cent. with a 1-h.p. alternating-current motor?—H. A. N.

811. It is desired to instal a motor-generator of 50 kw. capacity for interconnecting an alternating-current 2,000-volt 75 ~ system with a direct-current 460-volt system. The alternators are of the ironless core type, and the dynamos are compound wound. Describe the controlling arrangements for the set to be started up as a motor from the direct-current side, but to run either as an alternating-current or direct-current generator in parallel with the existing plant. Give a diagram of the necessary connections.—H. A. N.

ANSWERS.

Question No. 802.—Two rotary converters (three phase) are running in parallel on alternate-current side. They are connected on direct-current side with only positive of one and negative of the other closed. Explain how it is possible for a load to be taken off direct-current 'bus bars.

Answer to No. 802 (*awarded 7s. 6d.*).—The best way to deal with this question is to trace out the windings on a diagrammatic sketch of two two-pole rotaries with ring windings, and treat the rotaries as being generators. As the two machines must always run in synchronism, their armature angular positions will remain the same (under equal conditions). Following the paths through the armatures from positive to negative 'bus bars (Fig. 1): (1) part

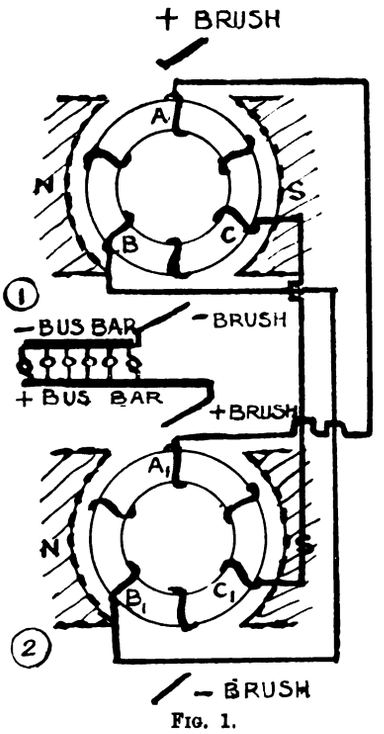

Fig. 1.

of current would flow from + brush (2) to A_1, by paralleling connection to A, thence through armature to – brush (1); (2) another part would flow from + brush (2), through armature (2) to C_1, by paralleling connection to C, through armature (1) to – brush (1); (3) the third part would flow from + brush (2) to B_1, thence to B and through armature (1) to – brush (1).

Summing up the E.M.F.'s in these paths it is readily seen that—

(1) E.M.F. (+ brush (2) to – brush (1)) = E;
(2) E.M.F. (+ brush (2) to C_1) + E.M.F. (C to – brush (1)) = E;
(3) E.M.F. (+ brush (2) to B_1) + E.M.F. (B to – brush (1)) = E;

where E = E.M.F. across rotary brushes.

It will be seen that for all armature angular positions these E.M.F.'s will always sum up equal to E. Hence, from + brush of one machine to – brush of the other there will be a continuous E.M.F. equal to that across brushes of one machine. It will be found that the E.M.F. between + brush (2) and A_1 will vary as Curve 1 in Fig. 2. Curve 2, half a period later in phase relation,

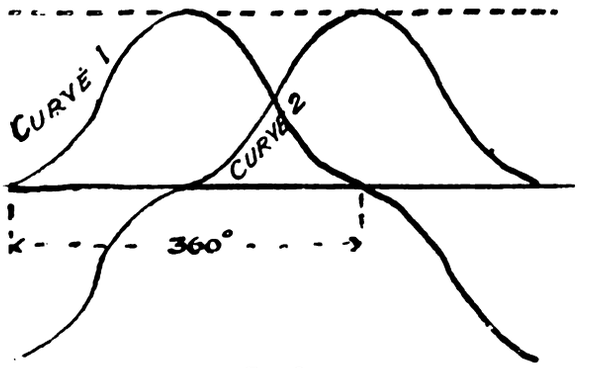

Fig. 2.

shows E.M.F. between A and – brush (1). Adding these two, we get a straight line + E.M.F. whose value is equal to that of the peak ordinate. Referring to Fig. 1, we find that when this peak E.M.F. is being generated, A_1 is in contact with – brush (2). Therefore, this continuous E.M.F. we get is equal to that across brushes of one rotary. In this method of connection nearly the same load could be taken from rotaries with same heating as when they are running in parallel on direct-current side, both on full load. This load would be about 75 per cent. of output of both rotaries.—J. R. S.

Answer to No. 802 (*awarded 7s. 6d.*).—By connecting the rotary converters on the direct-current side in the manner indicated the working of the machines has been very little altered, in so far that the load can be taken from the direct-current brushes, and, in general, the machines may be made to give an output equivalent to that of the two machines, although this would be undesirable owing to the undue heating of the armature which would result.

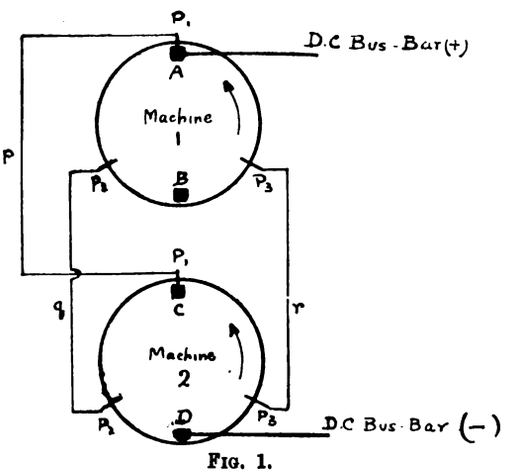

Fig. 1.

Fig 1 shows a diagrammatic view of the arrangement, the two machines being joined in parallel on the alternate-current side. The supply leads are taken off from P_1, P_2, and P_3, and as they do not concern us, for simplicity they are not shown. It is assumed that the machines are bipolar, as this supplies the simplest case. A and C are the positive and B and D the negative brushes of each machine, the

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load 'bus bars being connected to A and D. P_1, P_2, and P_3 are the three points on the winding of each machine, each 120deg. apart, which are connected to the three slip rings. The winding, together with these three points, is supposed to rotate in the direction indicated by the arrow. For the position of the armatures here represented, the positive brush of each machine coincides with the point P_1. This means that for this particular moment the direct-current 'bus bars are connected directly across C and D—*i.e.*, the brushes of the second machine—and the 'bus-bar voltage will be equal to that across the brushes of either machine. Now, when the machines have advanced by one-sixth of a revolution from this point, it can readily be seen that each of the negative brushes will coincide with point P_2. That is, for this particular moment the direct-current 'bus bars will be connected across machine 1, and the 'bus-bar voltage will equal the voltage across the brushes of either machine. This will occur six times for each revolution, each machine being alternately connected for an instant directly across the 'bus bars. Not only will the 'bus-bar voltage equal the direct-current voltage of either machine at these six particular instants, but for any position of the armatures. Fig. 2 represents an intermediate position, and denoting for any instant the voltages between the positive brushes of either machine and the points P_1, P_2, and P_3 by V_1, V_2, and V_3 respectively, and the voltages between the

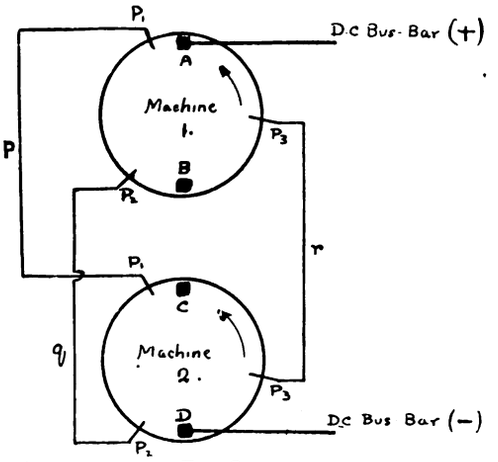


FIG. 2.

negative brushes and points P_1, P_2, and P_3 by V_4, V_5, and V_6, respectively, then we have

$$\left.\begin{aligned} V_1 + V_4 &= V \\ V_2 + V_5 &= V \\ V_3 + V_6 &= V \end{aligned}\right\} \text{'bus-bar volts.}$$

where V = direct-current voltage of either machine. That is, the voltage across the 'bus bars will be a direct-current voltage equal to that obtained across the brushes of either machine. The current taken from the direct-current 'bus bars will distribute itself unequally between the lines *p*, *q*, and *r*, and the load taken from the direct-current 'bus bars will share itself between the two machines, there being an alternate interchange of load between the machines, first one and then the other doing the bigger share. This interchange will occur six times for every revolution of the armature in the case we are considering, or, generally, six times per cycle.—A. P. Y.

Answer to No. 802 (*awarded* 5*s.*).—Suppose, for simplicity, that the two rotary converters are exactly similar machines, with the same number of poles and the same number of turns of wire on each armature. Let Fig. 1 represent one of these rotary converters, and suppose they are bipolar; the commutator is shown outside the armature, which is ring type, whilst the three slip-rings are represented as being internal to the armature winding, and are connected to three equidistant points in the armature winding. Since both machines are run off the same source of supply, and are run in synchronism with the generators, the currents in the coils of one armature will be in phase with the currents in the corresponding coils of the other armature both in magnitude and direction, so that at any instant the electrical state of every coil in one armature is exactly similar to that in the other.

Referring to Fig. 1, it will be seen that at the instant the commutator segment which is connected to slip-ring, A, is under the positive brush, the current in phase A will be a maximum and have a positive direction, so that at this particular instant the positive brush of the rotary converter is being supplied direct from the alternating line wire. This

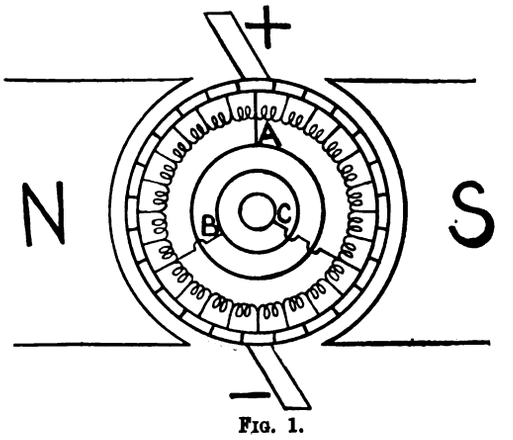
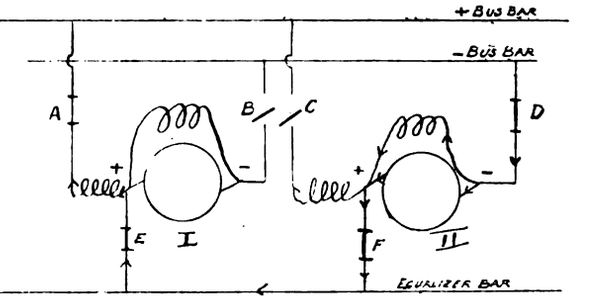


FIG. 1.

also occurs at the same instant in the other rotary converter, and is exactly the same as supplying the positive 'bus bar with two wires in parallel from one generator. This also occurs when the commutator segments connected to slip-ring B and C respectively are under the positive brush, and in the intermediate stages the conditions may be considered similar, because, though not being fed by one particular phase, the positive brush is collecting current which is the resultant of two phases, and equal to the maximum supplied by one. At the negative brush the same action takes place but in the opposite direction, so that the direct-current 'bus-bars may be considered as being supplied from one source with two positive and two negative leads in parallel. Now by cutting out one of each of these leads, it matters not which one, a load may be taken off the 'bus bars as before, so that in the case of the two rotary converters the positive of one and the negative of the other may easily supply the load.—B. W.

Answer to No. 802 (*awarded* 5*s.*).—The result stated in this query is, at first sight, rather astonishing, but after a slight inspection the cause at once appears. The accompanying sketch shows the direct-current side of the rotary converts as they would be connected up. It will be noticed that each converter has a series and a shunt field. In addition to closing the + switch, A, of one rotary and the negative, D, of the other, the equalising switches are also



closed; if they were open, *no* load would be taken by the rotaries. An electric circuit can now be traced from the − 'bus bar to the +, as shown by the arrows, through the armature and shunt of No. II. rotary, equalising switch, F, through the equaliser bar to switch, E, thence through series winding of rotary No. I., through + switch A to the + 'bus bar. It will be seen that rotary No. II. only delivers current as a shunt machine, its series coil being cut out. No. I. rotary is driven from the alternating side, but does not at all contribute to the (load) power of the 'bus bars.—N.

Question No. 803.—A Parsons two-phase alternator, 25 kw., is excited from a small exciter carried on an extension of the main shaft. The alternator field is connected directly across the exciter brushes through a Weston type of ammeter placed on the switchboard. There is a switch and regulating resistance in the exciter field. When the machine was started up, the current was in, say, the positive

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direction round the alternator field, as shown by the ammeter, which read properly. When the exciter field switch was opened and closed again, the current round the alternator field was reversed, as shown by the ammeter reading the wrong way. On testing it was found that every time the exciter switch was opened the current round the alternator field was reversed, the ammeter reading first right, then wrong, and so on apparently indefinitely. What is the cause of this?

Answer to No. 803 (*awarded 7s. 6d.*).—The effect noticed is due to the combined action of the self-induction of the alternator field winding and the armature reaction of the exciter. As soon as the exciter field switch is opened the voltage generated at the exciter brushes rapidly falls to zero as the exciter flux dies down, but this does not involve the equally rapid falling off of the alternator exciting current, for as soon as the alternator flux begins to drop a voltage of self-induction is set up in the alternator exciting winding owing to the unlooping of some of the flux looped with this winding. This voltage, in accordance with Lenz's law, is always in a direction tending to oppose the change to which it is due—*i.e.*, in this case the self-induction voltage tends to maintain the alternator exciting current at its original value. The net result is that the alternator exciting current and the alternator flux do fall off, but much less rapidly than if no self-induction were present, so that by the time the flux of the exciter has died down to zero there is still a large proportion of the alternator exciting current passing through the exciter armature and the alternator field winding.

Now, the tendency of the armature reaction of a dynamo armature with the usual forward brush lead is to reverse the polarity of the magnets. In normal work this tendency is, of course, overpowered by the field excitation, but in the case in question the exciter field excitation is zero at a time when there is still a considerable current in the exciter armature, so that the armature back ampere-turns are in a position to reverse the exciter polarity during the few seconds which elapse between the breaking of the exciter field circuit and the dying down of the exciter armature current to zero.

The reversed poles produced are probably quite weak, but, since the polarity with which a self-exciting dynamo excites itself simply depends on the polarity of the residual magnetism, however small, existing in the magnets when the exciting circuit is closed, it is easy to see that the next time the exciter is used the brush which was positive will become the negative one, and *vice versâ*, just as described. The reversal can be avoided (1) by giving the exciter brushes a slight *backward* lead for a few minutes immediately after breaking the exciter field circuit; or (2) by breaking the alternator field winding in place of the exciter field winding. This latter method would necessitate the employment of a field-breaking resistance, across which the alternator field would be connected just before connection with the exciter is

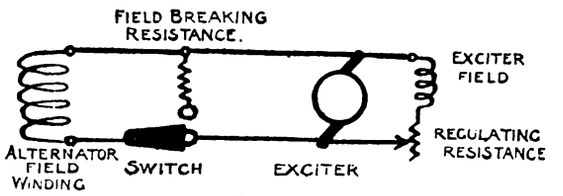


FIG. 1.

broken (see Fig. 1), in order to avoid an excessive rise of voltage due to the self-induction of the alternator field. Thus, if the field-breaking resistance were made equal to the resistance of the alternator field winding, the voltage could never rise to more than double the normal, however suddenly the switch might be opened.—Q.

Answer to No. 803 (*awarded 7s. 6d.*).—The cause of the main alternator field reversing is owing to the exciter field being reversed in the following way. Fig. 1 will show the polarity of the magnetic field due to the armature when running in the given direction, and it will be seen that part of the armature field tends to induce opposite polarity in the field magnets, as shown by the small letters on field magnet, whilst the other part has practically no direct effect on the poles. These first are within the two vertical lines, and are known as the demagnetising or back ampere turns, and are what we shall have to consider. From first principles we know that when a current is stopped in an inductive circuit, a current is induced that will tend to help the current to continue flowing. The effect of breaking the exciter field is to stop the current flowing round the alternator field, and, therefore, a sudden heavy current will be set up in the same direction as the generated current through the exciter armature. When the exciter field drops to zero there will be a fairly strong magnetic field due to this current flowing through the armature, which will induce opposite polarity in the exciter field magnets,

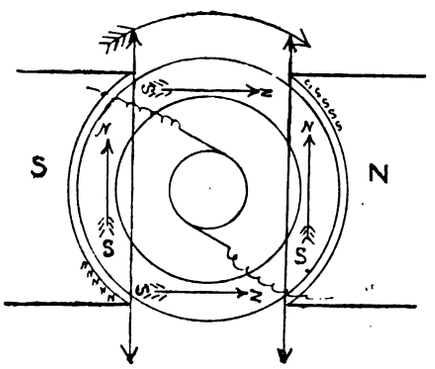
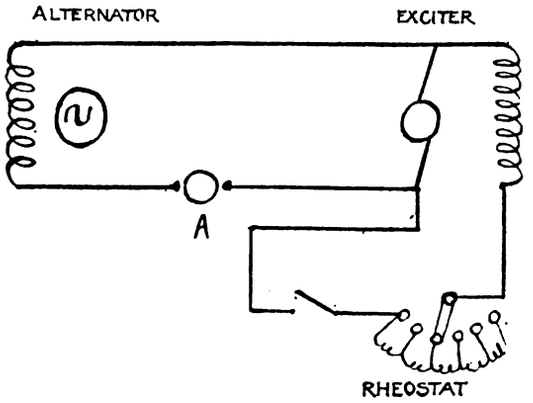


FIG. 1.

as shown in Fig. 1. Therefore, when the exciter is again started, the direction of current through the ammeter will be reversed.—A. W.

Answer to No 803 (*awarded 5s.*).—In this case it is evident that the trouble is caused by the reversal of the polarity of the small exciter. Referring to the diagram, suppose the



alternator to be running fully excited, and the exciter field switch to be suddenly opened. The current flowing round the field coils of the alternator cannot be instantly stopped, owing to the inductive nature of the circuit, but will tend to rise momentarily above its former value, according to the well-known principles of self-induction. Thus a current will continue to flow round the alternator field and through the exciter armature for some seconds, depending on the time constant of the field coils, and gradually falling to zero value. This current, it should be noted, will be in the same direction as before, and will produce a field in the exciter which will oppose that due to its own field coils. But since these coils are now unexcited, there remain only the residual magnetism in the iron, and this will be overpowered and its polarity reversed, with the result that when the field switch is again closed the machine will commence to build up in the opposite direction, and its poles will have changed, so that current will now flow round the alternator field in the opposite direction, as stated in the question, and the process will be repeated every time the exciter switch is opened.

The remedy, if one is needed, is to place a switch in the alternator field circuit, and to open this before the exciter field switch. The current may first be reduced as low as possible by means of the rheostat in the exciter field, and the switch should preferably be of the type which places a non-inductive resistance in circuit at the moment of breaking. A case somewhat similar to the above which came before the writer's notice, where current

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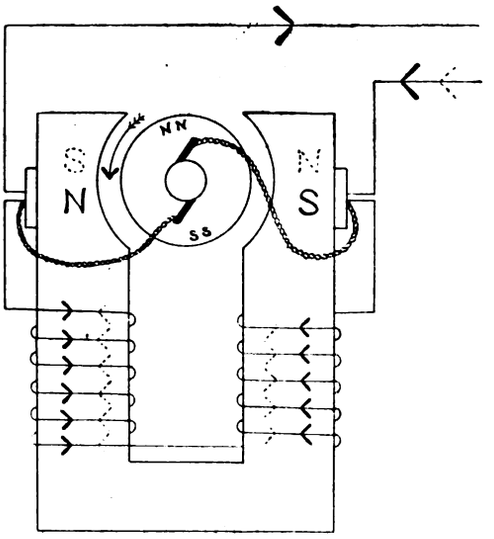
was led in at the brushes of a dynamo in order to test the armature, and on afterwards starting up the machine and proceeding to parallel it with others, it was found to have had its polarity reversed. It is also quite a common occurrence with all self-exciting shunt dynamos after a heavy short-circuit.—S.

Answer to No. 803 (*awarded* 5*s.*).—The polarity of the exciting dynamo is reversed each time the magnetising circuit is opened. When a current is flowing in a circuit and the circuit is suddenly opened, a temporary rush of current tends to flow in the same direction as that of the original current before the circuit was broken. This is an instance of Lenz's law. With a shunt dynamo a current returning in the opposite direction to the normal flow *strengthens* the field, but in this case, on breaking, the current tends to flow in the same direction as the normal; the result is, therefore, that the field is *weakened* while the armature polarity is strengthened. The effect of this two-fold action on the magnetic system of the exciting dynamo is then a reversal of its polarity. This will naturally take place each time the switch is opened when on load. A remedy would be to let the exciting current fall off before breaking the circuit; for instance, the speed should be considerably reduced before the switch is opened. It may also be possible to introduce sufficient resistance in the field circuit of the exciting dynamo before opening the switch, and thus prevent reversal. A few experiments will soon show how much resistance must be in circuit to



prevent this change of polarity. In the figure the full letters and arrows are intended to represent polarity and direction of current *before*, the dotted letters and arrows the polarity and direction of current *after* switch is opened. If the exciting dynamo is given much lead to the brushes, the polarity will be the more easily reversed.—M. M.

Answer to No. 803 (*awarded* 5*s.*).—In considering this question, first take the case of an alternator having a relatively large number of ampere-turns in the field circuit. If the field is fully excited and the circuit afterwards broken sharply, there would be a rise of pressure across the terminals of the magnet windings. This is caused by the lines of force falling and cutting the windings on the fields, the resultant E.M.F. being in the same direction as that previously applied, but of much greater magnitude; in some cases it may rise to millions of volts, and where no non-inductive resistance has been installed to take up the discharge a breakdown of the insulation has resulted. As the alternator field windings of the turbine set are connected directly across the exciter brushes, the armature being of very low resistance, and having comparatively few turns, it would take up the discharge from the alternator field after the exciter field circuit had been broken, but being of *too low a resistance* for that purpose, an enormous rush of current from the alternator fields to the exciter armature would be the result. This current being in the same direction as that previously supplied by the exciter, the armature would momentarily develop a field opposed to and more powerful than the residual field retained by the exciter magnets, the result being a reversal of the residual field, which would account for the alternator field current being alternately in opposite directions. If the turbine set was shut down before the exciter field switch was opened, it would allow the fields of the two machines to die down gradually, and the alternator field current would in all probability be found to be in the same direction when next the set was started up.—CLAUDE H. KLYNE.

Question No. 804.—I am employed at a paper mill, and frequently receive complaints from the printers about electricity in the paper. I have tried several experiments with it, but without success. What is the best method of reducing or preventing the effects complained of?

Answer to No. 804 (*awarded* 7*s.* 6*d.*).—Undoubtedly frictional electricity is the cause of the trouble. I was installing a dynamo several years ago, and it was driven by means of a leather belt from a wooden driving wheel. Passing close to the belt whilst the machine was running one day I was astonished to see a spark quite two or three inches long jump from the belt into my arm. The length of the spark showed that it was not a case of leakage from the machine, so I concluded that it was frictional electricity generated by the slipping of the belt on the wooden pulley above. I noticed that the portion of belt coming from the wooden pulley down on to the iron pulley of the machine was highly charged, but that the ascending portion of the belt had no charge whatever, showing that the electricity had escaped to earth through the iron pulley. Since then I have several times come across similar cases.

In the case mentioned by "J. W." the electricity is caused by the friction of the paper on a roller, or set of rollers. The annoyance to the men may be stopped in this way. Get a long strip of sheet tin, the width of the paper, and cut notches in it right along one edge so as to form a series of sharp points. Place this close to the paper, and connect the tin by a wire to earth. After the paper has passed these metal points, it will be found to have no charge left in it. To find the best place to fix this arrangement start where the paper leaves the machine, and test whether it is charged by holding the knuckle close to the paper. Work backwards until the spot where the electricity originates is located, and put the row of points just after the paper has left this spot. If the sparks cause discomfort, make the test by means of an electroscope, where the gold leaves fall together will be the point required. It would be an advantage to connect the framework of the machine to earth also. If "J. W." follows out these suggestions, I am confident that no more trouble will be experienced.—RESEARCH.

Answer to No. 804 (*awarded* 5*s.*).—Some years ago the writer had a similar experience, although it did not cause any trouble, with rolls of cloth intended for waterproofing. The cloth appeared to get charged, like one occasionally finds machine belts that are in a dry situation. "J. W." might try touching the paper with a series of metallic brushes just before folding or rolling, these brushes being connected to earth. Paper being an insulator, the brushes should, if possible, make contact with the whole surface in order to completely discharge the paper. It will sometimes be found that the paper patterns supplied with periodicals devoted to the art of dressmaking are charged sufficiently to be rather troublesome. If these patterns are held in the hand and stroked with an earthed knife blade, they will become completely discharged, and thus lose the tendency to stick together. Had there been more data given in the question, more explicit suggestions might have been offered as to the arrangement of an earthing device or devices. The effect of a static charge of electricity causes trouble in various cases—take, for instance, the wet-plate process of photography. After polishing a glass plate preparatory to coating it with collodion, it is as well to discharge the plate before pouring on the collodion. Evidently, the querist will have to prevent friction on the paper as much as possible, and devise some arrangement by which if the paper becomes charged it may be neutralised.—M. M.

[Other replies to Question No. 804 will be given in our next issue.—ED. *E. E.*]

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SEPTEMBER 8, 1905.

QUESTIONS AND ANSWERS.

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We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

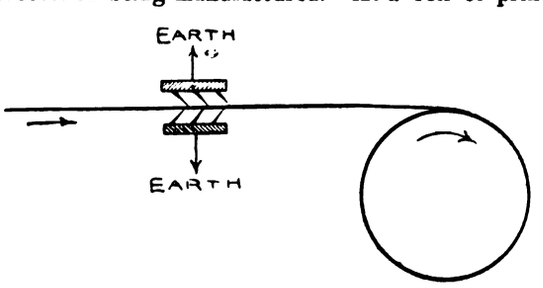
812. The owners of an isolated low-tension direct-current lighting and power installation in the colonies, supplying current to about 50 110-volt motors, varying in power from 1 h.p. to 55 h.p., are anxious to establish a repair shop on the premises, equipped with the necessary plant to effectually carry out all winding and repairs due to breakdowns and ordinary wear and tear. The motors are all of the four-pole type by various British manufacturers. Describe the most modern appliances for this class of work, with special reference to the possibility of manufacturing commutators at a reasonable outlay.—G. F.

813. A works is supplied with current from a power station with continuous current on the three-wire system, with 500 volts between the outers. It is required to split this up further at the works, for the purpose of speed regulation of the motors driving the various machines, by means of "shunt" or "shunt" and "armature" regulation combined. The voltages proposed are as follows: between outers 500 volts, between outer and middle wire 250 volts, between middle and intermediates 60 volts, between intermediates and outers 180 volts, which would enable the motors to be supplied with voltages of 500, 310, 250, 180, and 60. Show clearly how this could best be done. Further, would it be to the advantage of the company owning the works to put down their own generating plant for lighting and power, and, if so, what arrangement of generator would be best to adopt, without the use of balancers?—MOTOR-CONTROL.

ANSWERS.

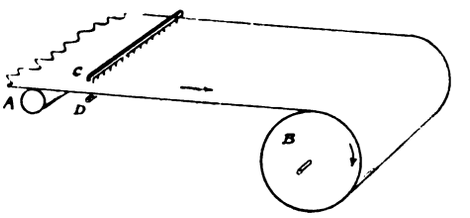
Question No. 804.—I am employed at a paper mill, and frequently receive complaints from the printers about electricity in the paper. I have tried several experiments with it, but without success. What is the best method of reducing or preventing the effects complained of?

Answer to No. 804 (*awarded 7s. 6d.*).—What I understand by the printers finding electricity in the paper is that they find the paper has an electrostatic charge of electricity, which, no doubt, is due to the tremendous friction which the surface of the paper is subjected to in the process of being manufactured. As a roll of printer's



paper is of a considerable length, it acts as a condenser of large capacity, and, therefore, takes a heavy charge, and being a very good insulator will retain the charge for a considerable period. The action of points on an electrostatically-charged body is well known, and I think a good method of discharging the paper would be to have, both above and below the paper before running on to the roll, two metallic bars, into which are fixed a large number of points or needles, these, of course, extending the whole breadth of the paper, and having each of these connected to earth, as shown in the accompanying sketch. The points would require to be sloped slightly in the direction in which the paper is travelling, to keep from tearing it.—B. W.

Answer to No. 804 (*awarded 7s. 6d.*).—The effect described by "J. W." as "electricity in the paper" is probably due to the friction to which the paper is subjected during its passage through the machines. Although no details are given in the question as to the treatment of the paper, it is probable that it finally passes in the form of a long strip over or under wooden or metal rollers. Some of these rollers may act as drivers and others merely as guides. The passage of the paper over these rollers would cause the paper and the roller to be oppositely electrified by friction. The same effect is often noticed on a leather belt driving a metal pulley, in which case sparks may often be drawn on to the hand held near the edge of the belt. To neutralise the charge on the paper, the frame of the machine should first be connected to a water-pipe or gas-pipe (preferably the former) by means of a wire. This



will "earth" the machine. In the figure A is the last roller on the machine which the paper touches before it is wound on the roll, B. C and D represent two metal combs, one above and the other below the surface of the paper. They consist each of a strip of metal with a number of points about 2in. apart arranged along their length. They should be fixed metallically to the frame of the machine as near the last roller as possible, as the paper would probably have only a slight up and down vibratory movement there. The points should be directed towards the surface of the paper in both cases. The combs could be quickly made for the test by soldering ordinary pins to an iron or brass strip. If this is not found satisfactory, the following arrangement might be tried: Paper, in passing over wooden rollers, would become negatively electrified, but in passing over metal rollers the paper would become positively electrified. Temporary wooden rollers might be fixed up above and below the paper just before it is rolled on B. If the electrical charge on the paper is increased, then metal rollers should be substituted. It is really a matter for experiment. Pith balls would be the quickest way of getting an idea of the relative charge in the two cases.—S. L.

Answer to No. 804 (*awarded 5s.*).—Some years ago I was for about 18 months working in a paper mill, and had much the same experience as "J. W." describes. The cause of this electrification seems to lie in the calenders. After the paper is made it is passed through a series of perfectly smooth steel rolls, which are all driven at a slightly different speed. Hence, as the paper passes between these rolls, it is subjected to a sort of rubbing action, which gives it a gloss and finish. It seems to be this rubbing in the calenders which causes this electrification, and this is difficult to get rid of. If the paper were damped, that might get rid of this objectionable effect, but then that would damage the paper and destroy the gloss. I have many a time seen sparks some inches long drawn from paper as it has left the calenders. In the case I am referring to, the difficulty was got over by suspending a horizontal copper wire from above so that it rested on and rubbed over the surface of the paper as it left the calenders before being rolled up. This wire was well earthed, and proved a great boon. Of course, this was rather a primitive method, and perhaps it would be better if the paper after leaving the calenders could be passed over one or two small rolls above and below it, which should, of course, be very well earthed. Of course, these rolls should be arranged so that although the paper passes over them it is not subjected to any more rubbing or

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friction, as in that case not much good will have been done. I think if "J. W." tries this method, he will have no more complaints from the printers.—E. R. ALEXANDER.

Question No. 805.—Show by comparative figures the advantage of using laminated poles compared with solid ones for direct-current machines. Is there any real gain in the use of the former, when air-gap is not less than half the width of slot ?

Answer to No. 805 (*awarded* 10*s.*).—Experiment has certainly shown that lamination of the pole-pieces, if carefully carried out, does reduce the iron losses of a machine even when the ratio $\frac{\text{slot opening}}{\text{air-gap}}$ is as small as 2, though the saving effected increases rapidly with this ratio. Comparative tests on the same machine with and without laminated pole-pieces are difficult to get at, but the question has often been investigated analytically, and the following rules deduced by R. Rüdenberg in a recent article (*Elektrotechnische Zeitschrift*, Feb. 23, 1905) enable, at least, an approximate calculation of the pole-piece eddy-current losses with solid poles to be made in any given case. This writer shows that, on the assumption that the flux density on the pole-face at a given instant varies from a minimum opposite the centre of a slot to a maximum opposite the centre of the next tooth, in accordance with a sine law (see

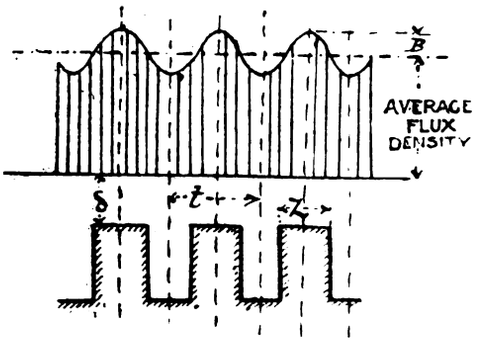

FIG. 1.

Fig. 1), the following expression holds good for solid-iron pole-pieces :

$$W = V^{1.5} \times B^2 \times \sqrt{\frac{t}{S \times \mu}} \times 4 \times 10^{-9},$$

where W = pole-piece eddy-current loss in watts per square centimetre of pole-face ;
V = peripheral speed of armature surface in centimetres per second ;
B = half the difference in flux density (C.G.S. lines per square centimetre) between points of minimum density (opposite slots) and points of maximum density (opposite teeth)—*i.e.*, the amplitude of the flux variations from the average (see Fig. 1) ;
t = slot pitch—*i.e.*, distance between the centre of one slot and the centre of the next, in centimetres (see Fig. 1) ;
S = specific resistance of pole-piece material in absolute units per centimetre cube = approximately 10^4 for wrought iron or steel and 10^5 for cast iron ;
μ = average permeability of the pole-piece material. This cannot be accurately determined, but may be estimated from the maximum and minimum pole-piece flux densities, and is usually about 1,000 for wrought-iron pole-pieces.

The value of B, as compared with the average air gap flux density, depends on the ratio of the slot opening to the air-gap length, and may be arrived at by means of any of the empirical rules used for deciding the effect of the slots on the air-gap resistance of slotted machines. The following simple rule due to Prof. Arnold, for instance, will give the required value of B directly :

$$B = \text{average flux density in air-gap} \times \left(\frac{t}{Z \times (X + \delta)} - 1\right),$$

where "average flux density" =

$$\frac{\text{total flux per pole in C.G.S. lines}}{\text{area of one pole-face in square centimetres}} ;$$

t = slot pitch, as above ;
Z = width of tooth top in centimetres (see Fig. 1) ;
δ = single air-gap in centimetres (see Fig. 1) ;
X = a variable depending on the ratio of slot opening to air-gap, and obtainable from the curve in Fig. 2.

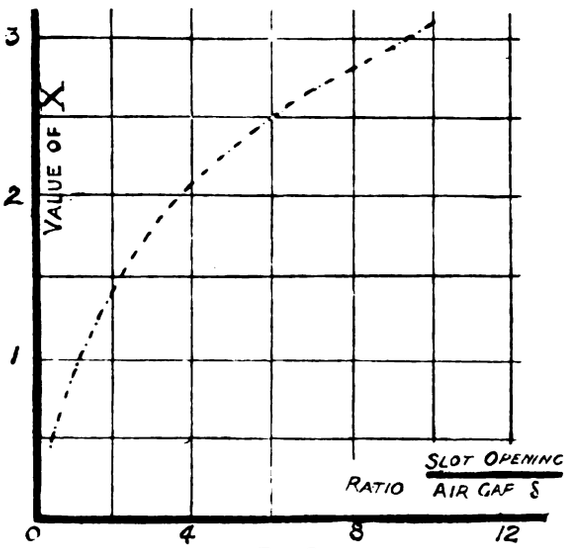

FIG. 2.

An example will help to make the method of application clear. A certain dynamo gives an output of 14 kw. at 1,000 r.p.m. It has an armature 12in. in diameter and 5in. long with 40 slots, each ·3in. wide. It has four solid cast-steel poles, with a pole-face area of 30 square inches each. The single air-gap (to the top of the teeth) is $\frac{1}{8}$in. Total flux per pole = $1{\cdot}4 \times 10^6$ C.G.S. lines. From these particulars the following values are obtained :

$$v = \frac{\pi \times 12 \times 1{,}000}{60} \times 2{\cdot}54 = 1{,}600\text{cm. per second.}$$

$$\text{Ratio } \frac{\text{slot opening}}{\text{air-gap}} = \frac{{\cdot}3}{{\cdot}125} = 2{\cdot}4. \quad \therefore X = 1{\cdot}5 \text{ approximate.}$$

$$t = \frac{12 \times \pi \times 2{\cdot}54}{40} = 2{\cdot}4\text{cm.} \quad Z = 2{\cdot}4 - ({\cdot}3 \times 2{\cdot}54) = 1{\cdot}64\text{cm.}$$

$$\delta = {\cdot}125 \times 2{\cdot}54 = {\cdot}32\text{cm.}$$

$$B = \frac{1{\cdot}4 \times 10^6}{30 \times 6{\cdot}45} \times \left(\frac{2{\cdot}4}{1{\cdot}64 + (1{\cdot}5 \times {\cdot}32)} - 1\right) = 1{,}070 \text{ C.G.S.}$$

lines per square centimetre.

S may be taken as 10^4, and μ as 1,000. Then,

$$W = 1{,}600^{1.5} \times 1{,}070^2 \times \sqrt{\frac{2{\cdot}4}{10^4 \times 10^3}} \times 4 \times 10^{-9}$$

$$= 64{,}000 \times 1{\cdot}15 \times 10^6 \times \frac{1{\cdot}55}{100 \times 31{\cdot}6} \times 4 \times 10^{-9}$$

$$= {\cdot}145 \text{ watts per square centimetre.}$$

Total eddy-current loss = ·145 × 30 × 6·45 × 4 = 112 watts = ·8 per cent of full load.

If the pole-pieces were thoroughly laminated to a depth of an inch or so, most of this loss would be avoided. The plane of the laminations must be parallel to the plane of rotation and not parallel to the length of the armature, as the latter arrangement would permit the eddy currents to complete their circuits through the back of the poles, and would scarcely diminish the losses at all. It is, further, of great importance that not even a thin skin of solid metal should be left at the pole-face, for the whole of the eddy-currents are in any case confined to a thickness of only one or two millimetres just at the surface. These currents, in fact, themselves counteract the flux changes which produce them, and cause a practically uniform flux distribution to be attained at a very small distance within the solid pole-face. The depth, d in centimetres, within the pole-face at which the flux fluctuations are reduced to one-hundredth of their surface value (and beyond which the eddy-current loss is, therefore, quite negligible) may be found by the expression :

$$d = {\cdot}73 \sqrt{\frac{s \cdot t}{v \cdot \mu}}.$$

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In the above example $d = 73\sqrt{\frac{10^4 \times 2{\cdot}4}{1{,}600 \times 10^3}} = {\cdot}09$cm., or just under 1mm.

If, therefore, quite a thin skin of solid metal exists on the pole-face, through machining or otherwise, most of the good effect of the laminations will disappear.

When the lamination is complete, the flux fluctuations penetrate to a considerably greater depth (probably to a depth equal to two or three times the width of the slot opening), and this gives rise to a certain amount of hysteresis loss. Experiment has shown, however, that this loss is not nearly so great as the eddy-current loss which it replaces.—Q.

Answer to No. 805 (*awarded* 7*s.* 6*d.*).—The advantage or otherwise of using laminated poles for direct-current machines must be considered from two points of view—first, as regards the limb itself, and, second, as regards the pole-face. By using stampings for the limbs the use of the best possible material is assured, and, what is even more important, material whose uniform permeability can be relied on. It is desirable to run the limbs at a fairly high density in order to get a short length of mean turn for the coils, but this is a dangerous practice if the limbs are of cast steel, as with a bad casting it may be impossible to get the desired flux without overheating the field coils. The yoke can be run at a lower density, and a variation of its permeability will not be so serious. Laminated poles also lend themselves easily to methods reducing the field distortion by armature reaction, as in the Johnson-Lundell dynamos (see Fig. 1). In these machines the

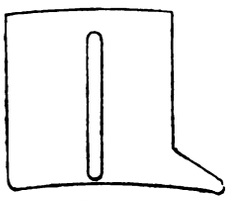

FIG. 1.

forward half of the limb is highly saturated at no load, as it supplies an air-gap of more than half the total area, and this prevents excessive densities under the trailing tip when the load comes on. Another point in favour of laminated poles may be mentioned—namely, that they respond more rapidly to a change of magnetising current. The eddy currents generated in a solid pole tend to prevent any change of flux. This is only of importance is some special machines, such as battery boosters. On the other hand, a laminated pole cannot, of course, be made circular, which is the most economical section as regards weight of field wire. A square limb has a longer periphery than a circular one of the same area in the ratio of 4 : 3·55, and the weights of wire required are in the same ratio. A circular coil is also cheaper to wind and insulate than a square one. As regards the pole-faces, if these are not laminated the air-gap should be not less than five-eighths of the width of slot In a given machine the eddy currents are proportional to the square of the peripheral velocity and to the square of the induction. With fairly high values of these the writer has known very marked heating of pole-shoes to result from reducing the air-gap from five-eighths to one-half the slot width.

Although it is quite possible to design a line of machines with this ratio of slot-gap, it is very convenient to be able to shorten the gap considerably in special cases. Also the laminated pole-shoe made by riveting punchings together is cheaper than any other form, the turning inside and outside of cast-iron pole-shoes being a very expensive piece of work.—W.

Answer to No. 805 (*awarded* 5*s*).—The use of laminated poles or pole-shoes with armatures having open slots prevents the formation of eddy currents in the pole-face. These eddy currents are caused by the uneven distribution of magnetic lines over the pole-face, due to the armature teeth, as shown in Fig. 1. These gaps in the magnetic lines becomes very marked when the air-gap is small, and almost disappear when the air-gap is large, owing to the fringing of the lines at the corners of the teeth (see Fig. 2). In a machine having an air-gap of one-quarter slot width, the total iron losses would be approximately reduced by half by using laminated poles in place of solid ones. Without fear of eddy currents, air-gaps can be reduced to an amount limited only by the necessary mechanical clearance, which results in a saving of copper in the field windings. Apart from the question of iron losses, experiments show that not only do solid poles

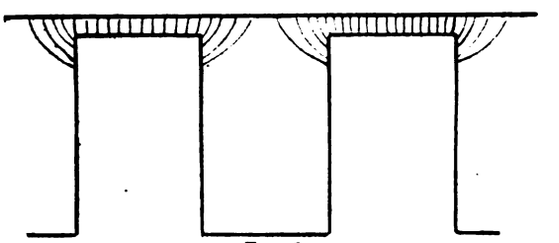

FIG. 1.

get overheated, but they radiate heat on to the armature and field windings, increasing the temperature rise of the machine throughout. Laminated poles have one disadvantage, that they cause humming unless they are built up very tightly. As to whether it is worth while using laminated poles when the air-gap is not less than half slot widths depends on the speed of the machine. The eddy-

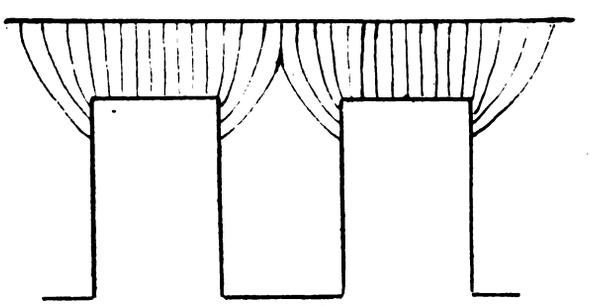

FIG. 2.

current loss is proportional to the square of the speed, so that one might say that for all high-speed machines, even with large air-gaps within reason, it is advisable to fit laminated poles.—H. O. B.

Answer to No. 805 (*awarded* 5*s*).—It is extremely doubtful whether any reliable tests are available to give figures as specified in the query. In any case figures would have to be modified for each particular machine, and also for every alteration in the load on the machine. Speaking generally, it does not appear to be worth while to laminate the field magnets of direct-current dynamos, although it is advantageous to have laminated pole-shoes. The eddy currents exist practically on the surface of the polar faces, and penetrate but little into the body of the magnets. By employing laminated poles these poles may be so shaped as to assist commutation; they may also be so arranged as to hold the magnet windings in position. As to the employment of laminated poles, a great deal will depend on the speed of the machine; although in high-speed dynamos laminated poles might be advisable, it would certainly not pay to fit them on slow-running machines. A large air-gap, with small and closely spaced teeth in the core, reduce eddy-current losses to a minimum, while a small air-gap with wide teeth have an opposite effect. In the number of this journal for Dec. 5, 1902, there is a paper on eddy currents by Dr. Thornton. In that paper the advantage of good workmanship is pointed out as an antidote to eddy current losses. It will therefore be seen that there are many points from which the question can be approached.—M. M.

Question No. 806.—At a power station they use several alternating arc lamps, B.T.H. enclosed type in parallel on a 220-volt circuit, with a choking coil in series. The carbons used are not consumed equally unless one of them is cored and the other solid. What is the reason they do not burn in equal quantities?

Answer to No. 806 (*awarded* 7*s.* 6*d.*).—The electrical properties of the circuit are the same for the forward as for the backward pulse of the alternating current, so that some physical explanation must be looked for. The most probable is the presence of convection currents in the enclosed space surrounding the carbons. In a direct-current arc

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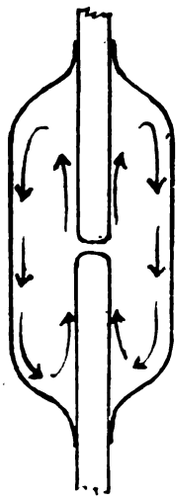
lamp the temperature of the thicker carbon which is cored and forms the crater is much higher than that of the smaller one. The hotter carbon burns away and disintegrates at a quicker rate than the other, so that carbons of equal diameters cannot be used. Referring to the



diagram, it will be seen that the convection currents, indicated by the small arrows, and which are caused by the rising of the heated gas from the neighbourhood of the arc, tend to heat the upper carbon and cool the lower one. This infers that it is the upper carbon which wastes away more rapidly. The cooling effect due to the convection currents in gases is sometimes very considerable, and has been tested with platinum wires heated to incandescence in a space which could either be a vacuum or filled with different gases. But a secondary effect with uncored carbons, due to the wandering nature of the alternating arc, is likely to be much more important than the purely cooling or heating effects of the convection currents. As the arc is wandering round the edges it will be driven up closer to the upper carbon, heating it more than the lower one, with consequent greater waste. If one carbon be cored, the arc is kept more central, and, therefore, out of the way of the convection currents. The latter will also not be so great or have such a marked influence. The softer core is a place of easier disintegration and provides a starting place for the arc.—E. S.

Answer to No. 806 (*awarded 7s. 6d.*).—In the question "H. W. C." does not mention whether it is the upper or the lower carbon that is consumed the quicker, or how much quicker one burns than the other. Now, in all alternating-current arc lamps the upper carbon wastes about 8 per cent. faster than the lower, unless the carbons are in a horizontal position, when they will burn evenly. This evidently proves that it is the upper carbons of the lamps in question that are burned the quickest. The reason for the lower carbon lasting so much longer than the upper is that small particles of carbon are continually falling from the upper and adhere to the lower. There is no advantage in using a solid carbon at the top and a cored one at the bottom, as the cored one only burns away more quickly, owing to the core being of a softer nature. The above may be proved by experiment in the following manner. Fit up one of the lamps with the ordinary solid carbons, and allow it to burn for a few hours in a horizontal position, taking care to measure the carbons before insertion. After it has been burning for a convenient time, take out carbons and again measure them. This will give the amount of carbon consumed in a measured time, and should in this case be the same for each carbon. Now fit up lamp with one cored and one solid carbon, and proceed as before (the lamp still remaining horizontal). This time it will be noticed that the cored carbon has burned very much faster than the solid one in the same amount of time, thus showing a disadvantage in using a cored carbon with a solid one. It will also be noticed that if the lamps have burned for the same length of time in each case, all the solid carbons will have lost practically the same length.—P. S.

Answer to No. 806 (*awarded* 5*s.*).—Theoretically speaking, the carbons in an alternating-current arc lamp should be consumed at equal rates, because, as the direction of the current changes regularly, the amount of carbon particles leaving one carbon during the first part of the cycle should equal the amount leaving the other during the second part of the cycle. There is, however, a consideration which is met with in practice which causes the top carbon to be consumed at a higher rate than the bottom carbon. This is that the flame of the arc plays mostly on the top carbon no matter in which direction the current is flowing. This is, of course, a peculiarity of all flames—that, no matter in what manner they are burning, they always tend to travel upwards, due, of course, to the fact that the flame is lighter in weight than the surrounding air. The result is that with the flame playing on the top carbon more than on the bottom one, the top carbon is consumed at a higher rate. The remedy applied in the question is that of coring the carbons. The core is softer than the outside of the carbon, and, therefore, this carbon is consumed at a higher rate. This difference of consumption mentioned in the question is not by any means as great as that met with in direct-current arc lamps, and I should hardly have thought it worth while to core the bottom carbon unless the lamps were run a long time without being attended to.—ERNEST P. HOLLIS.

Answer to No. 806 (*awarded* 5*s.*).—The question does not state which of the carbons, upper or lower, is cored and which solid. It is, however, supposed in answering this question that the upper is solid and the lower cored, the upper being the one which tends to burn away faster. A possible explanation is that a brisk circulation of the heated gases takes place inside the enclosing globe, the gases rising around the carbons and descending again close to the globe. The upper carbon would thus tend to be kept at a higher temperature, and, in consequence, deteriorate and oxidise (to the limited extent occurring in enclosed lamps) and volatilise at a faster rate than the other. Mr. Duddell has shown that an ordinary direct-current arc, either open or enclosed, between solid carbons, if shunted by a condenser in series with a self-induction, converts part of the direct current into an alternating one flowing in the local circuit, consisting of the condenser, self-induction, and arc. The writer suggests that in an alternating current arc the reverse operation may occur under some circumstances, part of the current in one direction being suppressed and augmented in the other direction, the unidirectional current being superimposed on the alternating current of the circuit, causing the carbons to burn unequally. A sensitive *moving-coil direct-current* ammeter inserted in the circuit would show the presence of the rectified current, if any.—W. J. L

Answer to No. 806 (*awarded* 5*s.*).—The phenomenon of the greater consumption of the upper carbon in an alternating-current arc lamp would appear to be due to the fact that, owing to the position of this carbon above the arc, a greater length of it is of necessity at a somewhat higher temperature than the lower carbon in consequence of heated particles of carbon in the "mist" being carried upwards by the air currents. This would make the upper carbon in a favourable condition for more rapid consumption than the lower carbon. The difference in consumption of the two carbons, both of the same quality and diameter, is about 8 per cent. generally. If the carbons are placed horizontally, the consumption is the same for both. When cored and solid carbons are used, it is usual to place the former at the top. The consumption is then equal on both carbons. Mr. Duddell has shown that the cores of carbons have generally a higher specific resistance than that of the carbon which surrounds them. Cored carbons give a steadier light, and require a lower voltage to maintain the arc. With the upper carbon cored the light obtained from each unit of surface is diminished, and this corresponds to a lower temperature. This would mean that the temperature of the upper cored carbon and the lower solid carbon would be more nearly equal, and correspond to equality in consumption.—S. L.

[N. B.—Will "S. L." kindly send his full address?]

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Supplement to "The Electrical Engineer,"
SEPTEMBER 15, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS

814. In the brake equipment of tramway rolling-stock, the present tendency is to put the brake blocks below the centre of wheel. Why is this so? And if the brake has more power in the lower position, explain the reason.—INTERESTED.

815 I want to make a solenoid that will operate the starting lever of a clock mechanism. The lever has to be pulled through a distance of ⅜in.; pull required, 1½lb. Is it practicable to make such a solenoid to operate from a few cells? Solenoid and plunger to be kept as small as possible. The starting lever could, perhaps, be lengthened so as to reduce the pull required, but, of course, the distance it would have to be moved through would be increased proportionately.—SOLENOID.

ANSWERS.

Question No. 807.—In a continuous-current central station it is believed a consumer is using his current to earth. Describe the best method of detecting and locating this consumer.

Answer to No. 807 (*awarded 7s. 6d.*).—When current is flowing through the earth due to some fault, it either returns or goes out through the Board of Trade panel, depending whether it is a positive or a negative fault.

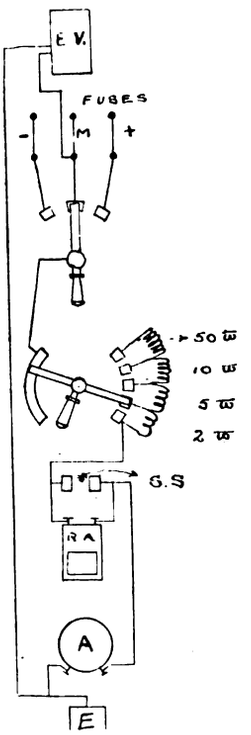

FIG. 1.

Fig. 1 shows the connections of the Board of Trade panel, by means of which any of the three mains can be put to earth through a suitable resistance depending on the size of the fault. E V is an electrostatic voltmeter connected between the middle wire and earth, and will give a good idea of the seriousness of the fault; if the fault is only due to a consumer using his current to earth, then this voltmeter will not read, as the volts have all dropped in his lamps. R A is a recording centre-zero ammeter reading 10 amperes each way, which is shunted by the switch, S S, when taking the earth readings on ammeter, A, which reads to about 70 amperes. There are two methods of locating an earth, depending whether it is a constant or intermittent one.

(1) *A Constant Earth.*—This is probably due to a fault on the mains, and too much current should not be passed through it, as it may develop into a short. To locate this, the network should be split up into two parts, so many feeders supplying each part. One part can be run on separate 'bus bars or the feeder ammeters noted to see on which part the earth is; this part is then split up again and so on until the fault is located to a length of distributor. (N B.—If the fault appears on a length of distributor which previously tested good, then test the feeders you have been using.) All the consumer's switches are then opened on this length, and if the earth is still on, disconnect this distributor and make a loop test to locate the position of the fault.

(2) *An Intermittent Earth.*—If this only comes on during lighting hours it may be assumed to be a consumer, and as the network cannot be split up on load some other method must be adopted. If it is a positive earth and the consumer is using his current to earth, then by putting the positive to earth on the Board of Trade panel the consumer's lights will go out, as both ends of his lamps are now to earth, and he will soon let the station know he has no light. If the consumer still lies low, then put the negative to earth, which will burst his lamps or blow his fuse.—H. E. T.

Answer to No. 807 (*awarded 7s 6d.*).—We will assume that the system used is the three-wire one, with the middle wire earthed only at the station, as this arrangement is by far the most common. If all the meters in use are fixed on the outers, and not on the middle wire, then the current used by the consumer will be measured by the meter whether his installation is earthed or not, unless he has cut the meter out with some cable. This would be very unlikely, as the first person to inspect the meter would detect the arrangement. If the meter is on the middle wire, he can render it useless by connecting his lamps to earth some distance from the corporation fuses, etc., and thus making detection difficult. But in this case the amount of current used would be registered on the earth leakage recorder connected to the middle wire in the station. Notice the hours that this earth leakage is recorded, as it affords a good indication of what kind of consumer he is. If he uses the current for power purposes, the leakage will show from 6 a.m. to 5 30 p.m. If for shop lighting, the likely hours are from dusk to 8 or 9 p.m., and on early closing nights it will be off; and if for private house lighting, he will use the current till late at night. It is very unlikely that he will be using it for motors, especially large ones, as he will only be able to get 200-250 volts. Three-wire stations make it a rule to only supply motors below 20 h.p. with 200 volts, so as to avoid out-of-balance troubles. Assuming that he is not a power consumer, choose a time when all motors are off and the leakage is on; get two assistants to pull the positive and negative switches out simultaneously, one feeder at a time, immediately closing them again, so as to only cause a slight blink on the lights. Carefully watch the earth ammeter needle all the time. When the feeder supplying this consumer is pulled out, the needle will go to zero momentarily. The reason why the positive and negative switches must be both pulled out at the same time is so as not to cause an out-of-balance current on the system. Suppose both feeders have 100 amperes load, and one switch only is pulled out, then there will be an out of balance of 100 amperes, which will perhaps overload the balancers. From the above observations the class of consumer will be known and the district where to look for him, so it should not take long to inspect this locality and see that all meters are connected to the outers, and have not been tampered

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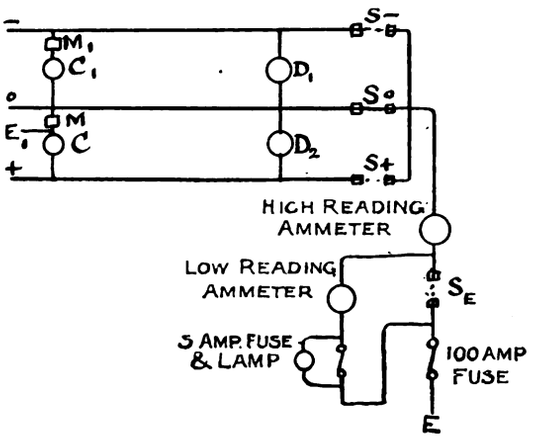
with. If he is a power consumer, all these consumer's meter connections must be inspected.

Another and much better method could be easily tried in most three-wire stations. The sketch shows the earth connections for the neutral wire used in many stations. Under ordinary conditions the middle switch, S_o, would be closed



connecting the middle wire to earth. A consumer, C, has his lamps connected to the positive side of the system and earth. Pull out S_o and insert S−, thus making the negative cable at earth potential. The positive cable will now be 460 volts above earth, and the consumer's fuse will blow and probably his lamps explode. He will at once send in a complaint, and thus expose himself. If he is artful, he may reinsert the fuse, get any fresh lamps required, and say nothing about the matter. Make it an expensive practice for him by earthing the negative for a moment when it is known he has his lamps on. Of course, if the consumer is on the negative side of the system, the positive must be earthed in order to burst his lamps. To make the sketch quite clear, the switch S_o is generally closed, earthing the middle wire through a small fuse. If an earth comes on either side of the system, this fuse blows, and the lamp in parallel lights up. This warns the attendant to make switch S_E, which now earths the neutral wire through a 100-ampere fuse. The consumer C has his meter, M, connected to the wrong main and earthed at E_1. The consumer C_1 has his meter, M_1, connected to the right main.

By using either of the two methods described "H. W. N." should be able to quickly stop the stealing of current from the mains.—RESEARCH.

Answer to No. 807 (*awarded 7s. 6d.*).—If the consumer is using his current directly to earth, his connections will be as shown in Fig. 1, where a tapping is taken off at A, and

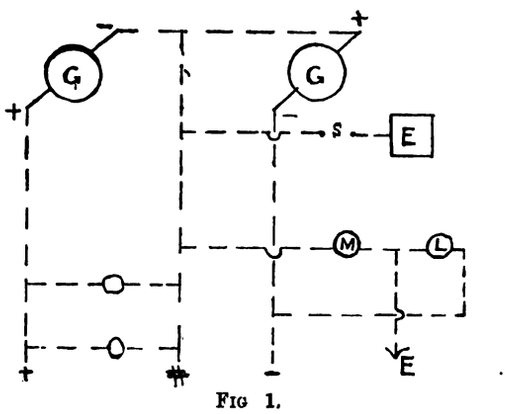


FIG 1.

so cause the current to miss the meter. A good method for testing the insulation resistance of the neutral, or outer, conductors without interrupting the supply is shown in Fig. 2, where the station battery is working in parallel with the generators, and both feeding into the network. E is the station earth-plate, connected through a switch to the neutral. A connection is also taken from the earth-plate through an ammeter to a two-way switch, and connected to three cells as shown. If the permanent earth is broken by the switch, and the two-way switch placed on contact B, the positive conductor of the positive battery will be connected to the earth-plate, and if an earth exists anywhere on the neutral a current will flow from the cells to the earth-plate, through earth into fault, and return along the neutral.

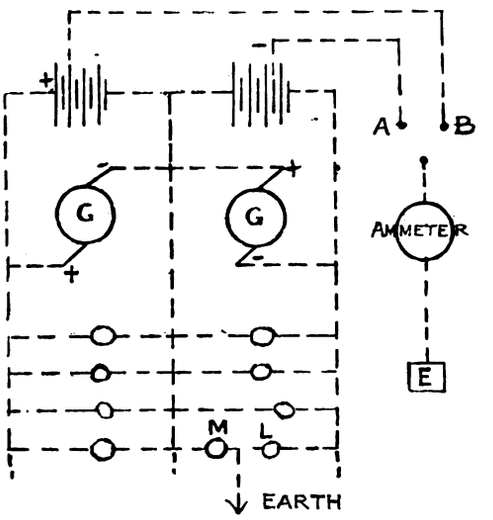


FIG. 2.

If the two-way switch is changed to contact A the same thing occurs, only the current is in the opposite direction. If an earth exists, the next step is to find it within a certain area. This can be effected very easily where there is a shunt central-zero ammeter, with a shunt between each neutral feeder, and the station neutral 'bus bar, to measure the current flowing through each neutral feeder. This test should be made when there is no likelihood of the supply altering for an hour. The permanent neutral earth at the station need not be interfered with during this test. Take readings from the ammeter and neutral feeder shunts of any current that is flowing between the neutral feeders and the station 'bus bar, and make a note of the direction of the current by central zero ammeter, then earth the negative side of the system through an ammeter and resistance, commencing with a few ohms. Fig. 3 shows the connections. The negative side is preferably earthed, for the reason that if for the purpose of testing it is necessary to put an extra strain on the insulation of either of the outers, the positive should always be in a better condition to sustain it, because the insulation resistance of the negative from earth is generally lower than positive. When the

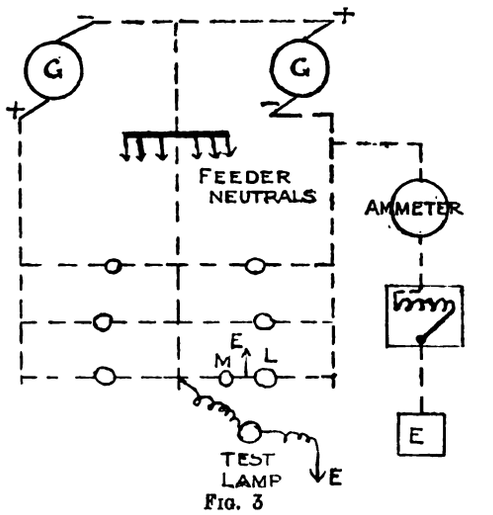


FIG. 3

negative outer is earthed through the resistance, R, take the readings of the ammeter, A, and as quickly as possible take another set of readings of the feeder neutral-wire currents. These will be found to have increased over the previous readings, in proportion to the ratio of distance between each feeder and the faulty main. If the system is a large one, with a number of feeders in parallel on the network, it may be necessary to increase the current permitted to pass to the earth-plate through the resistance, R, but it should be kept as low as possible to prevent the con

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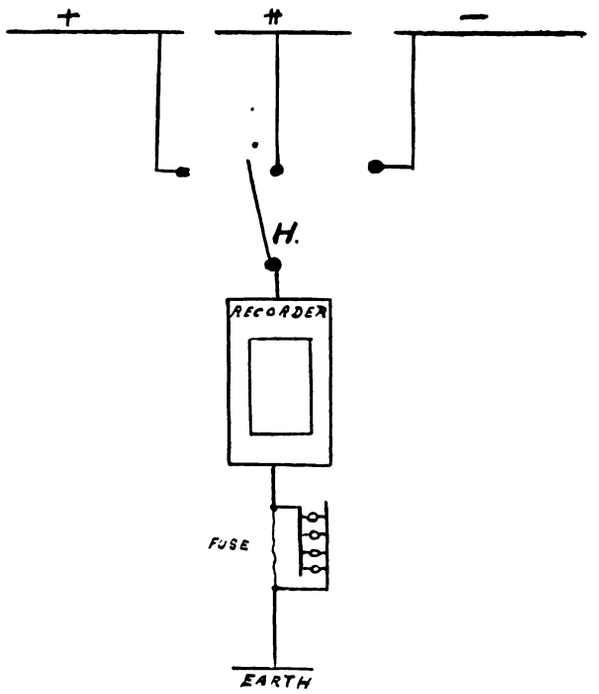
ditions of pressure on the main altering, so that the positive conductor of the system is put to a dangerous potential from earth, the Board of Trade limit being 250 volts, and to also prevent the possibility for seriously disturbing the defective wire. Having taken the second set of readings of the feeder neutral wire, it then remains to judge the locality of the fault. After the fault has been localised to a certain district, you can then split that portion of the network into section, making tests of each section until the faulty one is discovered. When the faulty section is found, you can then proceed to find at which junction box the faulty cable is connected. This can be done by Murray's loop test or by disconnecting the supply at each junction box, and test beneath the neutral and earth with an incandescent lamp of the same voltage as the supply. If it does not light, then connect up the supply again and go to the next box and disconnect the supply and try the lamp across the neutral and earth. If it lights, then the fault is at the last box which you have previously tested. Connect up the supply again and go to the faulty box, connect your lamp to the neutral and earth, then disconnect each consumer's main which is connected to the outer feeder, and the main which, when disconnected, puts the lamp out is the faulty consumer. This would, perhaps, be the quickest way, as the resistance of consumer's wires not being the same as the feeders will cause a great deal of testing by Murray's test, which has often been discussed in this paper.—J. P. S

Answer to No. 807 (*awarded* 5*s.*).—In continuous-current stations it is customary to earth the neutral 'bus bar through a fuse, across which is connected a batch of lamps, so that in the event of either of the outers being put to earth the fuse blows; but the neutral still remains earthed through the lamps and a current will flow, the magnitude of which depend on the resistance offered by the lamps. A consumer who takes his current from one of the outers and earth is obviously fed through the earth fuse, that is provided the neutral is not earthed in any other part of the system, except at the station; in which case his current will be recorded on the earth recorder, which is in series



with the fuse, together with any other earth current. If there is reason to believe that the whole of the earth current is due to the consumer in question, and that he is not committing the offence purposely, it is possible that by dimming his lights somewhat he will come round to the station and report the matter. This can easily be done by arranging the batch of lamps joined across the earth fuse to have about the same resistance as those on the installation, then by removing the fuse the resistance will be doubled and the lamps will burn a dull red. The most satisfactory way of dealing with such troubles—in fact, I might almost say, preventing them—is to have a special switch for flashing the two outers to earth. The arrangement will be best understood by referring to the sketch; + ++ − represent the three 'bus bars. A wire is taken from each to three separate contacts on a three contact switch, while the handle, H, is joined to earth through a fuse and recording ammeter. Under ordinary conditions the switch handle is kept on the centre contact, thus earthing the neutral. If one of the outers becomes earthed, the fuse blows, and the rush of current is recorded on the recorder, and if the outer remain down to earth, the lamps will light up and remain alight until the earth is removed, when the fuse is replaced. In order to test the current between either the outers and earth, the handle, H, is switched over to the two outside contacts separately, which will put the full pressure on the insulation between earth and copper on each of the outers. By flashing over about three times a day with a fair-size fuse, it not only clears a number of small earths on consumers' premises, but also locates any trouble like that under consideration. Suppose, for instance, a consumer was taking his current between positive and earth, then, when the negative is flushed, he will obtain just double the pressure, which will, in all probability, burn the lamps out and blow the fuse.—E. AUSTIN.

Answer to No. 807 (*awarded* 5*s.*).—If the system is a three-wire one, it follows that the consumer has earthed his middle wire for the purpose of getting his light free, though I may say that if the meter is properly connected up—namely, on the outers—he could not cheat the supply company, but would have to pay for it just the same, as it would all be metered. However, such a procedure is against the regulation of the Board of Trade, to say nothing of the amount of trouble it gives to the station engineer, so we must now look for a remedy. We will suppose the installation to be one of 220 volts, with the middle wire earthed at station. First of all, insulate the middle wire, then put the positive main to earth through a variable resistance in series with an ammeter, at the same time watching the ammeter. If the consumer has at that particular time got his middle wire to earth, there will be a sudden rush of current which may throw the pointer violently over, afterwards falling to zero, indicating that his neutral fuse has blown, and as he is not allowed to break the seals of the cut-out, location is self-evident, for he will have to make application for a new fuse; such a procedure might also go to prove that the meter had been placed on the middle wire instead of the outer, as there would really be no inducement for any consumer to earth his middle wire unless he knew this. The above answer is based on the assumption that the consumer had not removed his neutral fuse.

We will now deal with a consumer who is supposed to have removed his neutral fuse. Proceeding as before, we insulate the neutral wire; the effect of earthing the outers is now different, depending on what side of the system he is connected up to. If he is connected to the positive side, and the positive pole is earthed, his lamps will no longer burn, as the main will be at earth potential, but on earthing the negative pole there will be a potential difference of about 440 volts between positive pole and earth; this would result in blowing his positive fuse, together with a general blackening and bursting of his lamps. The excessive current might also show itself on the feeder ammeter of his particular section at the moment of earthing.

Another way, if the network is not a very large one, would be to split it up into sections, testing a section each day with some portable instrument, such as Evershed and Vignoles. This would be a slow way, but a sure one, providing the culprit was not fly enough to disconnect his earth every day.—H. P.

Question No 809.—In a station having water-tube boilers working at 200lb. per square inch, and using salt water for condensing, what is the best and quickest method of detecting small quantities of salt in the feed water? The presence of the salt being due to a leaky condenser. As it is desired to avoid "blowing down" as much as possible, to what density may the water in boilers be allowed to rise to before forming a dangerous scale? What percentage of the feed water should be "blown down" daily to maintain the density at a safe value?

Answer to No. 809 (*awarded* 10*s.*).—Salt water—for presumably in the case presented by "Practical" sea or tidal water is used—varies considerably in composition,

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The main constituents, however, in percentages of the total solids are of the following order: sodium chloride, 77 8; magnesium chloride, 10 9; magnesium sulphate, 4 7; calcium sulphate, 3 6; potassium sulphate, 2 5; calcium carbonate and magnesium bromide, 0 5—total, 100. Nearly 89 per cent. of the total solids being chlorides, the quickest and best method of detection is by means of the action of silver nitrate on soluble chlorides. Thus

$$AgNO_3 + NaCl = AgCl + NaNO_3.$$

A solution of silver nitrate precipitates the insoluble white silver chloride, and a ready method of determining the actual amount of chlorine—and thus salt—is presented. An indicator to determine the exact point at which the precipitation ends is needed for quantitative work, and potassium chromate is used. Thus, to detect the presence of salt, pour a small portion of the water into a clean white porcelain dish, add a few drops of a solution of potassium chromate, stir with a glass rod until the water is distinctly yellow. Then add silver nitrate solution, and if salt (or chlorine as chloride) is present a red colour is seen as the silver solution meets the water, this red disappearing on stirring, until the whole of the chloride is precipitated When this results, a permanent red takes the place of the yellow coloration. To accurately determine the amount of chlorine, a standard solution of silver nitrate is made by dissolving 4·79 grm. of pure silver nitrate in one litre (1,000 cubic centimetres) of distilled water; one cubic centimetre of this solution exactly precipitates one milligramme of chlorine. Seventy cubic centimetres of the boiler water is the best amount to take, and the silver nitrate is run in from a graduated burette until the red colour just becomes permanent on stirring. The number of cubic centimetres of silver nitrate used represents the milligrammes of chlorine in 70 cubic centimetres of the water, and, therefore, the number of grains per gallon. Multiply this by 1·68 to get the approximate grains of salt per gallon. If the water is acid, neutralise with sodium carbonate; if strongly alkaline, with nitric acid.

If sea-water in any quantity is allowed to enter a boiler working at high pressure, corrosion through the magnesium chloride is to be feared, and it is bad engineering practice to use leaky condensers served by salt water on high-pressure boilers. The best way to avoid trouble is to repair or renew the condenser, otherwise the user will always be liable to have difficulty and waste in his boilers. Marine practice allows of a density of 15deg. to 20deg. by the salinometer, which is practically a hydrometer with the density of fresh water marked zero, that of sea-water marked 10, and the scale continued to 35. A reading of 20 thus means that twice the amount of salt is in solution as would be in sea-water, and this would in no wise be allowed in land installations. Scale forming is not the primary danger, and corrosion is more to be feared, so that a minimum of salt water should be allowed.

It is the custom in a large station where the boiler feed is taken from a canal which is fed from a river just above the tidal limit, and thus contains at times a quantity of salt, to limit the maximum density to 1deg. salinometer—*i.e.*, about 130 grains of chlorine per gallon. Practically no trouble has been experienced, and this is probably due to the fact that the water is softened by a process involving the use of lime, and thus neutralising the magnesium salts. On one or two occasions when the softeners were out of use slight corrosion, as evidenced by the dirty-brown sediment in the gauge glasses, started although the density did not exceed 4deg. salinometer. It would seem that, save in very exceptional circumstances, 1deg. density—*i.e.*, 130 grains of chlorine per gallon—is a maximum, unsafe to exceed without the use of lime in the boiler itself. If this limit be exceeded, for every 100 grains of chlorine per gallon 2·6lb. of lime should be added to 1,000 gallons of boiled water. The amount of water to be blown down to keep the density which it is determined to work at depends on the density of the feed water. Assuming the density of the feed to be a degrees salinometer and the maximum allowable to be b degrees, then the quantity to be blown down is a/b of the total feed.—S. E. T.

Answer to No. 809 (*awarded 7s. 6d.*).—The best method of determining the salinity of feed water is to test it with a salinometer. A salinometer (quite an inexpensive instrument) is a special form of hydrometer, and consists of a glass or metal weighted bulb, attached to which is a graduated stem. On placing it in the liquid to be tested it floats in an upright position, and the amount to which the stem is immersed is inversely proportional to the density. The stem of the salinometer is graduated in "thirty seconds" or "ounces per gallon," sometimes in both, and reads correctly at a temperature of 200deg. F. Thirty-two parts of average sea-water contain one part by weight of solid matter; this amounts to about 5oz per gallon, so that if the salinometer be put into sea-water at 200deg. F. it will read "one" on the "thirty-two" scale and about "five" on the scale of ounces. Of this 5oz. about ·25oz. are sulphate of lime, which is the chief scale-forming constituent in sea-water. With regard to running at a safe density, Seaton gives 20oz, or four "thirty-two," as safe, but the amount of scale deposited does not depend on the density of the water in the boiler, but on the density of the feed and the amount evaporated. The salt itself is not deposited under a density of 12 "thirty-two"—a state of affairs which should not be even approached. Suppose the feed to contain ·1oz. of sulphate of lime per gallon, the water evaporated 10,000 gallons per day, at the end of three months 5,687lb. of scale will have been deposited in the boiler. If the specific gravity of the scale be 2·6, this amounts to $\frac{5,687 \times 1,728}{62·3 \times 2·6} = 60,750$ cubic inches. If the heating surface of the boiler be 2,000 square feet and the scale be deposited evenly all over it, the thickness will be ·211in.

To maintain the water in the boiler at a constant density, the water blown out must contain the same amount of solid matter as the feed has brought in since the last blow down. Hence the rule: the gallons of feed multiplied by its solid matter per gallon must equal the gallons blown off multiplied by its solid matter per gallon. Suppose it is desired to keep the boiler water density at 10oz and the feed-water density is 2oz., water evaporation per day A gallons, water blown off per day x gallons. Then

$$A \times 2 = x \times 10,$$

$$x = \frac{A}{5}.$$

Or the water blown off must equal one-fifth the total feed. This rule is not very accurate, and only serves to give one a rough idea as to how much to blow off, a process of trial and error being adopted to secure the exact result required, bearing in mind that the feed check valve must be shut when blowing down and the boiler must be pumped up again to its original level before retaking the density. If the station is situated on an estuary, there will not be nearly so much sulphate of lime per gallon as in ordinary sea-water, but this may or may not be made up for by carbonate of lime. Also the quality of the water will vary with the tides and the amount of fresh water brought down by the river. In any case, the sea-water around the British coast is not so dense as that in the open sea. Much the best way out of the difficulty, however, is to repair the leaky condenser, which, unless there are any very special reasons, should prove quite a simple matter.

Sulphate scale is extremely hard and difficult to remove, especially when carbonates are also present and the salinity of the water is favourable to electrolytic action and scum, which is apt to cause priming, so much so that marine boilers are universally provided with special scum cocks. At the same time it is usual in ocean-going steamers carrying a fresh water supplementary feed to make up the lost water with sea-water until the boilers arrive at a density of about half a "thirty-two," after which fresh water is used. This serves to put a very thin scale on the plates, which protects them against pitting and corrosion.—J. P.

[Other replies to Question No. 809 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
SEPTEMBER 22, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

816. Why should a Lancashire boiler give a dull boom at intervals of, say, half an hour, or less, which can be heard 30 yards away, and make the steam blow off suddenly at the safety valve when the blow-off cock happens to be leaking? The blow-off cock is of the Hopkinson type. The blow-off cock delivers below the surface of a stream of water. Also, would the above effect be likely to be at all detrimental to its safety?—ARC E. E.

ANSWERS.

Question No. 809.—In a station having water-tube boilers working at 200lb. per square inch, and using salt water for condensing, what is the best and quickest method of detecting small quantities of salt in the feed water? The presence of the salt being due to a leaky condenser. As it is desired to avoid "blowing down" as much as possible, to what density may the water in boilers be allowed to rise to before forming a dangerous scale? What percentage of the feed water should be "blown down" daily to maintain the density at a safe value?

Answer to No. 809 (*awarded* 5*s.*).—It is a very simple matter to show the presence of salt in water. It is best to get a chemical test-tube, but any glass will do. Put about an ounce of the water into it, then add two drops of pure nitric acid; stir thoroughly, and add one drop of a solution of pure nitrate of silver. If salt—*i.e.*, chloride of sodium—is present, a white precipitate or turbidity will appear immediately, and this will get darker in the daylight. Assuming that the feed water is free from mineral, etc, matter in solution, its density would be 1,000deg., and after having passed through the boilers, and so losing its gases, its density would increase somewhat in proportion to the mineral, etc., matter in solution. The mineral matter of sea-water is approximately: chloride of sodium, 2·60; chloride of potassium, ·07; chloride of magnesium, ·28; sulphate of lime, ·11; sulphate of magnesia, ·26—total mineral matter, 3·32 per 100 parts or per cent. by weight. To this must be added a very small quantity of organic matter. The density of sea-water is 1,020, and the solids found by analysis in a gallon amount to 2,700 grains, or about 6oz. Of all the above salts the sulphate of lime is the least soluble, and would therefore be the first to be deposited on the inside of the boilers.

Boiling water will dissolve about one grain in ½oz. of water as a maximum, and this is about four times as great a proportion as the sea-water contains naturally, so that the sea-water might be condensed by evaporation to about one-fourth of its bulk, which would correspond to a density of 1,080deg. after cooling to 60deg. F. This, therefore, would correspond to the maximum density allowable, as any further concentration would cause a deposit of sulphate of lime. All the other salts, being much more soluble, would not be affected. A careful consideration of these remarks will show that the amount to be blown out of the boiler bears no proportion to the amount of clean feed water pumped into the boilers, but must depend upon the amount of leakage from the condensing water, and so long as the density of the water in the boilers does not approach 1,080deg, no fear of deposit will be feared. The water must always be cooled to 60deg. F. before observing its density, and then the test must be very carefully and accurately made in a glass vessel.

The analysis of sea-water given above shows it to be loaded with other chlorides other than that of sodium, and each of these would respond to the nitrate of silver test, but, of course, that does not matter for our present purpose. However, it should be noted that chloride of magnesium is the worst enemy, because it decomposes under the influence of heat in the boilers, and so gives rise to active hydrochloric acid in the water in the boiler, and this will dissolve, and so damage the interior of the boiler and all its fittings, therefore every effort should be made to keep the condenser from leaking.—F. G. A.

Answer to No. 809 (*awarded* 5*s.*).—The best way of detecting small quantities of salt in the feed water is by using the naval hydrometer. All readers will well know the principle of and the method of using the hydrometer. The naval hydrometer, which is particularly suited for this case, differs only from other kinds in the matter of graduation. Sea-water contains $\frac{1}{37}$ part of solid matter, and the hydrometer is graduated into degrees, each degree representing the presence of one-tenth the solid matter in sea-water. Ten degrees represent the density of sea-water, or the presence of $\frac{1}{32}$ part of solid matter. The indication of $\frac{1}{320}$ part of solid matter will, I think, be enough for all practical purposes.

As regards the density to which the water in the boilers may be allowed to rise before forming a dangerous scale, this should not be more than between 30deg. or 40deg. on the hydrometer, indicating the presence of $\frac{3}{32}$ or $\frac{1}{8}$ parts of solid matter in the water. We have now to decide the quantity of feed water to be "blown down" daily to keep the density of the water at a safe constant value. Let x = the quantity of feed water and y = the water to be blown out. Then $x - y$ = the water evaporated. Suppose the water in the boiler is to be kept at a density equal to n times the density of the feed water, then the quantity of solid matter blown out is proportional to $n \times y$. The quantity of solid matter pumped in with the feed during the same time is proportional to x, and since the density of the water in the boiler remains constant, the solid matter blown out must equal that blown in. Therefore,

$$x \times 1 = y \times n,$$

or,

$$y = \frac{x}{n}.$$

Suppose that in our engine the density of the feed is 1 on the naval hydrometer—*i.e.*, $\frac{1}{10}$ the density of sea-water—and that the density in the boiler is to be limited to four times that of sea-water, in this case $n = 40$, and $\frac{1}{40}$ the total feed water must be blown out = 2½ per cent.—ERNEST P. HOLLIS.

Answer to No. 809 (*awarded* 5*s.*).—The best method of detecting quantities of salt in the feed water is by the use of the salinometer. Draw off some water from the boiler, when it has ceased the violent boiling caused by its being released from the pressure in the boiler. Try its temperature with a thermometer. If it is hotter than the degree marked on the salinometer, it must be left to cool until it comes to that degree; but if already too cool, warm it over a fire till it becomes of the proper degree. Dip the salinometer in the water so as to wet it all over, and then let it float. The quantity of salt can now be ascertained by noting the mark on the graduated scale on the stem of the salinometer the water stands at. Two hundred degrees Fahrenheit is the usual degree marked on the salinometer. The presence of salt in the feed water can be detected in another way by drawing some of the water off, boiling it and placing a thermometer in it; if the mercury rises above 212deg. it shows the presence of salt, as the boiling point of fresh water is 212deg., and that of salt water 213·2deg. It has been found by experience that when the density of water in a boiler is prevented from exceeding that point at which it contains $\frac{2}{33}$ its weight of salt, or 8oz. per gallon, no injurious scale will form. Before the percentage of the feed water to be blown down can be ascertained the density of it must be known. Assuming that the density of the feed water is $\frac{1}{132}$, or 1oz. of salt per gallon, and as the density of the water allowed in the boiler is $\frac{2}{33}$, or 8oz. of salt per gallon, it is clear that the water in the boiler must be reduced by evaporation to $\frac{1}{8}$ its bulk before it can contain $\frac{2}{33}$ of salt, or, in other words, $\frac{1}{8}$, or 12½ per cent., of the total feed water must be blown down daily to maintain the density of the water at a safe value.—GEORGE EMENS, JUN.

Question No. 810.—Discuss means of speed regulation of alternating-current low voltage motors, and state why the cost of variable-speed alternating-current motors exceeds that of constant-speed motors by a relatively high amount. What would be the best method for obtaining electrically a speed variation of 25 per cent. with a 1-h.p. alternating-current motor

Answer to No. 810 (*awarded* 7*s.* 6*d.*).—Leaving out of account a change of supply frequency as impracticable, there are only three ways of regulating an ordinary single or polyphase induction motor: (1) by changing the number of poles; (2) by reducing the stator terminal volts; (3) by inserting resistance into the rotor windings (Fig. 1) (1) only allows large changes of speed to be produced, such as those in the ratio of 1 : 2 or 1 : 4, and is, besides, expensive, owing to the special arrangement of the winding

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and the large number of ends that have to be brought out to the regulating switch. (2) is only applicable for small speed changes (say 10 to 15 per cent.), for a comparatively large percentage change in terminal volts is required to produce a small change in speed. Since the maximum torque which an induction motor will develop before stopping through overload varies as the square of the terminal volts, even a good motor, standing two or three times full load with full terminal volts, very soon reaches a point where the overload capacity is too small for practical work.

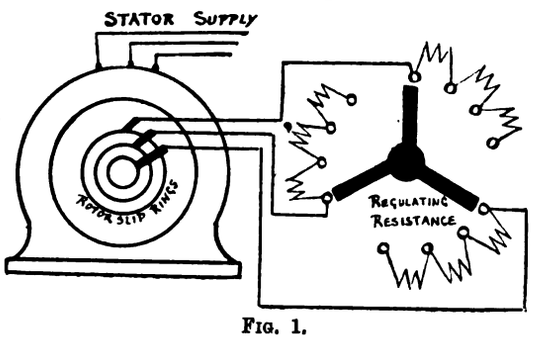

FIG. 1.

(3) is the method most commonly employed. It involves the use of a "wound" rotor fitted with slip-rings to enable the variable resistance to be inserted, and it is less efficient than either (1) or (2). It, however, enables any required speed variation to be produced, right down to zero speed if desired. The low efficiency is due to the fact that of the total energy a fraction proportional to the speed reduction effected is lost in the regulating resistance, just as in the case of an ordinary direct-current motor whose speed is regulated by inserting resistance in series with the armature. Thus, if the amounts of power taken into the motor at full speed and at 25 per cent. reduction in speed are equal, the useful power developed in the latter case will be practically 25 per cent. less than at full speed. If the machine is used at the lower speed continuously, of course this loss becomes a serious item, but if, as is more usual, the lower speed is only wanted occasionally, the all-day efficiency is not lowered appreciably. This method (3) would, therefore, undoubtedly be the best, both as regards first cost and stability of running, to adopt for the 25 per cent. reduction in the 1-h.p. motor mentioned, provided that the low speed is not wanted for a large proportion of the time. As regards the increased cost for variable-speed motors, this is only large in cases in which the normal constant-speed motor has a squirrel-cage rotor without slip-rings, for then the variable-speed motor (method 3) has to be provided with a special rotor fitted with rings (usually three) and a brush gear, often involving a fairly complete change of design. When the normal motor already has a "wound" (slip-ring) rotor the additional cost for variable speed should be little more than that of the regulating resistance, provided, of course, that the torque required at the low speed is no greater than the normal full load torque. The regulating resistance itself, especially in the case of small machines, is a somewhat expensive item, for, besides the fact that it has to dissipate a very large amount of energy (compared, for instance, with that of the shunt regulator of a direct-current motor), it has to have three arms and sets of contacts to correspond with the usual three slip-rings on the rotor.—Q.

Answer to No. 810 (*awarded 7s. 6d.*).—In induction or so-called constant-speed motors, the speed can be varied both by stator and rotor devices.

1. *Stator Regulation.*—(*a*) *Alteration in Number of Poles.*—This is a very good method when the speed is to be halved. The stator coils are in two sets, one of which can be reversed. The poles, which would be with eight poles, + −, + −, + −, + −, would become + −, − +, + −, − +. Two adjacent similar poles would act like a consequent pole. The great advantage of this kind of regulation lies in the fact that no energy is lost by the change. It corresponds but is not equivalent to the regulation of direct-current motors by alteration of the field current.

(*b*) *Alteration in the Frequency of the Working Current.* This method would be too expensive, as another machine would be required, and it would be cheaper to have two separate motors for the two different speeds.

2. *Rotor Regulation.*—(*a*) *Introduction of Resistance into the Circuit of the Rotor.*—The effect of this is seen most plainly with the aid of the given Heyland diagram. The details of this cannot be explained, as they would require too much space. $B_1 C_1$ represents the output that would be got when the rotor slip was 5 per cent. If $B_1 C_1$ represents 1 b.h.p., then with this motor a slip of 15 per cent. would be obtained when the rotor was giving out energy to the amount represented by $B_3 C_3$—*i.e.*, about 2·2 b.h.p.—and, therefore, 1·2 b.h.p. must be dissipated as heat in the rotor rheostat. Even though approximately only 10 per cent. variation in speed has been obtained, the motor has nearly reached its maximum output. More work, of course, can be got out of the motor, but not any more available reduction of speed. The amount of energy represented by $X C_3$ can be made use of by putting on a load equal to $B_3 C_3$ and cutting out the rotor resistance, but the speed will be exactly the same. $A_2 D_2$ represents its output as a constant-speed motor. Diagram I. would not be suitable for a 1-b.h.p. induction motor, but such a motor would very likely be worse in its regulation. On testing a ¼-b.h.p. three-phase induction motor, the variation of speed from no load to 100 per cent. overload was found to be only 18 per cent of the no-load speed.

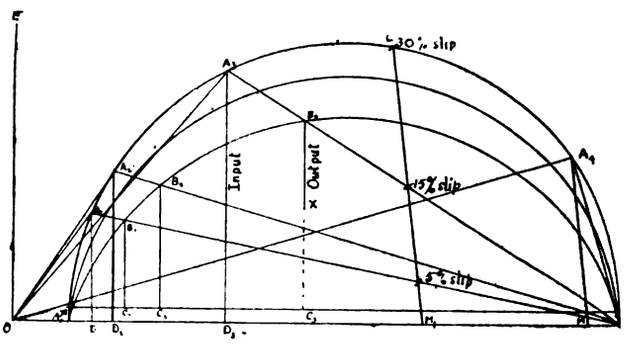

DIAGRAM I.

(*b*) *Cascade Regulation or Tandem Control.*—This is a variation of (*a*), where the energy represented by $X C_3$ in the first diagram is passed on to the stator of a coupled motor. This motor adds to the torque and prevents dissipation of energy as heat. The second motor has a starting resistance in its rotor circuit. The speed of the two when coupled is half that of either running alone. Supposing we consider the stator-rotor transformation ratio to be unity in both cases, we may approximately take the currents in the rotors of both to be equal. The torque of each motor will be the same as if it were running alone with this current, and, therefore, the number of revolutions for any particular output must be halved when the two are coupled.

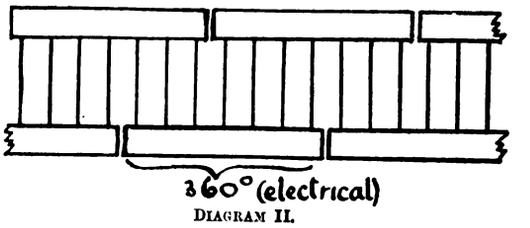

DIAGRAM II.

The best kind of motor to use for 25 per cent. speed variation would be a compensated series alternating motor where the armature is fed by a transformer from the stator circuit. The voltage on the armature could be varied by any reasonable amount, and the armature would have to speed up to produce the necessary back E.M.F. Such motors are not yet on the market in small sizes. The reason for the extra cost of variable-speed induction motors is that the rotor has to be wound and connections made to slip-rings, and these connected to a three-way rheostat, whereas a so-called constant-speed motor has a rotor circuit composed of straight conductors with the ends short-circuited, as shown in Diagram II. (Osnos type).—E. S.

Answer to No. 810 (*awarded 5s.*).—There are three commercial methods of electrically varying the speed of induc-

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tion motors: (1) by changing the number of poles; (2) variation of supply voltage; (3) resistance in rotor circuit.

1. The method of pole changing has been discussed at length in these columns quite recently; it has the following disadvantages: (*a*) The ratio of speed variation is practically fixed—a ratio of 2 to 1 is that chiefly employed. Other ratios of 4 to 3, 4 to 1, etc., can also be arranged, but with considerable complication. For a ratio of 2 to 1 the motor would be wound with the larger number of poles—*i.e.*, for the lower speed—with this arrangement the whole of the windings are active at both speeds, but with the other ratios mentioned above it is generally necessary to wind the motor with two or more separate windings—depending on the speed ratios required. With this system it is difficult and costly to arrange for small speed variation. (*b*) The switchgear is complicated with low-speed motors where separate windings are not used. (*c*) With reduced speeds the leakage increases, due to the larger number of poles, and the power factor decreases. The advantage of the system—especially with the 2 : 1 ratio with common winding—is that the efficiency is fairly high at both speeds, the decreased efficiency at the lower speeds being due to the increased rotor losses. The system is satisfactory where the motor has to run at either speed for any length of time.

2. The speed variation by means of supply voltage is chiefly used with "squirrel-cage" rotors, and is fairly satisfactory where the required speed variation does not exceed 50 per cent. The general practice is to wind the rotor with somewhat high-resistance coils, so that small changes of voltage produce a wide range of speed; the rotor C^2R losses, however, are permanently increased. It must also be remembered that the torque of induction motors varies as the square of the impressed volts.

3. The speed variation by rotor resistance is that chiefly employed, and generally meets with the average requirements where wound rotors are used. A liquid or metallic resistance is connected in the rotor circuit, the slip or speed variation being directly proportional to the resistance. The speed, therefore, can be varied within very wide and fine limits, as desired. The disadvantage of this method is the large C^2R losses in the resistance, the efficiency varying approximately as the speed with constant torque. The power consumption is, therefore, the same at all speeds, as in the case of the continuous-current motor with speed regulation by armature resistance.

Regarding the extra cost of variable-speed motors over the constant-speed motors, with method (1) the extra cost is due to the switchgear for changing the pole connections with motors with common windings, but with separate windings the motor size is increased, due to larger or more numerous slots. The rotor construction with wound rotors is also increased—*i.e.*, slip rings and brush gear—as it is necessary to wind for both speeds. No complicated switchgear is necessary for the motors with separate windings, a simple change-over switch only being required. (2) The extra cost of this method is only due to the auto-transformer to vary the voltage. The motor size is not increased. (3) With this system the motor size is not increased, the extra cost being only due to the regulating resistance, which depends on the speed variation required.

The best method of obtaining a speed regulation of 25 per cent. would be by rotor resistance with a wound rotor, or varying the voltage with a "squirrel-cage" rotor. It has been assumed that the motor in question is of the two or three phase type, although the writer has obtained satisfactory results with ordinary single-phase induction motors fitted with wound rotors and a speed regulation up to 25 per cent. with rotor resistance.—JUNO.

Answer to No. 810 (*awarded* 5*s*).—The factors upon which the speed of an induction motor depends are given by the equation

$$\text{R.P.M.} = \frac{\text{frequency}}{\text{number of pairs of poles}} \times 60.$$

This speed, however, is not that of the rotor, but that of the rotating field caused by the stator windings. The actual speed of the rotor differs by a small amount, known as the slip, from that of the rotating field. In most cases the rotor speed will be not more than 3 per cent. lower than that of the field. Now this slip is directly proportional to the resistance of the rotor winding.

From these facts it is clear that there are three direct methods of altering the speed of the rotor: (1) Alteration of the frequency of the supply. This method is obviously only available for very special cases, and need not be considered. (2) Variation of the number of pairs of poles of the stator windings. This arrangement is very inflexible, as unless a large number of poles are provided the steps are very great; thus a two-pole machine converted to four-pole will have its speed halved, and the larger the number of poles the greater become the difficulties of winding and switching over. (3) By altering the resistance of the rotor winding. This method, combining as it may the office of starter and controller, is easy and flexible; the windings, usually connected in star, are led to slip-rings, and a resistance may be included in the circuit, with speeds corresponding to each stop and a final position short-circuiting the resistance for the maximum speed. The main disadvantage consists in the fact that the torque and stator current will remain practically the same for all speeds. Thus at the lower speeds there is great waste of energy, as the output of the machine will decrease with the speed, while the power used will remain constant. In fact, the arrangement may be compared to the speed regulation of a shunt motor by inserting resistance in series with the armature.

Apart from these methods of altering speed, applicable to single motors, there is a method equivalent to the series-parallel control of direct-current motors. This is known as the tandem or cascade control, in which, instead of putting a resistance in the rotor circuit of No. 1 machine, the stator of a second machine is switched in, this second machine being designed to run at a lower speed and lower frequency; the two machines are coupled together, and machinery may be run from No. 1 machine alone at full speed, or with both machines at a lower speed, but with increased torque due to the second machine.

As regards the question of the price of variable-speed motors, there are obvious reasons for their relative costliness: (1) there is not such a great demand for them, consequently they are not made in large quantities, which naturally results in higher prices being demanded; (2) if made with a variable number of poles, a number of subdivisions of the winding are needed, increasing the labour, and a costly and complicated switchgear is required; (3) if made with variable resistance for rotor slip-rings are required and squirrel-cage windings cannot be used—moreover, the machine must be made of such a size as to develop its full output at its lowest speed, thus being larger than if built to give its output at the higher speed. The increased cost of the tandem system is so obvious as to need no comment.

The best method to employ for obtaining 25 per cent. speed variation for a 1-h.p. alternating-current motor is probably that of inserting a resistance in the rotor circuit, as this will only entail a drop in efficiency at the lower speeds, and will permit the use of intermediate speeds, while the winding the stator with eight poles, convertible to six, would be impracticable in the case of so small a motor.—H. W. B.

Answer to No. 810 (*awarded* 5*s*.).—There are three chief methods of varying the speed of induction motors: (1) by changing the number of poles in the stator; (2) by inserting resistances in circuit with the rotor; (3) by varying the voltage applied to the terminals of the motor by means of a compensator.

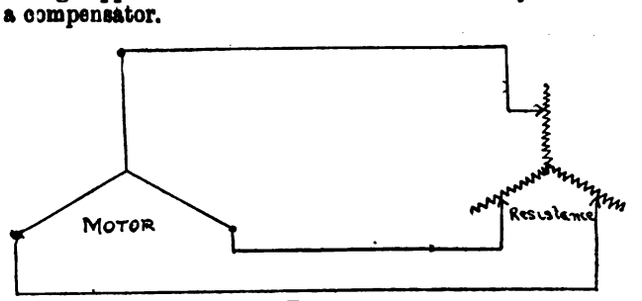

FIG. 1.

The first method has been well discussed in these columns very recently in answer to Question 794, so that I do not think that any explanation is called for here. The second

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one has not been explained recently, so that I will briefly consider. As is well known, the slip of an induction motor varies inversely as the rotor flux. Now, of course the rotor flux is proportional to the rotor current, so that it follows that if we diminish the rotor current by inserting resistance in the rotor, we can increase the slip of the rotor, and, therefore, diminish the speed. The connections of the resistance are as given in Fig 1. Thus by altering the value of the resistance, which is easily adjustable, we obtain various speeds for the motor.

The diagram of connections for the compensator used in the third method—*i e*, by varying the voltage across the terminals of the motor—is given in Fig. 2 L_1, L_2, L_3, M_1, M_2, M_3 are knife-blade terminals, and are mounted on a wood block, to which is connected the switch handle. T_1, T_2, T_3, T_4, T_5 and T_6 are connected to the small transformers. With the switch handle thrown over towards the transformers it will be seen that we have only a fraction of the voltage across the terminals, and when over towards F_1, F_2, F_3, F_4, F_5, and F_6 the full voltage of the mains is across the terminals of the motor. Having briefly described the three different methods, I have next to discuss their merits.

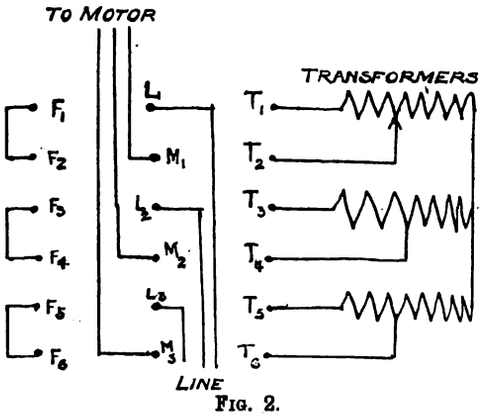

FIG. 2.

Each of the above has its own field of operation. The third method is the one mostly used in starting up machines in works. The simplicity of the compensator makes it especially useful for this. The second method can be and often is used for starting up machines in power stations where the method of operation is well understood. The first method can be used when a variable speed is required, but it will only give a few different speeds. Suppose we had a motor running at 400 r.p.m. with a frequency of 40 cycles per second, then the number of pairs of poles are $\frac{40 \times 60}{400}$ = six pairs of poles. With this number of poles we could get 45 different speeds by reducing the number of pairs of poles down to 4, 3, 2, and 1. With a proper resistance we could obtain several more intermediate speeds. With regard to the speed regulation of the 1-h.p. motor in the question, I think that, as the motor is only a small one, the second method would be best, because as the speed variation is only 25 per cent., the capital cost of the whole affair—motor and resistance—would be less than the pole-changing method. However, there is not much in it. The reason that the variable-speed motors cost most is because of the high cost of the pole-changing gear and of the resistances.—ERNEST. P. HOLLIS

Question No. 811.—It is desired to instal a motor generator of 50 kw. capacity for interconnecting an alternating-current 2 000-volt 75~ system with a direct-current 460-volt system. The alternators are of the ironless core type, and the dynamos are compound wound. Describe the controlling arrangements for the set to be started up as a motor from the direct-current side, but to run either as an alternating-current or direct-current generator in parallel with the existing plant. Give a diagram of the necessary connections.

Answer to No. 811 (*awarded* 7*s.* 6*d.*).—Since the main direct-current dynamos are compound wound, it will be necessary for the direct-current machine of the motor-generator set also to have a compound winding, but it will be best to use the series turns only when the direct-current side is a generator, as at other times this winding would merely act as a shunt to the series windings of the main generators and spoil their self-regulating properties. In order to be able to dispense with the series winding in this way (when the direct-current side is the motor), it will, of course, be necessary for the direct-current machine of the motor-generator set to have sufficient shunt excitation to let it run at the normal speed at all loads as a shunt motor. In most machines this would be the case, but if it is found that the shunt is insufficient, the series winding can be left in at all times without any change in connection, though it may be necessary to regulate the main generators partly by hand in consequence. The diagram of connections, assuming that the series winding is to be cut out, would be as in Fig. 1, and the process of operation would be as follows. To start up (for use as a generator on either the direct-current or alternating-current side) move switch A to the dotted position, so as to cut the series winding out and connect the dynamo brush direct to the outer bus bar. Then close the starting switch, B, slowly starting the set up. The alternator field is next excited by means of switch D, and the alternator volts are adjusted to the right value (2,000) on voltmeter V_1. The

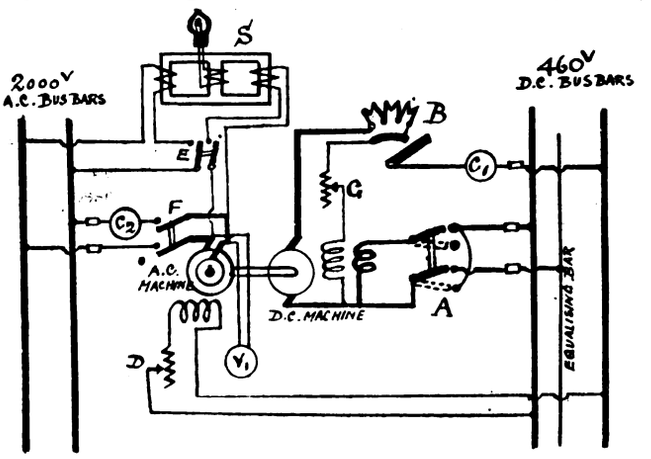

FIG 1.

synchronising switch, E is also closed, and when synchronism is indicated on the synchroniser, S, the speed being adjusted by switch G, the main alternator switch, F, is closed. The set is then in a position to act either as a direct-current generator driven by a synchronous alternating-current motor, or as an alternator driven by a shunt direct-current motor.

1. If the direct-current side is to be the generator, the next step will be to strengthen the direct-current field by switch G until the ammeter C_2 indicates no current (or even a slight generated current). Then move switch A into the full-line position, and strengthen or weaken the shunt by G in order to get any desired load out of the direct-current side, just as in the case of an ordinary steam-driven direct-current compound dynamo. At the same time the field of the alternator will require a slight adjustment, by means of switch D, in order to ensure its taking the minimum possible current, as indicated on C_1, for the particular load in use. This adjustment, however, would be very slight in the case of a coreless disc alternator, and if the field is once set at the best value for half load it can probably be left unaltered from no load to full load without much loss.

2 If the alternating-current side is to act as the generator, leave switch A in the dotted position permanently and weaken the direct-current shunt by means of G until the desired load is given out by the alternating-current side, at the same time suitably strengthening the alternator field by switch D. If the series winding of the direct-current side is not to be cut out when the machine is acting as a motor, the only alteration required will be in switch A, which will be an ordinary double-pole switch without special contacts, and it will make the full-line connections permanently. It will be seen that, owing to the presence of the equalising bar, no reversal of current through the series winding will take place when the direct current machine is converted from a dynamo into a motor.—Q.

[Other replies to Question No. 811 will be given in our next issue.—ED. *E. E.*]

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SEPTEMBER 29, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

817. A car weighing 10 tons when loaded gets out of control down an incline of 1·5 in 100, and moves at the rate of 20 miles an hour, and on the application of the emergency brake it is pulled up in a distance of 20 yards. What is the energy dissipated, the average brake power, the retardation, and the time taken in pulling up?—A. D.

818. I am anxious to study the wave forms in various parts of an alternating-current circuit. Can anyone describe the construction of a simple form of "oscillograph"?—FIFTYQUIDA.

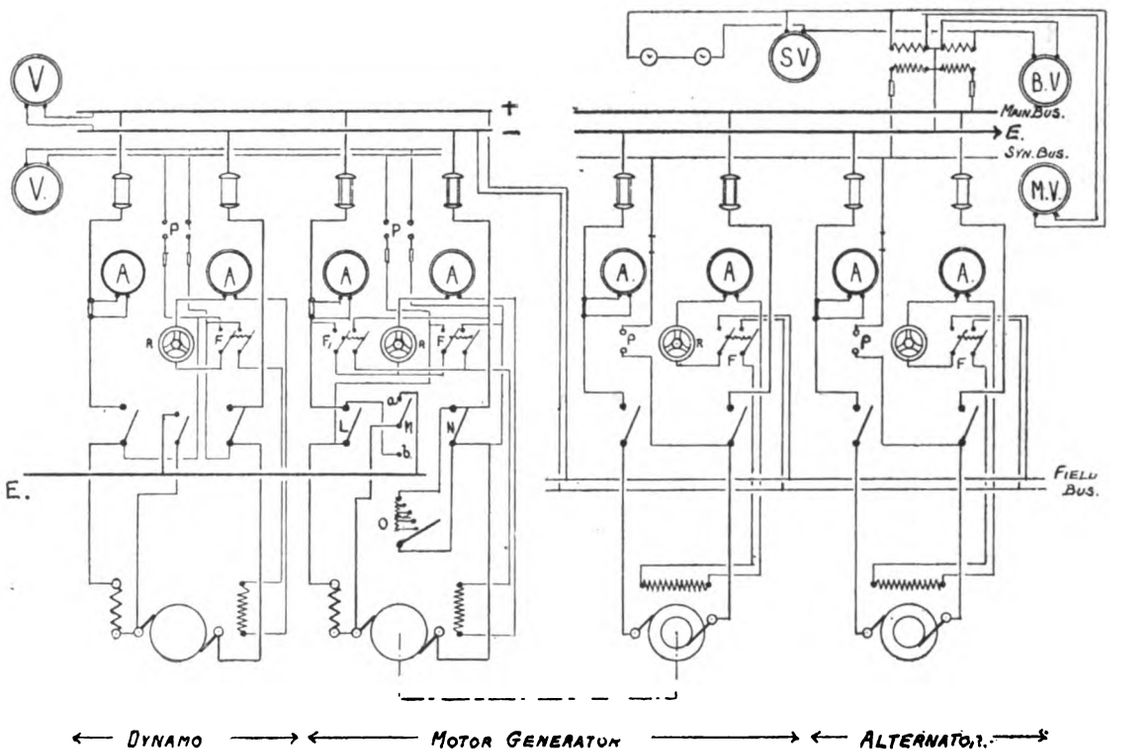
ANSWERS.

Question No. 811.—It is desired to instal a motor-generator of 50 kw. capacity for interconnecting an alternating-current 2,000-volt 76 ~ system with a direct-current 460-volt system. The alternators are of the ironless core type, and the dynamos are compound wound. Describe the controlling arrangements for the set to be started up as a motor from the direct-current side, but to run either as an alternating-current or direct-current generator in parallel with the existing plant. Give a diagram of the necessary connections.

Answer to No. 811 (*awarded 7s 6d.*).—In providing the controlling gear for such a small unit as a 50-kw. motor-generator, one needs to consider the question from, among others, the standpoints of (1) reliability; (2) cost; (3) utility. The relative importance of the second item will depend upon the size of the station, but in any case it should bear a due proportion to the cost of the set itself. Again, while it would probably be desirable to make it conform to the rest of the switchgear, yet none but necessary apparatus should be included, on the score of cost. Let us assume a small station with single-phase alternating-current plant, and with the general arrangement of the switchgear shown on the "dynamo" and "alternator" panels in the figure. Since the motor-generator is to be run in parallel with compound-wound dynamos, we will assume the generator to be compound wound, to include this case — though this is by no means necessary, and increases cost. On the panels marked "motor-generator" I have shown the essential connections for running such a machine coupled to its single-phase synchronous motor. It will be noticed that two field switches are provided for the generator. One is arranged to give the excitation from the 460-volt direct-current 'bus bars and the other couples the field on to the generator terminals. The use of these switches becomes apparent later.

O is a resistance switch divided into sections of such value as to limit the starting current to a reasonable amount, and whose exact resistance depends on the armature resistance of the generator and the supply pressure. Except for these and the double-throw equaliser switch, the gear is similar to the dynamo arrangements. P is merely a paralleling voltmeter plug. Only one of these is in use for either board, the alternating-current and direct-current plugs being sufficiently dissimilar to avoid their insertion into the wrong sockets.

The operation of starting is as follows: The 'bus-bar field switch of the generator is closed and the field brought up to a maximum. Switch O being open, M—the equaliser switch—is closed to *b*, this being connected to the + 'bus bar through a fuse. Next, O is closed step by step as the machine speeds up, when N is closed and O again opened full. The set is now to be synchronised with the alternating-current 'bus-bar pressure. Close the left-hand alternator (motor) switch and insert the paralleling plug. Now, with the field resistance all in, close the field switch and bring the motor excitation up to normal. The lamps and synchronising voltmeter will now be indicating; synchronise by reducing the generator field and parallel. The generator field switches must now be changed over



(this can be done without breaking the field so long as M and N are closed). Now open out M and N and close L and M on to *a*. Bring machine volts up to 'bus volts and close N, putting the motor-generator in on the load. To pick up load on the direct-current side increase generator field, and to pick up load on alternate-current side decrease generator field, which will then be acting as motor. No regulation can be effected with the single-phase motor field. This should be adjusted to give minimum current when motoring, and to maintain voltage when generating. A speed indicator should be provided on the motor-generator, for use when running the alternate-current load alone.

The necessity for self-exciting the generator becomes apparent when we remember that in the event of the fuses blowing it would be impossible otherwise to open the switches to replace a fuse without breaking the field. It should be noted that the two field switches should never be in together except when either M and N (M being in *b*) or L and N are both in, otherwise the armature becomes connected to the 'bus bars through the field switches. The field discharge resistances are shown separate, but need not be so. The field switches should clear the discharge contacts when "off," and a pause should be made on these

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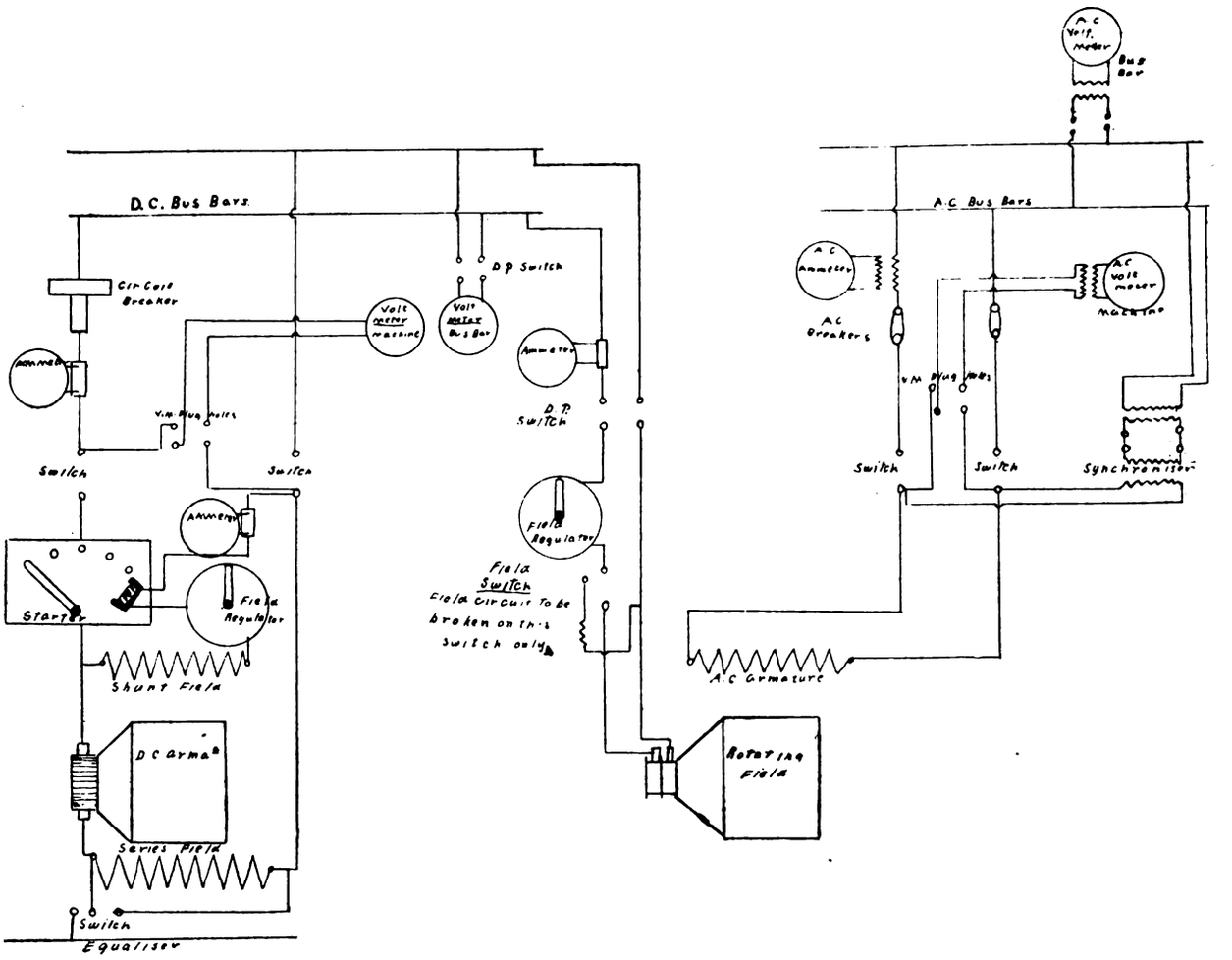
contacts when opening to give time for the field to collapse slowly.

Note.—By an error a fuse has been shown on the earthed pole of the alternators; this should be omitted as unnecessary.—PERPLEX.

Answer to No. 811 (*awarded* 7*s.* 6*d.*).—In this question the number of phases is not stated, and so the writer has assumed a single-phase plant. The diagram shows the connections for an installation which seems to meet the case. The following notes on working will serve to explain the diagram more fully than the references. On the direct-current side is shown a compound-wound machine designed to run as a shunt motor or compound generator. A throw-over switch is shown for operating the series field, which will allow of connection being made to the equaliser bar, or the series-field short-circuiting cable. This is necessary to enable the machine to run at an even speed as a motor, which is essential in the present case, for the compound winding will probably be designed for over-compounding when generating, and if left in circuit when motoring it would necessarily weaken the field as the load increased, and cause unsteady running. On the alternating-current side an ordinary synchronous motor is represented, with a rotating field excited off the direct-current bars, with a field regulator in circuit. Synchronising gear is also shown.



In starting up, the following is the method that should be employed. Short-circuit the series field, and close the circuit breaker and main switches on the direct-current side, then close the armature circuit through the starter. The exciting circuit on the synchronous machine must next be closed. Before closing the alternating-current switches, it is necessary to bring the machine up to synchronous speed, and also up to voltage. The former operation is performed on the direct-current machine by means of the field regulator shown in the left of the diagram, which adjusts the resistance in the field circuit, thus regulating the speed. Adjusting the alternating-current voltage is performed on the exciter field regulator, shown in the centre of the diagram. When the voltage and speed are correct, the alternating-current main switches may be closed. To run the set as an alternating-current generator, the load regulation must be made on the exciter field regulator, increasing the exciting current, causing the machine to take up its work. To run the set as a direct-current generator, switch in as directed above, and regulate the load on the direct-current machine field regulator, increasing the field current, causing the voltage to rise, and the machine to take the load. When a small load has been put on the direct-current machine (working as a generator) close the series field switch on the equaliser bar, when the machine will be working as a compound generator. If the machine is working on a traction or other variable load in parallel with compound generators, some difficulty may be experienced in paralleling on the alternating-current side, due to voltage variation on the direct-current bars. In place of the ordinary synchronising lamp a synchroscope would be advisable, as ready indication is given of the speed of the incoming machine, whether too fast or too slow.—E. P. A.

Answer to No. 811 (*awarded* 5*s.*).—The following is a description of plant that has been working satisfactorily for the last three or four years. The step switch shown in the diagram is out of proportion to the main switches, but this is to emphasise it as the querist desires. It is advisable to start up the machine as a shunt motor; this will necessitate a short-circuiting switch for the series coils. If starting up compound, there should be an equalising bar fixed so that any two machines required to be run in parallel can be connected on to it. The top contacts of the mains switches are connected to copper strips, Z, which run vertically up the board, and can be plugged on to any 'bus bar. The shunt coils and the synchronous motor field leads are also connected to these strips. Before starting up see that the field resistance is all out, making the field as strong as possible. For starting, a step switch is used, the resistances between the contacts being able to carry about one-third of the full current for a minute or two. (The first coil of the resistance is slightly thicker than the others.) The length of time the switch is kept on each step is determined by watching the ammeter in circuit. As the machine gathers speed and the back E.M.F. rises, the current will drop to a very small amount. When the step switch is in the top contact, raise the speed of the

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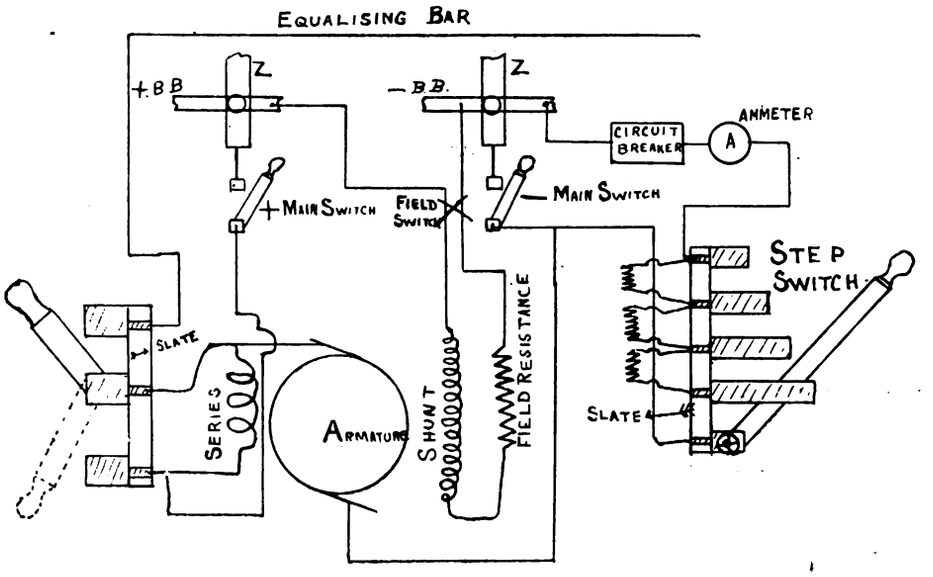
machine by weakening the fields, and make the fields of the alternate-current machine synchronise in, trip the circuit breaker (which is in circuit as a safeguard though not essential), and take out the step switch. The set is now running from the alternate-current side, and is to be paralleled in with the 46 ampere-volt system. This can be done with a paralleling voltmeter, which is placed in two contacts let into the switchboard. The contacts are connected through a fuse to the top and botton of the – switch, and when the voltmeter reads zero, showing that there is no difference of potential between the top and bottom of the switch, close the switch. The machines can now be used to generate either alternating or continuous.—F. B. M.



Answer to No. 811 (*awarded* 5*s.*).—Having a long acquaintance on a large power company with a considerable number of motor-generators, I can recommend the following method of starting up as one which will well suit the case. The great point is to start the machine up with a small amount of current, in order that there may be no kicks on the voltage of the lighting system. As the motor-generator in question is only a very small one, indeed, there is not much danger of any large kicks in voltage when starting up, as, in the first place, it will take little current to start, and, secondly, when started it will quickly come up to speed, and if there has been any drop or rise in voltage it will quickly recover itself. The best way of doing this is by inserting a resistance in between the lighting system and the motor-generator terminals. The best kind of resistance switch to use is the step resistance. I have found that the general idea of this starting resistance is not understood by those who are not acquainted with motor-generator sub-station work. In Fig. 1 I have given a cross-sectional elevation of the switch, and also a diagram of connections of the resistance. It will be seen that, on putting the starting switch on the first contact, all the resistance will be in circuit, and the machine will start up slowly, and when it has developed sufficient back E.M.F. the current taken will die down to a small amount, and the switch can then be advanced to the second contact, and so on. When, finally, the last contact is reached all the resistance is cut out, and the full voltage of the lighting system will be across the terminals of the motor-generator. Herewith I have given a diagram of connections showing fully the complete arrangement. The auxiliary starting circuit consists of (1) an auxiliary switch, (2) a circuit breaker or fuse, (3) the step starting switch described above, (4) an ammeter. There is an extra contact put on the equaliser switch of the machine (if it be not already there), so that when the switch is in one position it acts as an equaliser switch, but when in the second position it short-circuits the series turns on the direct-current side; the reason for this I will describe later.

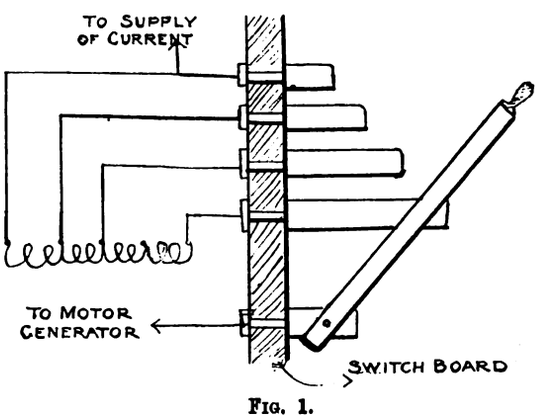


FIG. 1.

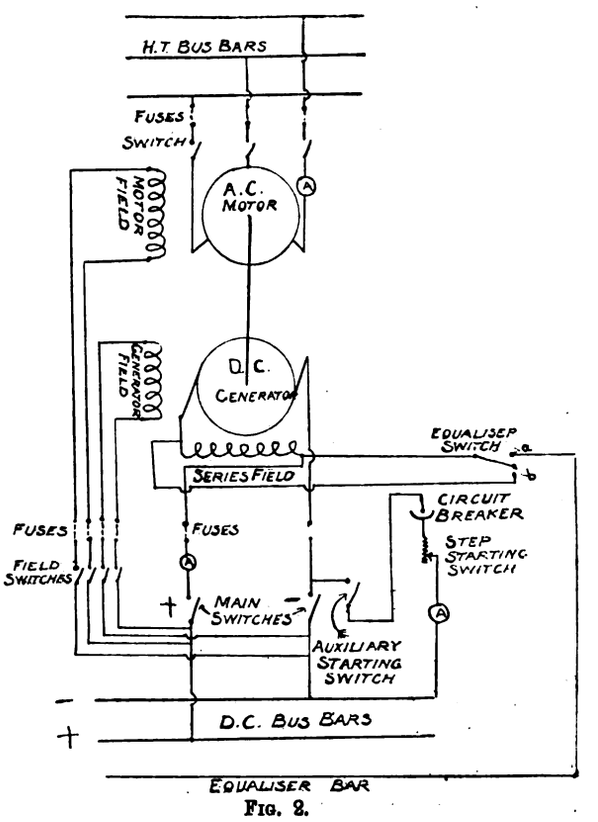


FIG. 2.

I will now go through the complete process of starting up the motor-generator, which can be followed on the diagram. First cut out all the resistance of the field of the generator, put in the field switch. We must have as strong a field as possible in order to start up slowly. Now, always on starting up *the series turns must be short-circuited*, or the starting current will weaken the field and the machine may run away, so put the equaliser switch in its proper position for doing this. Now put in in order the following: positive main switch,

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auxiliary switch circuit breaker. We are now ready to start up the machine. I may here say that a fuse may take the place of the circuit breaker, but the latter is the more useful, as the only time it is likely to come out is, perhaps, in a shut down, when we are in a hurry to start up and have been too quick with the starting switch, and it will take a considerable time to replace the fuse. Now put the step starting switch on its first contact, and the machine will start up. Note on the ammeter when the starting current has died down and bring the switch up on to the second contact; repeat this till all the resistance is cut out. Then weaken the field by means of the field rheostat (not shown in diagram) until it is near synchronous speed. If the motor is just an induction motor, then the high-tension switch may now be put in. If it is a synchronous motor, put in motor field switch, raise volts to the voltage of 'bus bar, and synchronise in the usual way. Then trip the circuit breaker in the starting circuit, and take out step and auxiliary switches, parallel in with the negative main switch in the usual way, first of all compounding the machine by putting the equaliser switch in its proper position. Thus the operation of starting up has been performed.

There is one observation I must make, and that is when the motor-generator is to be used for converting direct into alternating current, the series turns on the direct-current field *must be short-circuited*. The reason for this is obvious. We shall weaken the field by passing the current round the series turns, as they are then in opposition to the shunt turns on the machine.—ERNEST P. HOLLIS.

Question No. 812.—The owners of an isolated low-tension direct-current lighting and power installation in the colonies, supplying current to about 50 110-volt motors, varying in power from 1 h.p. to 55 h.p., are anxious to establish a repair shop on the premises, equipped with the necessary plant to effectually carry out all winding and repairs due to breakdowns and ordinary wear and tear. The motors are all of the four-pole type by various British manufacturers. Describe the most modern appliances for this class of work, with special reference to the possibility of manufacturing commutators at a reasonable outlay.

Answer to No. 812 (*awarded 7s. 6d.*).—In this question I assume that "G. F." does not wish to go to any unnecessary expense with his workshop, therefore the following tools will be absolutely necessary. First of all you will require a lathe—this should have back gears, screw-cutting, and traversing arrangement. The diameter of the largest armature would be helpful in this question, but I will suppose that the lathe centres are 7in. from the bed; this means that if anything more than 14in. diameter is to be machined on the lathe, it will require the headstock, poppit, and tool rest to be packed up (which is very common in practice) with wood, or, better still, to have castings made and machined to fit the bed. This would come cheaper than having a larger lathe, also being more convenient for the smaller work. Now, when a lathe is packed up as described above, it generally puts the traversing arrangement out of action, owing to the wheels not meeting. This may be overcome by running a small flat belt off the driving wheel on to the driven, the only difference being that the direction of traverse will be reversed. The next thing you will require is a drilling machine with small drill chuck and set of drills. The machine I would recommend is one by Barnes and Co., which stands about 5ft. 8in. in height, having a traversing arrangement and taking any size drill from $\frac{1}{16}$in. to about 1$\frac{1}{2}$in., and capable of drilling anything up to 3ft. in height. You will also find a hand drilling machine very useful for doing small jobs without taking a machine to pieces. Next, you will need several sets of taps, ranging according to size of screws on machines; also screw dies. The latter need not go above $\frac{1}{2}$in. diameter, and any larger screws can be made on the lathe providing you get a set of chasers for finishing these larger sizes after screw-cutting. A small stock of standard bolts and nuts will be found very useful, and also a small quantity of hexagon steel of various sizes for odd sizes of bolts and nuts. A small shaping machine would certainly add to the convenience of the workshop, but is not absolutely necessary, as such jobs as slotting and putting keyways in shafts, etc., can be done on the lathe. The lathe may also be used as a winding machine for field-magnet coils in the following manner. Arrange the coil former in the lathe so that it runs fairly true, fix a small groove pulley in the tool rest to guide the wire on to the former, then traverse the guide pulley along by means of the screw-cutting wheels, which are easily calculated. For example, suppose the wire to be wound is 1mm. diameter, then wheels capable of cutting 26 or 27 threads per inch would do, thus allowing a little for insulation. The direction of traverse would have to be reversed for the backward journey, but this is generally a very simple matter. You will also have to be prepared for the burning out of armature coils, and I think the following would be advisable: get three or four finished coils for each size of armature from the makers of the motors; then, if any breakdown in this respect occurs, it is only a simple matter to remove the burnt coil and insert a new one. Probably the worst job will be winding the wire bands on the armature again, but this is not a long job if done on the lathe. The following sundry tools will be found necessary: hacksaw, tap wrenches, various sizes and shapes of files, three-jaw self-centering chuck and carriers for lathe, a small portable forge for forging tools for lathe, etc., an emery wheel about 6in. diameter and $\frac{3}{8}$in. wide, leaving unmentioned such tools as hammers, chisels, etc., which are absolutely necessary.

Now as regards commutator making. The writer does not think it advisable to attempt making them all through, but rather to buy the bars ready shaped (as shown in Fig. 1), and build them up yourself. The uniformity in thickness of the mica insulation is a very important item.

FIG. 1.

This should be ganged for thickness and cut to size before commencing to build. You may then start in the following manner: Turn up a piece of hard wood to the same diameter as the inside of commutator to be built, erect it vertically on a flat surface; then start to build the segments up around it, taking care that all the mica used is sound, otherwise it will undoubtedly cause endless trouble. When the desired number of bars are all built round, get two steel bands (as shown in Fig. 2), place them round the commutator, and tighten up slightly.

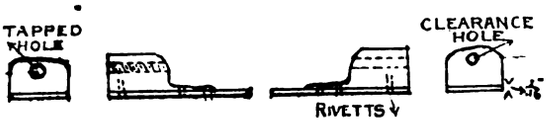

FIG. 2.

The wooden centre can now be removed, after which the bands must be tightened up as much as possible. The commutator is now ready to have its ends turned up to fit the end plates. When this is done the ends can be bolted on in the ordinary manner, the bands removed, and the commutator put on a mandrel and turned up over the top. Now comes the end connections. These may be of several forms: (1) If the armature is wound with round wire, the ends of the segments can be drilled, the ends of the wire inserted and soldered in. (2) If wound with rectangular bars a spider will have to be fitted to the commutator, and may be done in the following manner: Drill a small hole in each commutator segment the required distance from the end and not more than $\frac{1}{4}$in. deep. Again put the commutator on a mandrel in a lathe, and with a thin parting-off tool fixed horizontally in the tool-holder proceed in the same way as you would in slotting a shaft on the lathe—viz., by winding the tool forward and backward, putting on a small cut each time before the forward stroke. I have suggested the method of slotting to do away with the expense of a milling machine. The last thing is to solder on the copper connections, this being a very simple matter. You will find a good illustration of a spider in Maycock's "Electric Lighting and Power Distribution," p 375, vol. i.—E. W.

[Other replies to Question No. 812 will be given in our next issue.—ED. *E. E.*]

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OCTOBER 6, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

819. A three-phase plant generates current at 440 volts for power and transformed to 120 volts for lighting. The lighting circuit was originally wired for 240 volts continuous current. Could the transformers be dispensed with, and current taken from the mains and neutral point earthed, to obtain more light at about 250 volts? And taking, say, 100 amperes on each phase, what would be the current in the neutral wire?—STEAM-TRAP.

820. Two single-phase induction motors of exactly same horse-power but by different makers, when doing similar work require exactly same current and same voltage. Wattmeter, however, on motor No. 1 registers only two-thirds that of meter on No. 2. (1) Is this because power factor of first motor is only two-thirds that of power factor of No. 2? (2) As current × voltage is much greater than watts paid for, who pays for lost energy? (3) Does not the above point to the suggestion that if two motors of similar amperage give same torque, but that one has lower power factor than the other, the lower power factor one is cheaper to run from consumer's standpoint?—AMATEUR.

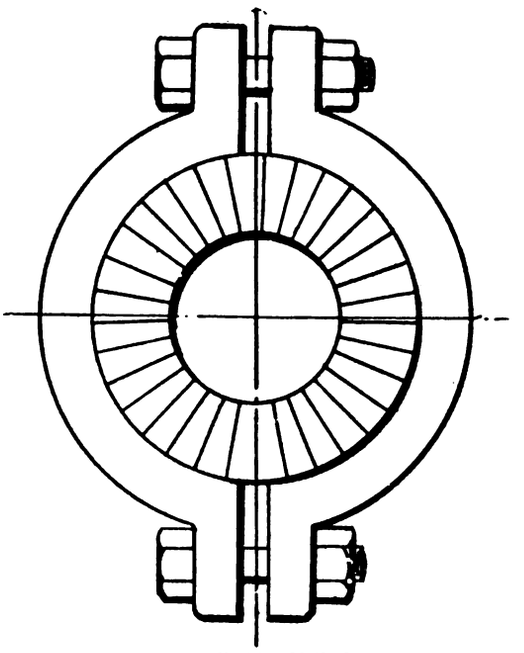
ANSWERS.

Question No. 812.—The owners of an isolated low-tension direct-current lighting and power installation in the colonies, supplying current to about 50 110-volt motors, varying in power from 1 h.p. to 55 h.p., are anxious to establish a repair shop on the premises, equipped with the necessary plant to effectually carry out all winding and repairs due to breakdowns and ordinary wear and tear. The motors are all of the four-pole type by various British manufacturers. Describe the most modern appliances for this class of work, with special reference to the possibility of manufacturing commutators at a reasonable outlay.

Answer to No. 812 (*awarded 7s. 6d*).—In a repair shop of this description, generally the work has to be executed with the utmost speed, but it does not call for any high-class automatic tools, such as capstan lathes, etc., and, further, need only be a small shop. As British-made motors are used throughout, there will not be much cause for repairs due to faulty material or workmanship. The necessary equipment would be approximately as follows.

Machine Shop.—Back-geared, screw-cutting lathe large enough to accommodate largest armature, fitted with surfacing and traversing motion. Provided with a large gap, this machine may be used for all sorts of boring and turning, and fitted with a revolution counter fixed on the headstock it makes a suitable machine for field-coil winding, the counter enabling the turns per coil to be ascertained. Suitable supply of tools for above. Small 6in. centre lathe, screw-cutting and traversing motion suitable for small brass and iron turning, etc. Vertical pillar drilling machine with swinging table and automatic feed. Small sensitive bench drill. Plain vertical milling machine, rising and lowering table, automatic feed, etc.—this machine could be used for milling, surface milling, metal sawing, and cleaning out commutator lugs, etc. Ten-inch or twelve-inch double emery grinder, grindstone, etc. Portable gantry crane for lifting work in and out of lathes, etc., and suitable benches and vices.

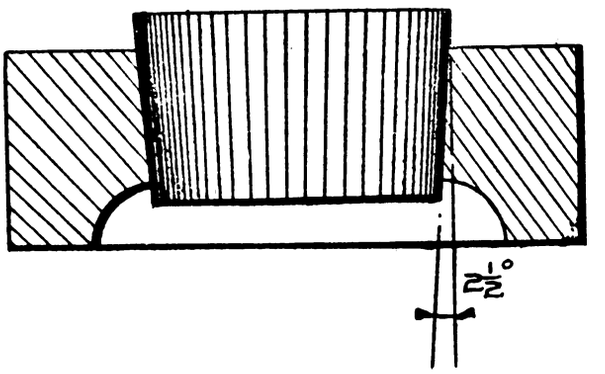
Test Room and Winding Shop.—The above shop should be kept clear from the shop dealing with swarf metal, etc, and should be equipped with the following apparatus: winding benches, cast-iron armature trestles, armature and field-coil formers, sheet-iron oven for drying and baking, heated to a temperature of, say, 100deg. to 180deg. F., and gas stoves suitable for soldering irons. All banding of armatures may be done in the lathe. A low erecting table and test bed should be constructed of about 4in. by 4in. timber, on which motors can be conveniently lifted. A small switchboard should be fixed for testing purposes near the test bed, and provided with the following instruments: ammeter, voltmeter, main double-pole switch and fuses,



Split Ring Method.

and two or three branch switches and fuses. A Wheatstone bridge should be provided, also an Evershed's 220-volt "Megger" testing set, small ammeter, and sundry instruments. The whole of the machine tools should, preferably, be driven from shafting which in turn is driven from a motor.

Commutator Construction.—It is assumed that commutators will not be manufactured in any quantity, but only for the purpose of replacing a worn-out or damaged one, therefore a large outlay will be unnecessary. The most substantial commutator is made with the aid of a hydraulic press.



Taper Die Method.

The necessary section of hard-drawn copper strip should be obtained and sawn off to a gauge, allowing for machining, endwise, and tapered on the broad edge about 2½deg. When all the sections are assembled, with ·03in. mica between, they form a cone with the required taper for forcing into a steel die by hydraulic pressure. This die should be of steel, turned all over and bored to the same taper, the bore being just large enough to allow the small diameter of commutator to enter. The mass should then be pressed home and the complete die put in a lathe for the purpose of machining the copper—that is, turning the V for the $\frac{1}{16}$in. mica end rings and boring—the malleable sleeve and washer being tightened up and the complete

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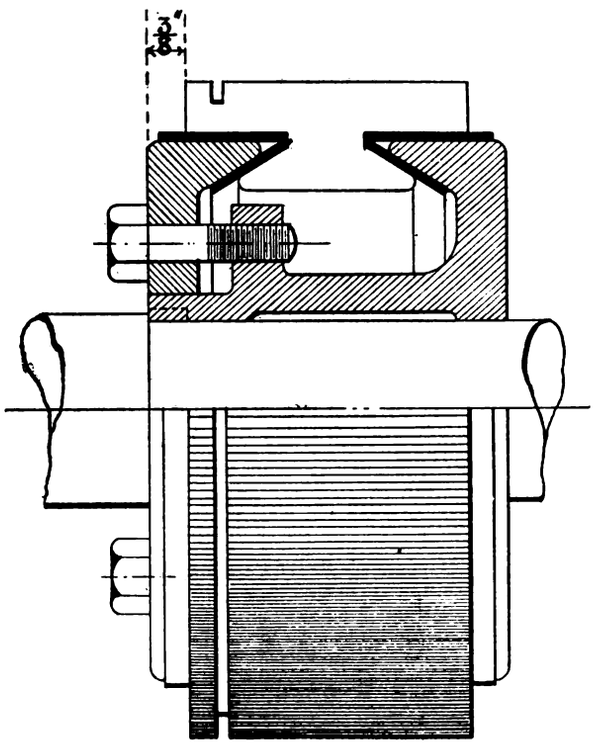
commutator removed by hydraulic pressure, fixed on a mandrel and turned up, the slotting being done between the centres of a milling machine. There are other cheaper methods of making a commutator, such as gripping the bars between a wrought-iron split collar, as shown, the whole lot being put in the lathe and machined, but it does not make such a sound job and the bars are liable to sink. A finished armature should always have the commutator ground up dead smooth by an electrically-driven emery wheel fixed in the lathe tool box. These wheels are keyed direct on to the motor shaft, and the motor can be run from an ordinary



lampholder. The sketch herewith shows the construction of a very reliable commutator if built in the manner described above.—PETER DEAN.

Answer to No. 812 (*awarded* 5*s*).—A small shop, or even a corner of the fitting shop, should be set apart for these repairs; cleanliness and tidiness are no mean adjuncts in connection with the renovating of electrical apparatus. The most essential tool is a lathe; this lathe need not necessarily be normally large enough to take the largest armatures, as iron or wooden packing pieces can be placed below the heads when these larger armatures are under repair. If the lathe is arranged for screw-cutting, *any* work connected with repairing the motors can be accomplished. It would be convenient to have two lathes, one much smaller than the other, but this would increase the first cost. A small drilling machine would be useful, but in order to keep down the first cost it can easily be arranged to do any drilling in the lathe. By means of the lathe commutators may be turned and new bands wound on the armatures, also bent spindles may be straightened and new ones turned. In the hands of a competent workman a lathe can be made to do almost anything. A number of drums and stands should be provided, so that the cotton-covered wire may be run through varnish, and thus prepared for winding on armatures or magnet bobbins. A low bench, with suitable V blocks, will be wanted for rewinding armatures. If the armatures have former-wound coils, formers should be provided for each size, and care taken to have spare coils ready for replacing faulty ones. There should also be formers for winding magnet coils: if these coils are on bobbins, there should be wooden carriers to enable the bobbins to be placed in the lathe for rewinding. Unless care is taken to support some magnet bobbins, they are liable to be forced out of shape during winding, and are thereby prevented from being slipped over the magnets. A small press will be necessary in order to repair or make new mica rings for the commutators. Iron mandrels and clips will be required to build up commutators; by means of several layers of paper or metal liners one mandrel may be made to do duty for several sizes, and in like manner liners may be used with the clips.

To build up a new commutator is quite a straightforward affair. Some considerable skill, however, is required to replace a faulty section in a fixed commutator. To perform this operation, first unsolder the armature wires from the lug of the faulty section and twist several turns of wire round the commutator to hold sections in position; then unscrew nuts and remove the outer insulating ring. By means of a thin knife then slacken and withdraw the faulty section. Replace with a new one, tighten up rings, solder in wires, and file or turn the new section down to size. Patterns for sections of the various commutators should be in the store, so that a new set of castings can be obtained immediately if required. A small forge and anvil for iron work, also means for heating soldering irons, must be provided. A testing set for measurements and a linesman's detector should also form part of the kit. If there are any white metal bearings, a stock of metal, with pot and ladle, will be necessary for re-running bearings. Another item will be a fitter's bench; this should be provided with two vices, one a strong, 6in. the other a small vice for light work. For repairs on the larger-sized motors a jack will be useful, also some lifting tackle. There should also be blocks of wood wedges, etc., for use as "packing" when taking out and in the heavy armatures. An assortment of screws and bolts, brass and iron rods, ebonite, mica, armature and magnet wire, solder, etc., should be in the store. With regard to the brushes and brush gear, endeavour should be made to keep as nearly to one type as possible, so that fewer spare parts will be necessary; try and eliminate all oddities, and replace with a common form. As to the possibility of making commutators cheaply, that is pretty much a personal equation. Have good metal patterns and obtain sound castings. To build up the commutators quickly and well demands skill, and a detailed description would make this answer too long, but "G. F." may be assured that commutators can be made cheaply with quite simple appliances. M. M.

Answer to No. 812 (*awarded* 5*s*.).—In any repair shop, such as is referred to in the above question, the choice of suitable machinery depends, to a very large extent, upon local conditions and local requirements. Thus, it is obvious that where motor repairs are not very numerous, a multiplication of appliances would lead to a dead loss—the investment would produce but little return. Whilst, on the other hand, if the repairs are numerous, it would be a distinct advantage to equip the shop with appliances which would facilitate the execution of *any* repair. Of course, the nature of the repairs required is a very important factor to consider, and it is one which should not, by any means, be disregarded.

From the above question it is inferred that the chief repairs which will have to be effected are those on the commutators of the motors, although these may not constitute all the work of the shop. In the opinion of the writer, the following are the principal appliances required in order to satisfy the conditions of the question: lathes, milling machine, drilling machine, and assembling rings. The lathes should be two in number, one being for the smaller sizes of motors, and the other for the larger sizes. The exact size of each lathe should be in due proportion to the size of the motors, or else facility will not result. The milling machine should be obtained for the purpose of tapering the copper segments for the commutators, these segments being either hard-drawn or drop-forged. The drilling machine is useful, though not absolutely essential, and it could, therefore, at a pinch, be dropped out of the list. The assembling rings are for the purpose of facilitating the building up of the commutators, because without their use, or the use of their equivalent, the process of commutator building would be a long and tedious one, and it would not be attended with the best results. Several sizes of these rings, however, must be obtained, as each size of commutator will require its own separate assembling ring. One type of assembling ring, which could be conveniently used, consists of two concentric rings of stout iron. The outer ring is a continuous, unbroken ring, whilst the inner ring is made up

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of a number of segments, eight or twelve being a very convenient number. Each of these segments has a couple of pins screwed into it, which pins project outwards, and fit easily, yet not too loosely, into holes drilled in the outer ring. The assembling ring is placed horizontally, and the copper segments and mica plates are built up inside the inner ring. When all the segments and plates have been fitted in, the segments of the inner ring are forced inwards by means of screws in the outer ring. This operation naturally results in causing the copper and mica sections to fit together more closely, and the built-up commutator can then be fitted on to the spider of the armature, and the operations of insulating, clamping, and surface turning can then be completed.

Should there be much rewinding of armatures to be done, the use of formers will facilitate the operation of winding. If all the motors are of standard types, to procure suitable formers will not be very difficult.—G. W. BURLEY.

Question No. 813.—A works is supplied with current from a power station with continuous current on the three-wire system, with 500 volts between the outers. It is required to split this up further at the works, for the purpose of speed regulation of the motors driving the various machines, by means of "shunt" or "shunt" and "armature" regulation combined. The voltages proposed are as follows: between outers 500 volts, between outer and middle wire 250 volts, between middle and intermediates 60 volts, between intermediates and outers 180 volts, which would enable the motors to be supplied with voltages of 500, 310, 250, 180, and 60. Show clearly how this could best be done. Further, would it be to the advantage of the company owning the works to put down their own generating plant for lighting and power, and, if so, what arrangement of generator would be best to adopt, without the use of balancers?

Answer to No. 813 (*awarded 7s. 6d.*).—It may be as well to point out that the voltages as mentioned in the question cannot be obtained, since the sum of the voltages between neutral and intermediate and intermediate and outer must equal that between neutral and outer. If the first-mentioned voltage were 70 (instead of 60), the condition would be fulfilled, since 70 + 180 = 250. Assuming 70 volts to be the correct figure, the simplest method of splitting up the voltage is to instal a dynamo giving continuous current at 140 volts. This machine should also be provided with slip-rings connected to the windings, so that it can give off three-phase current. These slip rings are connected to a suitably designed choking coil star connected, the centre point of the star being connected to the neutral 'bus bar, as shown in Diagram 1. The method of driving the dynamo is immaterial—a small steam-engine or electric motor could be used, or even a second winding for 500 volts wound on the same core and connected to 'bus bars. In this case, however, the machine would require two commutators, and probably the best method is to drive by an independent motor. The capacity of the dynamo will, of course, depend on the number of machines supplied by it at any time. With the connection shown on Diagram 1, voltages of 70, 140, 180, 250, 320, and 500 could be obtained, the current obtaining a return circuit through the choking coil and slip-rings of the dynamo in the case of the voltages 70, 180, or 320.

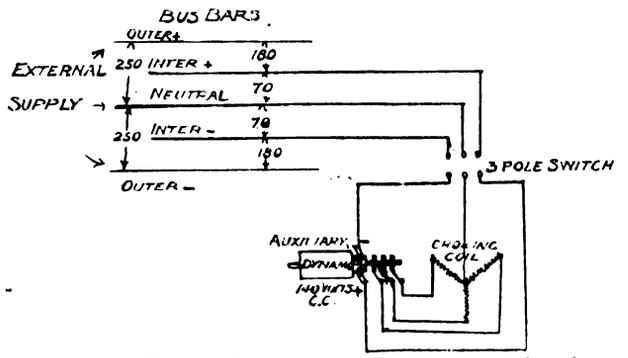

DIAGRAM 1.—Dynamo, 140 v. c.c., 91 v. three-phase. External supply, three-wire c.c., 500 v. outers.

The question of private generating plant depends entirely on the prices at which the works could produce or buy power. Many modern works produce their own power at will under 1d. a unit with a moderately good load factor, this price covering interest and depreciation. If the company installed their own plant, it would be best to instal a dynamo with two independent windings on the same core, one giving 500 volts, one 140 volts, etc. Each winding would also have independent slip-rings, and these would be connected to suitable points on the choking coil, as in Diagram 2. If more than one generator was running at once, each one should have an independent choking coil, with neutral connected to neutral 'bus bar, as this would save synchronising the generators with each other. The generators could be driven by any convenient source of power, and would, of course, have to be paralleled on the continuous-current sides. A very similar method of supply to the ones described has been installed by a firm in the North, and is used to supply motors driving machine tools, etc. There are various other combinations of the same principles which can be used to attain the same results, but the methods described above are, perhaps, the simplest, and require the least outlay in plant.

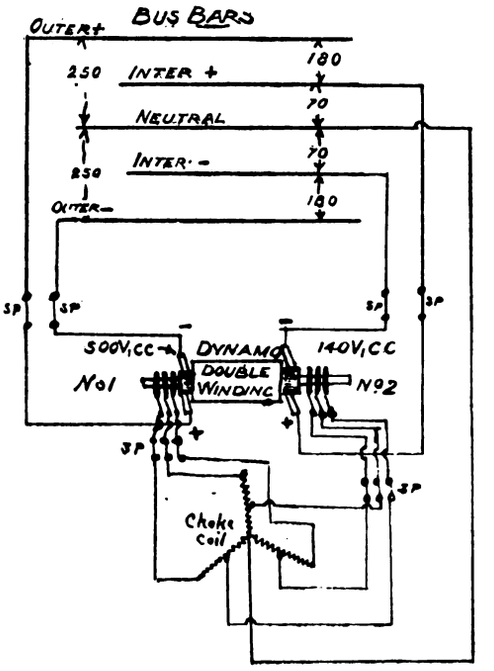

DIAGRAM 2.—No. 1 winding, 500 v. c.c. and 325 v. three-phase; No. 2 winding 140 v. c.c. and 91 v. three-phase. Single shunt-wound field excited any convenient way.

It must, of course, be understood that the function of the three-phase choking coil is to take the out-of-balance current only, so that the capacity need only be small. The explanation of the choking coil's action in passing the out-of-balance continuous current has already been dealt with in Question No. 745, which appeared in these columns some months ago.—ROTARY.

Answer to No. 813 (*awarded 7s. 6d.*).—In this question the problem set is to convert a three-wire system into a five-wire system. Such five-wire systems are often used with printing machinery on a small scale, and, of course, on a large scale at Manchester. There are two methods by which the voltage may be sub-divided at the works: (1) By using a five-wire balancer consisting of four machines all on the same shaft and wound for the voltages given. This balancing arrangement is shown in Fig. 1. (2) By using a battery of about 300 cells. (This is the number our company use for working a large shipyard.)

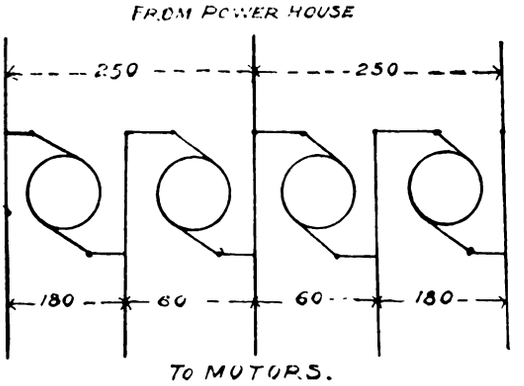

FIG. 1.

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These cells are tapped in the requisite manner for supplying the voltages desired.

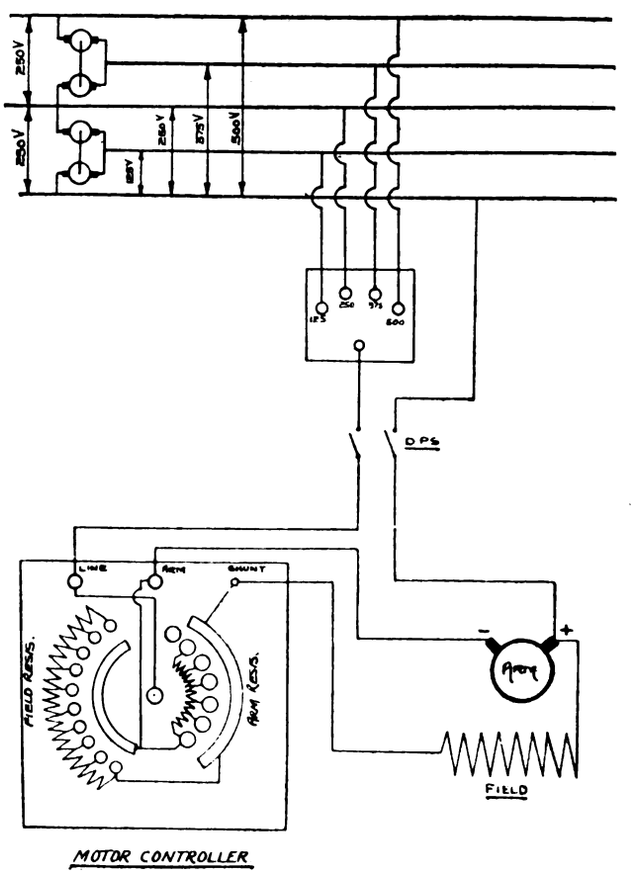
Either of the two above methods will do as far as working is concerned. The battery will, of course, cost more than the balancers. I think, however, that the other conditions of the question will help to decide this. The point now to be decided is, should the company owning the works put down its own plant for lighting and power, or take it from the power company? I note that before the change is made to the five-wire system they are taking it from the power company, and not generating it themselves. This point cannot be decided one way or another without further data on the subject. It depends entirely on the local conditions, a few of which I have enumerated below. They all decide the price at which the power company will supply the power: (*a*) the amount of power taken by the works; (*b*) the load factor. This will depend on whether the works run all night or not—a very important point, indeed.

It appears, however, that the price of the power is fixed, and that unless large extensions have taken place, which will increase the amount of power taken, the price of power will not be altered. Now, if this price be high, it may pay the works to put down their own plant, but not unless, and even then I do not think it would pay them unless they took a fairly large amount. Let us consider a hypothetical case. Suppose the works took an average load of 400 amperes at 500 volts = 200 kw. This would be a fairly large works. They should get their power for a comparatively small amount, say $\frac{7}{8}$d. per unit. I do not think that they could generate it themselves at less than 1$\frac{1}{4}$d. to 1$\frac{1}{2}$d. per unit, and I think that, except under exceptional circumstances necessitating an exceedingly high charge by the supply company, it would not pay the works to generate it themselves. Now, in my opinion, it would pay the works to put down a battery for sub dividing the voltage as required. There are two reasons for this. The first of these is this: during the winter months the works load and the lighting load would overlap at the power station. Now, if the works company put down a battery they could discharge it during these times of maximum load at the power station. They could then make an agreement with the power company not to take any power during these times, all the power being taken from the battery, which would thus perform a double purpose. The power company would then reduce their price of power—it would pay them to have this arrangement, and without the slightest doubt they would be very pleased to do it.

The second reason why it is better to instal a battery is that it would come in useful during a "shut down" at the power station. These happen even in the best-appointed places, especially on high-tension systems, and they are very costly, since they lay the whole works idle until the power is put on again. Indeed, I know of a case in which the main reason for installing a battery was to keep the works going during any "shut down" which might occur. I think, therefore, that it will pay the works to take the power company under the conditions given above, and use a battery for sub-dividing the voltage, running the works off the battery during times of maximum load at the power-house, and thereby obtaining a reduction in the price of the power. An attempt should be made to get the power company to put down the battery themselves, and, all things being considered, I think they would do it for only a small increase in the price of the power.—ERNEST P. HOLLIS.

Answer to No. 813 (*awarded* 5*s.*).—The speed control of electric motors is a very interesting subject, and has been widely discussed by many engineers both in England and America. Should the interested party require valuable information upon this subject, I would refer them to some papers read at the meetings of the American Institute of Electrical Engineers, contained in vol. xx, 1902, of the *Proceedings*. I note that the works in question possess a 500-volt three-wire supply, and require further subdivision, but I do not see how this can be accomplished without the aid of balancers in some form or other. It practically amounts to a five-wire distribution with uneven voltages—namely, 500, 320, 250, 180, and 70 volts—and specially-wound balancers or storage batteries would have to be used.

The diagram herewith represents a five-wire system with standard voltages—viz., 125, 250, 375, and 500 volts—these being obtained by using two balancers as shown, all intermediate speeds, both up and down, being secured by armature and shunt regulation with the special controller. Care must be taken to see that the motors will stand an increase of speed by field resistance without sparking. It is generally agreed upon that speed control by ohmic resistance in the armature circuit is very wasteful, and should be avoided wherever possible. I believe a more suitable method of attaining the same end is to instal variable-speed motors, with a 2 to 1 speed ratio, across a three wire system, and obtain intermediate steps with field regulation only. A 4 to 1 ratio is thus secured without any C^2R loss.



MOTOR CONTROLLER

The method of connecting will be as shown in sketch, except that three wires are used in place of five. The motors should be evenly distributed on either side of the system, and in the case of outside supply the necessary balancers will be located at the generating station. Very satisfactory motors with a 2 or even 4 to 1 ratio of speed may be obtained, and I believe the extra outlay on these would come well under the cost of installing a complicated five-wire system throughout the works, together with balancers. In addition to the controller, a switch for connecting the various circuits to the motor must be used; also a double-pole main switch. It will be noted that no overload or "no-voltage" attachment is shown on the controller, but these may, of course, be added if required.

With reference to the latter part of the question, as no figures whatever are given, it must be left to the owner to decide whether or not he will instal his own generating plant, bearing in mind that a large reduction in the price of energy can be secured for an all-day load. Should a much finer speed variation be required, the well-known Ward-Leonard or teaser system of motor control might with advantage be considered.—P. DEAN.

[Other replies to Question No. 813 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
OCTOBER 13, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

821. In a certain power station it is desired to test a 700-kilovolt-ampere two-phase alternator, direct coupled to a triple-expansion Belliss engine, for the steam consumption—*i.e*, pounds of water—per kilowatt-hour. There is available a water resistance capable of taking 1,200 kw., if required. The set has its own condenser—steam-driven air and circulating pump. There is a feed tank 12ft. by 7ft. by 6ft., into which several condensers discharge, the temperature being from 80deg. to 120deg. F. The feed to the boilers being pumped from this tank through an economiser to the boilers (Babcock and Wilcox. Meldrum Koker stokers, and forced draught), the steam for the jets can, if necessary, be supplied from an independent boiler. It is not required to take into account the steam used by the condensing plant. It is proposed to run the test for five hours. Is this long enough? Please give full details of the usual method of conducting such a test, especially the best way of measuring the water at the hot-well, the various readings required, etc. Also name any good practical books dealing with engine and boiler tests (not American). The steam pressure at the engine stop valve is 170lb. with about 100deg. F. of superheat.—ELECTRON.

ANSWERS.

Question No. 813.—A works is supplied with current from a power station with continuous current on the three-wire system, with 500 volts between the outers. It is required to split this up further at the works, for the purpose of speed regulation of the motors driving the various machines, by means of "shunt" or "shunt" and "armature" regulation combined. The voltages proposed are as follows: between outers 500 volts, between outer and middle wire 250 volts, between middle and intermediates 60 volts, between intermediates and outers 180 volts, which would enable the motors to be supplied with voltages of 500, 310, 250, 180, and 60. Show clearly how this could best be done. Further, would it be to the advantage of the company owning the works to put down their own generating plant for lighting and power, and, if so, what arrangement of generator would be best to adopt, without the use of balancers?

Answer to No. 813 (*awarded 7s. 6d.*).—In this question neither the size of the works nor the kind of work turned out is mentioned, but it is evident that variable-speed continuous-current motors are considered necessary. The voltages into which it is proposed to divide the present 500-volt supply will allow of obtaining 500, 310, 250, 190, 120, and 60 volts. From Table I. we see that a minimum of 12 per cent. of the total voltage is obtainable. The difference in the voltage in changing from one step to the next is shown in the third column, and is expressed as a percentage:

	Voltage on the motor.	Per cent. of total voltage.	Difference of percentage for each controller step.
Table I.	500	100	
			−38
	310	62	
			−12
	250	50	
			−12
	190	38	
			−14
	120	24	
			−12
	60	12	
Table II.	240	100	
			−17
	200	83	
			−16
	160	67	
			−17
	120	50	
			−17
	80	33	
			−16
	40	17	

This, however, entails a five-wire distribution. The Bullock Company, of America, use a four-wire system with balancers, as shown in Fig. 1. The voltages obtained are shown in Table II. By this means a minimum of 16 per cent. of the total voltage is obtainable, and the steps are more equal throughout than in Table I. Moreover, there are only four wires used, as shown in Fig. 1. A proportionate division of the voltage can be made on the 500-volt system, but the figures obtained are not standard voltages. These multi-voltage systems, however, have the disadvantage that the switching arrangements are complex, and, further, that there is a danger of the machine slowing up whilst the motor is being switched from one voltage to the next. With "armature" or "series" regulation the speed of the motor will be high before the tool gets on the work, and will be lower when the tool is cutting. This is due to the voltage drop on the series resistance, which voltage drop varies with the load on the motor. These difficulties do not occur with shunt-controlled motors, which can be obtained with a speed variation down to 25 per cent. of the maximum, the efficiency varying 6 per cent. or less throughout the range at a constant power output. The rise of speed on such a motor would be 6 per cent. or less when the load was thrown off. Speed variation in this way can be obtained down to 17 per cent. of full speed. The points mentioned above have a bearing on the choice of a generator, but the primary consideration is the kind of work turned out of the shops, as this will determine the type of motor, which in its turn determines the type of generator. If the works be large, it is possible that there is a sufficient number of machines requiring a constant speed drive to warrant putting in an alternate-current supply and using induction motors. Speed variations are not obtained as efficiently on these as on the continuous-current shunt-controlled motors. In dusty places, or in an explosive atmosphere, a squirrel cage open-type motor may be employed. An enclosed continuous-current motor working under these conditions would be large for its output. In Messrs. Harland and Wolff's shipyard, owing to the various types of drive required, both continuous-current and alternate-current supply have been put down. The device is also adopted of having an engine to drive an alternating-current and continuous-current generator on

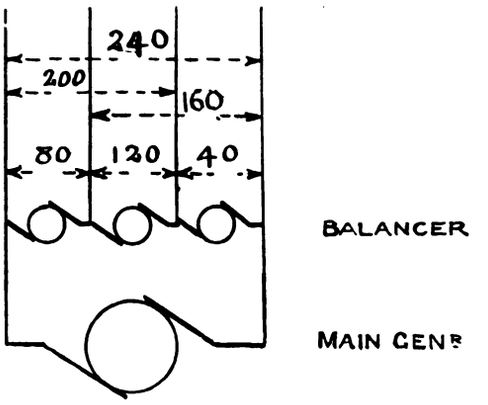

FIG 1.

the same shaft. There is also a synchronous motor-generator, which links together the continuous-current and alternating-current systems. When only the alternating-current generator is working, the motor-generator is driven from the alternating-current side, and supplies the small amount of continuous current required. When the continuous-current generator is working, the opposite conditions obtain. This arrangement is adopted, since at times of small demand the total alternating current and continuous current required may not be more than that which it is possible to supply from one engine. There are two engines arranged as above, and the third drives an alternating-current generator. As to whether it would be to the advantage of the company to put down its own plant for lighting and power, it may be mentioned that there are cases in which the saving due to electrical driving has been more than sufficient to pay for the lighting required. As the works are already built, there can be no saving in the actual fabric, but it should be borne in mind for future extensions that electric driving does not call for the heavy walls required by shafting transmission. This brings up the question of "individual" or "group" driving of the tools. No hard-and-fast rule can be laid down to cover all cases, but it is evident that with the individual drive, in which one motor drives one machine, the speed and output are independent of any other machine, and it may be worked up to its full capacity.

In "group" driving it is advantageous to group together on the one countershaft machines of the same size, speed, kind of work, etc. Seeing that the 500-volt supply is now available in the works, it is probable that the load factor is known, and this would form a basis in deciding as to the size of generators required. In deciding on the motors for individual or group driving, it is convenient to use a test

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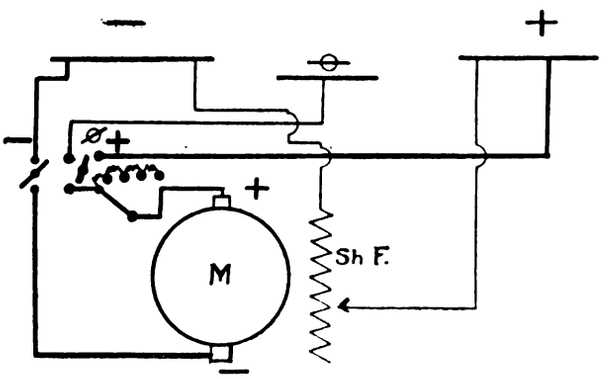
motor which is moved about from tool to tool. In this way, with the help of a recording ammeter and meter, much useful information can be obtained, which will prevent a motor being supplied which is either too large or too small for its work.

The above considerations should help to settle the question regarding the plant required, whilst actual details of the supply company's price for current and the cost of generating same in the works should settle the question as to a separate plant being put down.—L. S. S.

Answer to No. 813 (*awarded* 5*s.*).—The method of obtaining the speed regulation suggested by "Motor Control" is quite too complicated to be entertained. All that is desired can be now obtained by using the ordinary three-wire system, which, in addition, is far cheaper to instal and run than any multiple-wire system such as that described. If more particulars had been given as to the class of machinery it is required to drive, it would have been possible to give a definite scheme; as it is, only a general idea of what is best to use under certain conditions can be given. It is now found to be more economical to divide the machines to be driven into two classes: (1) those machines which run at fixed speeds not often varied, and (2) those machines requiring varying speeds and which require full power at all speeds. The first class are then driven from line shafts by a single (or according to the number of machines) or more motors, and are placed where head-room and space for operating overhead cranes is not required. The second class are run by separate motors to each machine, which may be placed anywhere it is convenient, and whose speed regulation is obtained by varying the field strength of the motor. The accompanying diagram shows the idea and



the method of obtaining the speed regulation. The positive neutral and negative bars are connected as shown to the main switch of the motor, M, and it will be noticed that one arm of the double-pole switch can be connected to either the neutral or positive side of the system. Sh. F. shows the variable shunt field. Now, suppose the motor to run normally at, say, 900 r.p.m. with full field strength and its armature connected across the outers, it will then run at 450 r.p.m. with full field strength and its armature across the one outer and the 'mid wire. Now weaken the field and bring the speed up to 900 r.p.m. again, when the armature can be switched across the outers, and the fields again strengthened to keep the speed at 900; and from this point it will be possible to weaken the field enough to bring the speed to 1,900 r.p.m., or even more, without causing destructive sparking. And it is due to the fact that motors can now be built to run between such wide limits of speed simply by varying the field, and at the same time not incurring the risk of sparking, that the old multiple-voltage system and methods of working with resistance permanently in the armature have been rendered unnecessary. As to it being more economical to generate power on the premises than buy it, as stated before, not enough data have been given to give a definite answer. If there is a steady load for eight or ten hours per day, and the demand is anything over 50 kw., a modern installation driven by gas-engines working from suction producers will, if the proper type of engine is used, give very economical results. Some tables of results actually obtained over prolonged periods of running, which I have by me, show the cost per unit generated to be as low as ·25d., including all charges, such as attendance, depreciation, etc., this being with plant of units of 30 kw. capacity and upwards. There would also be another advantage in having a separate generating station—viz, that the system could be operated at a lower voltage if the works did not cover a very large area, and motors of small capacity, wound for 250 volts or higher, are very much more liable to give trouble and have a lower efficiency and higher capital cost than motors wound for, say, 220 and 110 volts.—W. T. W.

Question No. 814.—In the brake equipment of tramway rolling-stock, the present tendency is to put the brake blocks below the centre of wheel. Why is this so? And if the brake has more power in the lower position, explain the reason.

Answer to No. 814 (*awarded* 7*s.* 6*d.*).—The great aim in the design of brake equipment is to obtain the greatest brake power in the shortest time. Herein lies the reason for having the brakes fixed on the top of the wheel. First of all let us imagine the brakes to be fixed on the top of the wheel. This, of course, is never likely to happen, but on second thought it will be seen that it is only an exaggeration of the principle of having the brakes fixed above the centre. It will readily be seen that if the brake is applied it will tend to lift the car from the axle, and on this being done the power is at an end. Screwing the brake any further would just be simply raising the car. Again, when the car is travelling the springs are compressed, and before power of any consequence can be applied on the wheel, this compression must be taken off. This would mean the car being raised at least 2in., while the motorman would be thinking he was grinding a street organ.

Let us now look at the matter with the brakes fixed below the centre. It is a well-known fact that a man can exert more power by pulling against himself than merely allowing his own weight to be the power. Although a man is not a tramcar, the same principle applies. When the power is applied from the car to the under portion of the wheels, it tends to bring the car and wheels close together, and when this is done, still greater power can be applied according to the multiplying mechanism. Again referring to the springs being compressed by the weight of the car, when the power is applied underneath the wheels it tends to still further compress the springs, and when this compression begins it will be seen that the power is equal to the weight of the car, additional power being applied at will. It is practically impossible to apply the brake to the centre of the wheel, as the oscillation of the car and the direction in which the wheels are running would alter its position to either above or below the centre. The brake power should be nothing less than 100 per cent. of the weight of the car unloaded.—C. W. G.

Answer to No. 814 (*awarded* 7*s.* 6*d.*).—The chief drawback in tramway rolling-stock having the brake blocks placed above the centre of the wheels is the trouble that ensues from the vibration of the car when the brake is applied. When the blocks are in this position and pressure brought to bear on them, it transmits the whole weight of the car from the springs on to the brake-block hangers, forming a rigid connection between the body of the car and the wheels, and subjecting the car to all vibration and shock due to inequalities of the tramway. This soon causes heavy wear and tear on the motors, gearing, etc., besides severely straining the brake gear, rendering risk of fracture imminent. By placing the brake blocks below the centre of the wheels this defect is avoided, as the weight of the car is still on the springs when the brake is applied; and when the springs are compressed by the oscillation of the car the tendency of the brake block is to leave the wheels for an instant, thus giving great elasticity between the body of the car and the wheels, and gaining the full benefit of the springs.

There is no gain in power by placing the brake blocks below the centre of the wheels; to gain power we would have to alter the mechanical advantage of the brake levers. A simple way of finding the pressure on the brake blocks of a hand-brake is to determine the ratio the brake wheel at which the power is applied bears to the brake blocks, and multiply this ratio by the force in pounds exerted on the wheel. This gives the total pressure in pounds on the brake blocks, neglecting friction. For example, suppose a brake wheel 16in. diameter is so connected to the

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brake blocks that during 10 revolutions of the wheel the blocks move through the space of 1in. The ratio between wheel and blocks will be $\frac{16 \times 3{\cdot}1416 \times 10}{1} = 504$ to 1. This multiplied by the force exerted on the brake wheel, say 30lb = 15,120lb. total pressure on the brake blocks.—GEORGE EMENS, JUN.

Answer to No. 814 (*awarded* 5*s.*).—The principal reason for fitting the brake blocks below the centre of the wheel is to obtain the maximum braking effect for a given pull

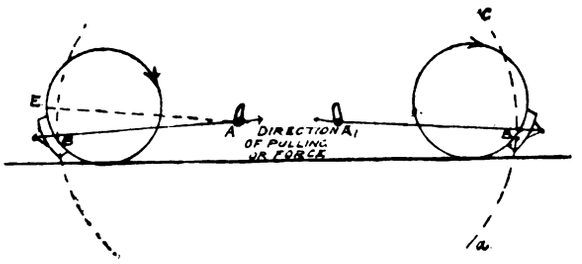


FIG. 1.

on the rods. In Fig. 1 is shown diagrammatically and to scale the relative positions of the wheels, blocks, and rods as they exist on a particular truck. The wheels are supposed to be rotating in a clockwise direction, and the brakes are pulled up to the wheels by a force acting at points A and A_1, and in a direction indicated by the arrows. It will be evident that the wheel to the left will tend to draw block B towards point E. Now the distance A – E is greater than A – B, and as the point A is fixed by the pull exerted there to pull on the brake, any movement of the block towards E must necessarily cause the pressure on the wheel to increase, and so help the braking of the car. Now in the case of block B_1, the rotating wheel will help to throw the block away from the rim, and cause it to move in the circle $c-d$, with A_1 as centre, thus increasing the distance between the block and the wheel. It will now be clear that a certain amount of force will be used up in overcoming the centrifugal force exerted on block B_1, that there will be an increase of braking effort on block B due to the centrifugal force there, and the net result will be in proportion to the pull on points A and A_1. When the wheels rotate in the opposite direction, block B_1 behaves exactly similar to block B, and *vice versâ*.

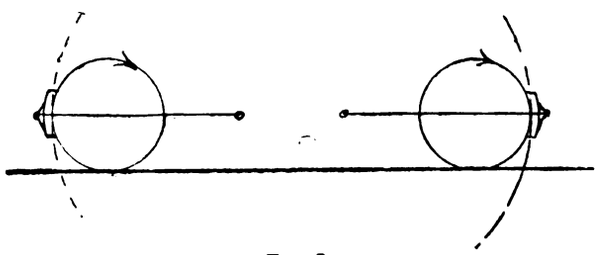


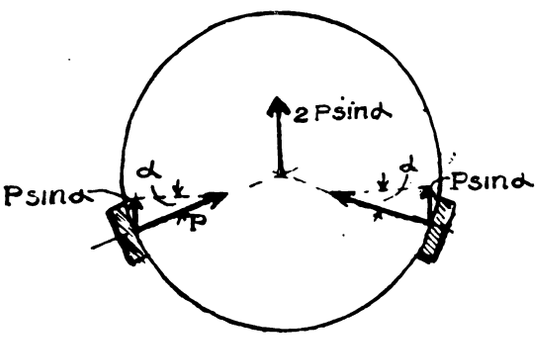
FIG. 2.

In Fig. 2 the blocks are shown fitted at the centres, and it will be seen that whichever way the wheels are revolving the blocks will tend to move in the circles shown by the dotted lines, and *both* blocks will be carried away from the wheel, so that a larger proportion of the force acting through the rods will be required to overcome centrifugal force than when the conditions are as represented in Fig. 1.

With the blocks so hung advantage is also taken of the force of gravity to assist the pulling-off springs in keeping the blocks off the wheel when the brakes are out of action, although this depends upon the point from which the blocks are suspended. Again, if the blocks were on or above the centres, and a portion of the block broke away, it would be liable to be carried into the under-gear, and thus cause considerable damage.—E. T. A.

Answer to No. 814 (*awarded* 5*s.*).—The braking power will be slightly increased by placing the brake blocks below the centre of the wheel, as can be seen from the accompanying diagram. Let P be the pressure exerted by each block against the wheel, then the axle will press against the top half of the bearing with a force 2 P sin α (sum of the two vertical components of forces P), in addition to the pressure exerted by the weight of the car. This will increase the friction between the axle and the bearing, and, therefore, the braking power. Let R be the radius of the wheel, u_1 the frictional coefficient between blocks and wheel. Then if the blocks are placed on the horizontal centre line, the braking effect will be

$$2 \, P \, R \, u_1.$$



Let r be the radius of the bearing, and u_2 the frictional coefficient between axle and bearing. Then if the blocks are placed below the centre, the braking effect will be

$$2 \, P \, R \, u_1 + 2 \, P \, r \, u_2 \sin \alpha.$$

Increase of braking effect per cent.

$$100 \, \frac{r}{R} \times \frac{u_2}{u_1} \times \sin \alpha.$$

Taking, for instance, R = 15in., r = 2in., $u_1 = {\cdot}18$, $u_2 = {\cdot}06$, α = 10deg.

$$100 \times \frac{2}{15} \times \frac{{\cdot}06}{{\cdot}18} \times {\cdot}17 = {\cdot}76 \text{ per cent.}$$

The increase in the braking power would be less than 1 per cent., therefore hardly worth troubling about.—ALTERNATOR.

Question No. 815.—I want to make a solenoid that will operate the starting lever of a clock mechanism. The lever has to be pulled through a distance of ⅜in.; pull required, 1½lb. Is it practicable to make such a solenoid to operate from a few cells? Solenoid and plunger to be kept as small as possible. The starting lever could, perhaps, be lengthened so as to reduce the pull required, but, of course, the distance it would have to be moved through would be increased proportionately.

Answer to No. 815 (*awarded* 7*s.* 6*d.*).—The subject of designing solenoids to give a predetermined pull has been very fully discussed in recent articles in the American technical Press (*American Electrician*, March and July, 1905, and *Electrical World and Engineer*, May 20, 1905). Following on the lines indicated in these articles it is possible to design a solenoid to give a 1½lb. pull through a ⅜in. distance when worked by a few cells, although these will have to be of the small accumulator type.

It is found experimentally that the "stopped" solenoid is the best type to be employed, either with or without a coned plunger and recessed stop. This latter arrangement merely tends to make the pull more even over the whole distance of travel, but does not increase the initial pull. The different parts should be proportioned as follows: (*a*) the mean path for the flux in the yoke should not exceed two times the length of the path in the core and plunger when the latter is right in against the stop, otherwise the plunger travel is so small in comparison with its diameter that an ordinary electromagnet would do; (*b*) the neck of the solenoid through which the plunger travels should be about 2½ times the diameter, so that the magnetic reluctance at this point is low compared with the main air-gap—the brass bushing around the plunger should be about $\frac{1}{16}$in. thick; (*c*) a small brass plate $\frac{1}{16}$in. thick is necessary between the plunger and core to make the magnet release quickly when the current is cut off. After these preliminary considerations, we proceed to find the number of ampere-turns necessary for different plunger lengths, and then can calculate the diameter of the plunger to give the required pull.

The plunger should be made of good machinery steel, and this requires about 470 ampere-turns per inch of length for B = 120,000 lines per square inch. The yoke should be

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of cast steel, and requires about 15 ampere-turns per inch of length for B = 120,000 lines per square inch. The air-gap between the ends of the plunger and core will require 2,350 ampere-turns when the plunger is "home," and the annular air-gap 235 ampere-turns under similar conditions. The total excitation, therefore, to produce a magnetic density of 120,000 lines per square inch in the plunger when it is against the buffer plate will be $2,585 + 500\ l$, or, say, $2,600 + 500\ l$, where l = length of core and plunger path.

By assuming trial values for the length, l, we find the necessary ampere-turns as tabulated below:

Length of plunger and core.	Ampere-turns required.
1·5in.	3,350
1·75in.	3,475
1·875in.	3,538
2in.	3,600
2·125in.	3,662
2·25in.	3,725
2·375in.	3,788
2·5in.	3,850
2·75in.	3,975

From these values of the ampere-turns we can calculate the pull in pounds by a formula given by C. R. Underhill in the *Electrical World and Engineer* for May 20, 1905:

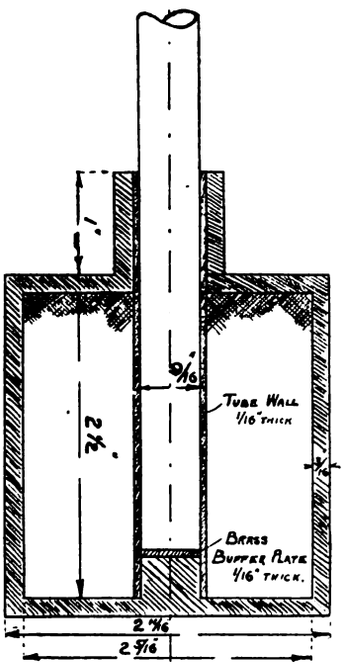
Pull in pounds

$$= \text{area of plunger} \left\{ \frac{(\text{A.T.})^2}{7,075,600\ l^2} + \frac{P_o(\text{A.T.} - n)}{10,000 - n} \right\}.$$

Where P_o = pull at 10,000 ampere-turns and one square inch of plunger and n = ampere-turn factor given in table below, L = length of winding and l = distance of travel.

L	P_o	n
1	33	3,660
2	28·3	3,150
3	23·4	2,800

If we take a diameter of plunger of ·55in., or about $\frac{9}{16}$in., and length of coil 2½in., we find from above formula that the pull is 1·7lb., which leaves a safe margin of 0·2lb. The dimensions of the solenoid would then be as shown in



the sketch, and the only remaining item is to settle on the size of wire to be employed. This is calculated as follows:

The resistance of the coil = mean length in feet × turns × ·8 × 10^{-5} ÷ section in square inches.

$$\therefore \text{the section of wire} = \frac{l_m \times T \times \cdot 8 \times 10^{-5}}{\text{resistance}}$$

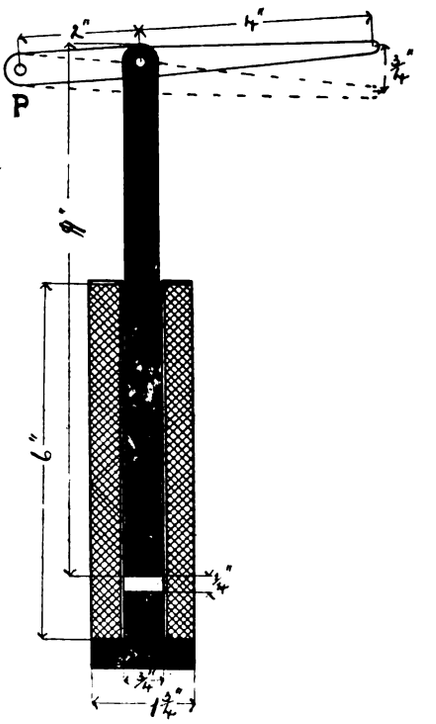
$$= \frac{l_m \times \text{ampere-turns} \times \cdot 8 \times 10^{-5}}{\text{volts across coil}}$$

(since C = E/R)

$$= \frac{0{\cdot}39 \times 3,850 \times \cdot 8 \times 10^{-5}}{6} = \cdot 002.$$

This is on the assumption for battery of cells with total voltage = 6 volts. Using No. 17 S.W.G., the coil consists of 518 turns, or 14 layers of 37 turns per layer, and has a resistance of 0·675 ohm. To excite this coil, three small accumulators would be necessary, as it would be found practically impossible to do so from ordinary dry cells. If the pull were decreased and the distance of travel of the plunger increased in a like proportion, the length of the coil would have to be increased, with the result that more ampere-turns would be necessary; the desired result would be then still more difficult to obtain. If the pull be increased and the distance of travel be decreased in like proportion, it will be found on substituting the figures in the formula given above that the diameter of the plunger will be slightly decreased, but the ampere-turns will not be appreciably decreased, and the solenoid itself will not be so well proportioned.—F. H. P.

Answer to No. 815 (*awarded* 5*s.*).—To make such a solenoid is quite feasible, and any number of different combinations might be devised to effect the purpose. The arrangement of solenoid and plunger shown in sketch, with the aid of two secondary cells, will give the necessary motion. The movable core is of soft iron, $\frac{5}{8}$in. in diameter and 9in. in length. The bobbin is made of brass, but the bottom cheek is of soft iron; part of this piece of iron enters the solenoid and forms a fixed core. This fixed core greatly increases the pull obtained. With a solenoid the great difficulty is to get a pull through any considerable distance, therefore it is best to have the core moving through as small a space as possible. In this case the core is given a movement of ¼in. in the best position relatively to the winding, this movement being multiplied by three by means of the lever working round the fixed point, P. The other end of lever will, therefore, move through a distance of ¾in., the amount of displacement specified in the question. The coil consists



of six layers of 80 turns each of No. 18 S.W.G. double cotton-covered copper wire; this winding will have an approximate resistance of ·8 ohm. Two cells will be required to provide the energising current; these cells should be of such a size as to have a discharging current of four to five amperes. It would be impracticable to so arrange matters that a small pull should take place through a longer distance; with a solenoid, as with an ordinary electromagnet, the pull falls off enormously with only a small increase in distance.—M. M.

[Other replies to Question No. 815 will be given in our next issue.—Ed. *E. E.*]

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Supplement to "The Electrical Engineer,"
OCTOBER 20, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

822. It is desired to work the bellows of a church organ by a single-phase motor. Describe the best way of doing this, and sketch the automatic starting and regulating switch. The motor would require to be of about 1 h.p.—J. A. M.

823. In a station with which I am connected there is installed a turbo-generator with compensating coils in series, with the armature wound in slots in the pole faces. The object of these coils is to enable the machine to commute sparklessly with a fixed position of the brushes at all loads. Will someone please explain exactly how this is effected?—J. P.

ANSWERS.

Question No. 815.—I want to make a solenoid that will operate the starting lever of a clock mechanism. The lever has to be pulled through a distance of ¾in.; pull required, 1½lb. Is it practicable to make such a solenoid to operate from a few cells? Solenoid and plunger to be kept as small as possible. The starting lever could, perhaps, be lengthened so as to reduce the pull required, but, of course, the distance it would have to be moved through would be increased proportionately.

Answer to No. 815 (*awarded 7s. 6d.*).—No, I am afraid it will not be possible to operate the starting lever from a solenoid supplied by a few cells. In the first place, I must express surprise that a clock mechanism should require such a large pull as 1½lb., and unless this pull be considerably modified the operation by means of a solenoid will be out of the question, as I will now proceed to show. Prof. S. P. Thompson read before the International Electrical Congress at St. Louis a paper on "The Predetermination of the Plunger Electromagnet," in which he gave the formulæ I have used below.

If the magnetic circuit of the solenoid is of good iron and completely closed except for an air-gap of length 2in., the pull in pounds is

$$P = B^2 A/72{,}134{,}000 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where A is the cross-section of the iron in square inches, and B is the flux per square inch. Further,

$$B \times 2 \times 0{\cdot}3138 = C S \quad . \quad . \quad . \quad . \quad (2)$$

where C is the current in amperes exciting the solenoid, and S is the number of turns. C S, is therefore, the ampere-turns. We can now substitute the value given in the question for P—*i.e.*, 1½lb. in equation (1). We also require a value for the cross-sectional area of the core. To keep the flux down we must make A as large as possible, but, of course, by increasing A we increase the dimensions of the solenoid. The maximum value of A which can be allowed is, I think, one-quarter of a square inch. It will be seen that if we make A very large we shall require more wire on the solenoid, and, therefore, increase its resistance. Substituting these values in equation (1) we get

$$\tfrac{3}{2} = B^2 \times \tfrac{1}{4}/72{,}134{,}000$$
$$B^2 = 432{,}804{,}000$$
$$B = 20{,}800 \text{ lines per square inch.}$$

Now, of course, we must keep the air-gap as small as possible. This is done by arranging things so that at the end of the ¾in. stroke the plunger is just at the bottom of the solenoid, and then at the beginning of the stroke the air-gap will be the least possible—*i.e.*, ¾in. Substituting the values above for B and 2 in equation (2) we get

$$C S = 20{,}800 \times {\cdot}75 \times {\cdot}3138$$
$$= 4{,}888 \text{ ampere-turns.}$$

The question states that the starting lever could, perhaps, be strengthened to reduce the pull. Suppose we double the length of the lever, and, therefore, halve the pull. We require one-quarter the flux but twice the stroke, therefore we require one-half the number of ampere-turns—*i.e.*, 2,444. It will be practically impossible without having an enormous solenoid to have 4,888 ampere-turns even with a large number of cells. I think, however, it is possible to increase the lever to twice its length so that we require only 2,444 ampere-turns to construct a suitable solenoid, though even then it will be a large one. However, I will calculate it out.

First of all we must find the inside diameter of the solenoid. The area of the core is first found. Area $= \pi r^2$;

$${\cdot}25 = \frac{22}{7} r^2; \quad r^2 = \frac{7}{88}; \quad r = {\cdot}3, \text{ nearly.}$$

We may take the inside radius of the solenoid as ·35in. This allows for the inside casing. A suitable wire will be No. 21 S.W.G. The number of turns per linear inch with this wire is 23·8, and its resistance is ·0007786 ohm per linear inch. Now let us suppose we can get from our cells two amperes, then the number of turns required = 1,222. Suppose we make our solenoid 6in. long. We then have to wind our solenoid with $\frac{1{,}222}{6 \times 23{\cdot}8}$ = say nine layers of wire, each layer containing 24 turns. The outside radius of our solenoid will be ·35 + 9 × diameter of wire = ·35 + 9 × ·042 = ·69in. The mean radius of each turn

$$= {\cdot}35 + \frac{9 + {\cdot}042}{2} = {\cdot}54\text{in.}$$

The total length of wire will be

$$= \frac{{\cdot}54 \times 44 \times 1{,}222}{7}$$
$$= 4{,}148\text{in.}$$

The resistance of the solenoid then will be

$$4{,}148 \times {\cdot}0007786$$
$$= 3{\cdot}2 \text{ ohms.}$$

Now, I should advise "Solenoid" to use two four-volt accumulators in series. When fully charged the voltage will be about 4·2 each, or 8·4 the two, and the internal resistance may be about ·2 ohm each. On a discharge of about two amperes the voltage will fall to eight volts. The current obtained then will be

$$\frac{8}{3{\cdot}2 + {\cdot}4} = \frac{8}{3{\cdot}6} = 2\,2 \text{ amperes.}$$

It will be impossible to use Leclanché cells because they have a high internal resistance, and even a large number of them would not give a current large enough for our purpose under the above conditions. I think that if it be possible to increase the length of the lever as above, the solenoid I have designed will give the requisite pull.—ERNEST P. HOLLIS.

Answer to No. 815 (*awarded 7s. 6d.*).—It is quite possible to make a solenoid to work from a few cells and be capable of doing all that is specified in the question. If the solenoid is to be used only occasionally, and for not more than an hour at a stretch, a battery of about six Daniell cells would be sufficient. If the solenoid is to be used frequently, and is likely to be used for more than an hour at a stretch, it will be found much more convenient and economical to use three two-volt 10-20 ampere-hour accumulators instead of the Daniell cells.

From my experience of solenoids, I should think the following arrangement would be the best under the circumstances. The smallest size which the coil can be conveniently made is 2in. long by 1½in. diameter. The

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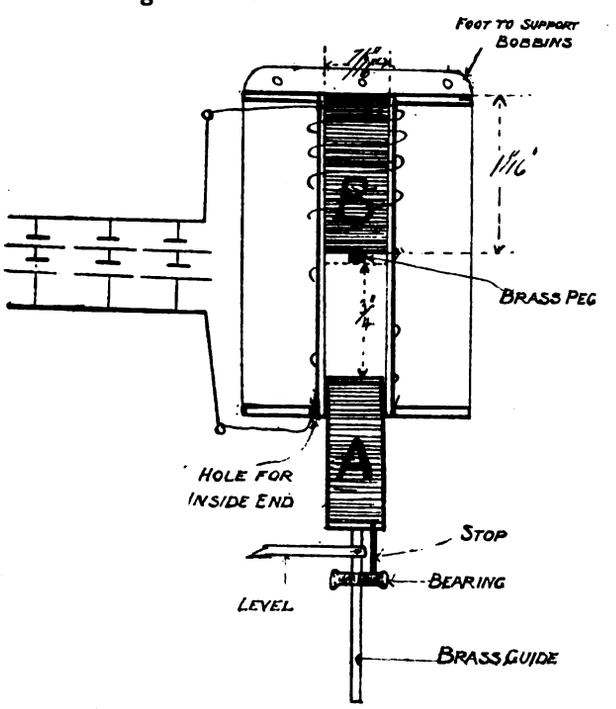
plunger (A in sketch) should be of wrought iron and about $\frac{3}{8}$in. diameter, therefore in order to allow a fair clearance the inside diameter of solenoid must be about $\frac{7}{16}$in.; the plunger should be about 1in. long. This leaves $\frac{1}{4}$in. of it in the solenoid when the plunger is in the "off" position. A piece of wrought iron (B in the sketch) is permanently fixed as shown by making it an easy driving fit into the inside of the solenoid. When the current is switched on this becomes a magnet, and as such assists the solenoid in lifting A. This arrangement, which is equivalent to increasing the ampere-turns, enables a smaller coil to be used than would otherwise be possible. The winding space available on the bobbin is 2in. by ·5in., and since from sketch the mean diameter of the winding is 1in., the mean length of one turn is 3·2in. (approximate). The ampere-turns required to give the pull of 1½lb. will be about 2,000 with the arrangement shown.



The voltage and the arrangement of the cells must now be considered. If six Daniell cells are used, they will be best connected up as shown in the sketch—that is, connected up two in series, and the three sets of two all in parallel. This gives roughly two volts. If three two-volt accumulators are used, they can be all connected in parallel. With either of these two sources of current it will be possible to get five amperes without overworking the cells, provided that the source is chosen in accordance with the advice given above.

Having decided on using two volts and five amperes, the maximum allowable resistance of the winding is $=\frac{2}{5}=$·4 ohm. Also, since 2,000 ampere-turns are required,

$$\text{turns}=\frac{2{,}000}{5}=400 \text{ turns.}$$

These 400 turns must be got into the space of 2in. × ·5in., or one square inch. ∴ (assuming no "bedding")

$$\text{diameter of one turn}=\frac{1\cdot0}{400}=\cdot0025 \text{ square inch.}$$

From this area the diameter is found:

$$\text{Area}=\cdot785\,d^2. \quad \therefore \text{ diameter } (d)=\sqrt{\frac{a}{\cdot785}}=\frac{\cdot0025}{\cdot785}=\cdot057\text{in.}$$

Allowing for insulation, the diameter of the wire will be about ·052in. The total length of wire is 3·2in. × 400 = 1,280in. = 36 yards (approximate); ∴ resistance per yard of wire must be ·012 ohm. Also the wire must carry five amperes without heating up unduly.

The wire which most closely meets the above requirements as regards diameter, resistance per yard, and carrying capacity is found from wire tables to be 17 S.W.G. This is the wire which must be used to wind the coil. About 1¼lb. of wire will be required.

The bobbin on which the coil is to be wound may be easily made by obtaining a piece of brass tube $\frac{7}{16}$in. inside diameter and long enough to take 2in. of winding and allow of a flange, cut out of thin sheet brass, being soldered on to each end. The inside of the bobbin must be perfectly smooth. As the voltage is so very low, the bobbin need not be insulated, but can have the wire wound on directly. The wire, which should be either single cotton or silk covered, must be carefully examined, as it is being wound on, to see that there are no bare places. If there are any, a small piece of silk ribbon should be wrapt round the bare wire, to insulate it. As both ends of the wire are wanted to be free, it will be necessary to drill a small hole in one of the flanges in the position shown, and through this the commencing end must be passed. When all the wire has been wound on as tightly as possible, and the bobbin is full, it must be well tied down to prevent its coming unwound. This can best be done by wrapping some insulating tape round the coil, and then finishing off with a layer of string tightly tied. The solenoid can then be mounted on a board, and connected up.—H. A. C.

Question No. 816.—Why should a Lancashire boiler give a dull boom at intervals of, say, half an hour, or less, which can be heard 30 yards away, and make the steam blow off suddenly at the safety valve when the blow-off cock happens to be leaking? The blow-off cock is of the Hopkinson type. The blow-off cock delivers below the surface to a stream of water. Also, would the above effect be likely to be at all detrimental to its safety?

Answer to No. 816 (*awarded* 10*s.*).—The dull boom is evidently one of the effects of "water-hammer" caused by the sudden condensation of steam *in* the blow-off pipe and *around* that end of it which discharges below the surface of the stream. The reason why the steam blows off suddenly at the safety valve is that the blow-off pipe transmits the shock caused by "water-hammer" to the boiler, and this acts in the following manner: In the ordinary course of generating steam the inner surface of the boiler below water-level is covered with myriads of small bubbles of steam, which, as they grow larger, rise uniformly to the surface and thus keep up the steam pressure. The shock or sudden vibration has the effect of instantaneously detaching thousands of bubbles of steam, which but for the shock would have clung a little longer to the metal surface. These bubbles, in addition to those rising normally, produce a more furious boiling and a more copious generation of steam. This increases the pressure and lifts the safety valve. There will also be the danger of "priming." The effect of shock in detaching steam bubbles from surfaces below water-level may be observed by striking any small vessel, such as a saucepan, containing water kept almost at boiling point.

Now for the cause of the intervals of 30 minutes or less. The blow-off pipe is either higher than the water-level of the stream and has a downward bend at the end to discharge under water, or the blow-off pipe is below the water-level of the stream, and is simply carried through the side of the stream, thus entering the water. In either case the pipe will in ordinary working be always full of water, for in the case where it is higher than the water-level, on opening and then closing the cock a vacuum will be formed in the pipe, and the water from the stream will rush up and fill it.

Now, suppose the blow-off cock is leaking sufficiently to produce the results stated in the question, at first the water leaking through the cock will be cooled by the water in the pipe, but gradually the water and the pipe will get warmer, and their temperature will eventually rise to atmospheric boiling point. The water which now leaks through the cock, coming from a condition where the boiling point is high to the lower boiling point of the atmosphere, passes at once into steam; this drives back the water in the pipe and fills the pipe with steam. Further leakage increases the steam pressure in the pipe, and eventually the pressure rises sufficiently for the steam to drive back the head of water (due to discharging under the surface). The steam now rushes out into the stream, only to be immediately condensed. As the leak is not great enough to keep up the steam pressure, the water from the stream rushes up the pipe, condensing the remaining steam, and gaining energy as it travels until it strikes the plug of the blow-off valve or any

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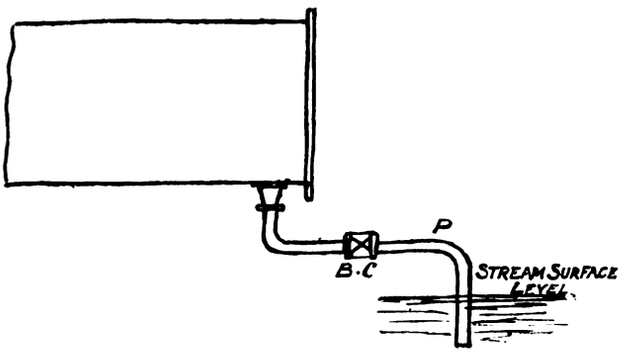
bends in the pipe. This produces the shock. The dull boom is heard so far away by reason of some of the sound being generated in the water of the stream by condensation of the steam issuing from the pipe. All shock is bad for boilers, and ought to be stopped.

If it be imperative to sometimes discharge under water, then a branch pipe ought to be taken from the existing pipe near to the blow-off cock and be led so as to discharge into the stream *above* the water-level. Two additional valves will be required, one in the branch pipe and one in the original pipe, placed beyond the branch, so that the discharge may be directed through either of them.

Some boiler explosions appear to be due to an instantaneous increase in the generation of steam, the nature of which is unknown, and such cases as the one in question ought to be promptly dealt with.—F. P. S.

Answer to No. 816 (*awarded* 7*s.* 6*d*).—The figure represents the probable arrangement of the blow-off from the boiler. The end of the pipe, P, being under water, a seal is thereby effected, and gradually the pipe is filled with water, partly by steam condensed after passing the cock, partly by water escaping through, and partly by water which creeps up to fill the vacuum caused by the condensation. So that, at a certain instant, the pipe, P, is full of water right up to the blow-off cock, B C. Now, the action of blowing off, whether by leakage or by the normal opening of the valve, creates in a less or greater degree a vacuum in the blow-off cock and connector, so that if the leakage be at all intermittent—as most probably it is—there will be an instant when (the pipe, P, being full) water is sucked back into the connection to the boiler.



This is possible at the instant P is full on account of the inertia, as it were, of the column of water, and before the pipe is cleared by the pressure. The water entering the vacuum is instantaneously vaporised, and the resultant comparatively large volume of steam, encased, so to speak, in an envelope of water, causes a disruptive increase of pressure. Hence the boom and the blowing off at the safety valve. The pipe, P, is cleared at the same time and the operation repeats itself. The effect on the boiler cannot but be detrimental; any sudden increases of pressure tend to strain the shell, and as the blow-off cock leak will naturally increase, the effect will be multiplied. The introduction of disruptive strains of this type will certainly not conduce to safety, even though they may not be absolutely dangerous. The remedy, of course, is to cut the pipe, P, so that it has a free delivery outside the stream.—S. E. T.

Answer to No. 816 (*awarded* 7*s.* 6*d.*).—The cause of this effect is the leaking of the blow-off cock, which allows hot water to accumulate in the delivery pipe. No doubt this pipe is laid so that it drains towards the stream in which its end is immersed, and the hot water being lighter than the cold water of the stream accumulates for a short distance only up the pipe, while hot or perhaps boiling water flows down the pipe in a continuous stream, which warms the pipe and at the same time fills it with vapour or perhaps steam. This condition cannot remain in equilibrium for long, because the heat and vapour are accumulating steadily in the pipe, and so the water at its lower extremity is blown out, but the pressure being thus relieved and the warm water driven out into the stream, cold water enters the pipe, and, of course, rapidly condenses the vapour as it comes in contact with it, and is consequently drawn up the vacuous pipe with considerable rapidity and force to strike the blow-off cock, which communicates the blow to the boiler and so gives a sudden jerk to the safety valve, and lets a little steam blow out there. The cold water now sinks back again by its own weight to a point of equilibrium and the process is repeated, but, the pipe being cold and large and the leak of hot water being small, some time is required to fill the pipe with vapour again for the necessary pressure for a fresh start. I consider that this action would be distinctly detrimental to the boiler, because the blow from the water is hard and powerful, and will probably in time injure the boiler plate holding the blow-off cock. In addition to its force, the blow thus given is frequent, and, therefore, it is almost certain to be doing some more or less subtle injury to the boiler. It is the sort of action which would crack a plate, break a rivet, or make a leak, and I do not believe that the Boiler Insurance Company would allow it to continue, especially as the remedy is so simple and inexpensive.

There are two easy and satisfactory remedies. First, remove the lower end of the pipe from the stream or brook so that it is open to the air—this is the best; secondly, repair the blow-off cock so that it does not leak, and if the outlet of the pipe cannot be taken out of the stream or brook, bore a $\frac{1}{4}$in. hole in it to let air in, but be careful in this case that the hot water and steam at blowing-off times do not get through it and do any damage.—F. G. A.

Answer to No. 816 (*awarded* 5*s*).—The following is probably the cause of the "boom." The outlet of the discharge pipe is below the surface of a stream, so that in its normal condition it is full of cold water right up to the blow-down cock. When the blow-down cock leaks, the cold water in the pipe is gradually displaced by the incoming hot water, which, if the pipe has a drop towards the stream (which is probable), will tend to collect at the boiler end by virtue of its lighter density; as the water leaks through, the temperature will increase until it is at boiling point, when, as the water is completely void of absorbed air, there will be a sudden generation of steam that will blow the pipe out clear, causing the rumble noted. When the pressure in the pipe is reduced sufficiently, the remaining steam will condense and the cold water will rush back into the pipe, whence the operations are repeated. If it is a deadweight safety valve, the sudden shock on the boiler would cause the valve seatings to jar, so allowing steam to escape. There is a danger of the continued shocks disturbing the boiler on its settings, and causing the joints on the boiler to blown-down cock to leak. If the discharge has a turned-down bend in the water the disturbance would be aggravated.—J. A. V. AND G. A. T.

Question No. 817.—A car weighing 10 tons when loaded gets out of control down an incline of 1·5 in 100, and moves at the rate of 20 miles an hour, and on the application of the emergency brake it is pulled up in a distance of 20 yards. What is the energy dissipated, the average brake power, the retardation, and the time taken in pulling up

Answer to No. 817 (*awarded* 7*s.* 6*d.*).—In this question no mention is made of friction or windage losses which would have a retarding effect on the car. The 1·5 per cent. grade would have the effect of adding to the kinetic energy energy of the car. In Fig. 1, if the length of the inclined

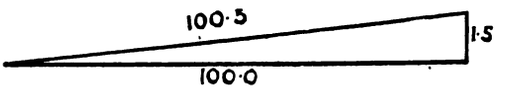


Fig. 1.

track = 100·5, this corresponds to a horizontal length of 100·0, the third side of the triangle corresponding to the per cent. grade. The kinetic energy of the car should for extreme accuracy be calculated in two parts: (1) the kinetic energy stored in it due to its motion along a horizontal plane proportional to the side 100·0; and (2) the kinetic energy stored in it due to its falling, under the influence of gravity, through a vertical distance proportional to the side 1·5. This second part has been taken to be cancelled by the retarding effect due to friction and windage losses.

The kinetic energy of the car in moving along horizontally

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$= \frac{1}{2} m v^2$, where m = weight in lbs./32, and v = velocity in feet per second.

$$\therefore \text{ K.E.} = \frac{1}{2} \times \frac{10 \times 2{,}240}{32} \times (29{\cdot}35)^2$$

$$= 301{,}800 \text{ foot-pounds.}$$

This equals the *energy dissipated* during the pulling up of the car by braking. Further, force = mass × acceleration, or $f = m\,a$. Also, work or energy = force × distance, or $W = f\,s$.

$$\therefore W = m\,a\,s \qquad (s = 60\text{ft.}).$$

$$W = 301{,}800 = m\ a\ s = \frac{10 \times 2.240}{32} \times a \times 60.$$

$$\therefore a = 7{\cdot}18 \text{ feet per second per second.}$$

This equals the *retardation*. Now, the velocity of a body, v, at the end of a time t, the initial velocity being V, and the acceleration being a, is $v = V + a\ t$. In this case the brakes cause a negative acceleration—*i.e.*, a retardation,

$$\therefore v = V - a\ t.$$

Now at the end of the journey, the car being at rest, $v = 0$; also V = 29·35ft. per minute, and a, as already found, = 7·18.

$$\therefore 0 = 29{\cdot}35 - 7{\cdot}19\ t. \quad \therefore t = 4{\cdot}09 \text{ seconds.}$$

This is the *time taken in pulling up*. We can now find the average brake power. Thus

$$f = m\ a = \frac{10 \times 2{,}240}{32} \times 7{\cdot}18.$$

$$\therefore f = 5{,}030\text{lb.}$$

That this is so can be seen by multiplying this average brake power by the distance travelled, and the result should be the energy dissipated in braking. Thus

$$5{,}030 \times 60 = 301{,}800 \text{ foot-pounds.}$$

It is interesting to see how the kinetic energy of the car is destroyed by braking and the car finally brought to a standstill. This is set forth in Table A. The results are only of slide-rule accuracy, and are calculated to the end of the fourth second, at which point it will be seen that the velocity of the car is reduced to 0·58ft. per second.

TABLE A.

Time.	Kinetic energy.	Velocity.	Mean velocity during the second.	Kinetic energy lost during the second.
0	301,800	29·3		
End of first second ...	172,500	22·12	4·17	21,000
End of second second	79,200	14·94	11·35	57,000
End of third second...	22,200	7·76	18·53	93 300
End of fourth second	1,200	0·58	25·71	129,300

—S. S. L.

Answer to No. 817 (*awarded* 7*s.* 6*d.*).—(*a*) The energy dissipated is evidently the difference between the energy stored in the car on putting on the brake and the energy stored in the car when it is brought to rest, which is zero—that is, the energy dissipated is simply the kinetic energy due to a mass of 10 tons moving at 20 miles an hour, or $\frac{88}{3}$ft. per second, since 15 miles an hour is the same as 22ft. per second. This is, in foot-poundals,

$$\frac{1}{2} \times 10 \times 2{,}240 \times \frac{88}{3} \times \frac{88}{3},$$

which, taking g (the acceleration due to gravity of a freely falling body) as being 32·2, is equal to

$$\frac{1}{2} \times 10 \times 2{,}240 \times \frac{88}{3} \times \frac{88}{3} \times \frac{1}{32{\cdot}2} \text{ foot-pounds,}$$

i.e., to 299,200 foot-pounds.

(*b*) The retardation can be got from the usual formula connecting initial and final velocity with acceleration and space passed over. It is assumed that the retardation is constant, which might not be quite correct under some circumstances. If the brake acts electrically by friction on the rails, then as the car slows down the pressure will alter, and, consequently, the retardation will diminish as rest is approached; the same will apply if the wheels are locked by pressure applied electromagnetically, and the braking takes place by friction between rails and wheels, the latter not revolving. Assuming, however, that retardation is constant, we have

(Final velocity)² = (initial velocity)² + (2 × acceleration × space passed over)

or, $$0 = \frac{88}{3} \times \frac{88}{3} + 2 \times a \times 3 \times 20$$

or, $$A = -\frac{88 \times 88}{1{,}080} = -7{\cdot}17\text{ft. per second per second,}$$

the negative sign showing that the acceleration acts against the car's motion retarding it.

(*c*) The time taken in pulling up is got from the formula connecting space passed over with initial velocity, acceleration, and time during which the acceleration acts.

Space passed over = initial velocity × time + ½ acceleration × (time)²

or, $$60 = \frac{88}{3} \times t - \frac{1}{2} \times \frac{968}{135}\ t^2$$

or, $$15 = \frac{22}{3}\ t - \frac{121}{135}\ t^2$$

or, $$121\ t^2 - 990\ t + 2{,}025 = 0$$

or, $$(11\ t - 45)^2 = 0,$$

which shows that the car pulls up in $\frac{45}{11}$ or $4\frac{1}{11}$ seconds.

(*d*) It is not very clear what is meant by "average brake power." If it is to be taken as the average horse-power due to the action of the brake in pulling up, we must find the retarding force exerted by the brake. The net retarding force is got from the knowledge of the mass acted upon and the negative acceleration, or retardation, produced by the retarding force.

Retarding force (poundals)

$$= -10 \times 2{,}240 \times \frac{968}{135}.$$

This is the resultant of all the forces acting on the car—that is, it is the difference between the retarding force applied by the brakes and the accelerating force due to the car being on an inclined plane. This accelerating force, according to the triangle of forces proper to the particular plane under consideration, is $\frac{1{\cdot}5}{100} \times 10 \times 2{,}240 \times 32{\cdot}2$ poundals. Hence the retarding force exerted by the brakes is

$$\left(\frac{1{\cdot}5}{100} \times 10 \times 2{,}240 \times 32{\cdot}2\right) + \left(\frac{968}{135} \times 10 \times 2{,}240\right) \text{ poundals,}$$

which, worked out, gives

$$\left\{\left(\frac{1{\cdot}5}{100} \times 32{\cdot}2\right) + \left(\frac{968}{135}\right)\right\} 10 \times 2{,}240 \text{ poundals,}$$

or, $$\left\{\frac{1{\cdot}5}{100} + \frac{968}{135 \times 32{\cdot}2}\right\} \times 10 \times 2{,}240\text{lb., or } 5{,}321\text{lb.}$$

This acts for $\frac{45}{11}$ seconds, so that the horse-power during the retarding is given by

$$5{,}321 \times 60 \times \frac{11}{45} \times \frac{1}{33{,}000} \times 60$$

or, $$141{\cdot}9 \text{ h.p.}$$

This answers (*d*) whether horse-power or only actual backward pull is intended. It should be noted that if the wheels are revolving during the braking, there is, in addition to the braking retardation, that due to the friction of wheels and motors in their bearings, this force being equal to the total mass of the cars, multiplied by 32·2 times the coefficient of friction effective for the rolling between the car and the rails: this force would thus be given in poundals, and would, of course, need to be subtracted from the force previously found to be due to the brakes, as it acts in the same direction as the net retarding force. As, however, the coefficient of rolling friction is not given, this quantity is indefinite, and the result given is obviously a maximum possible value.—T. C.

[Other replies to Question No. 817 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
OCTOBER 27, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

824. What modifications, if any, may be made in the design of the *mechanical* parts of a rotary converter in comparison with a motor-generator of the same capacity?—R. C. S.

[N.B.—Will "R. C. S." kindly send his name and address?—ED. *E. E.*]

ANSWERS.

Question No. 817.—A car weighing 10 tons when loaded gets out of control down an incline of 1·5 in 100, and moves at the rate of 20 miles an hour, and on the application of the emergency brake it is pulled up in a distance of 20 yards. What is the energy dissipated, the average brake power, the retardation, and the time taken in pulling up

Answer to No. 817 (*awarded* 5*s.*).—The total energy dissipated by the car during the process of pulling up consists of two parts. In the first place, the car, owing to its velocity, will have a certain kinetic energy; and in the second place, since the car drops through a certain distance during the time in which it is being stopped, it will also have (at the instant when the brakes are applied) a certain amount of energy due to its position, or, as it is termed, potential energy. The sum of the above two quantities of energy represents the amount which has to be dissipated before the car is brought to rest.

Now, the kinetic energy of a moving body is equal to $\frac{1}{2}\frac{M V^2}{32\cdot2}$ foot-pounds, M and V being the mass in pounds and velocity in feet per second respectively.

$\therefore$ K. E. of car $= \frac{2,240 \times 10 \times (29\cdot33)^2}{2 \times 32\cdot2} = 299,100$ ft.-lbs.

Again, while the car is moving through a distance of 20 yards along the road it will fall vertically through $60 \times \cdot015 = \cdot9$ft.

$\therefore$ potential energy given to car $= 10 \times 2,240 \times \cdot9 = 20,160$ foot-pounds.

$\therefore$ total energy to be dissipated during braking operation $= 299,100 + 20,160 = 319,260$ foot-pounds.

Now, in order to get the retardation and the time occupied in stopping the car, it will be necessary to know the law according to which the brakes act. For instance, whether the retardation is, or is not, uniform. Let us consider it to be uniform; then it will be evident that the average velocity during the period of braking will be 10 miles per hour, or 14·67ft. per second, and the time occupied in pulling up will be $\frac{60}{14\cdot67} = 4\cdot09$ seconds. The retardation being the decrease in velocity per second is evidently

$$\frac{29\cdot33}{4\cdot09} = 7\cdot17\text{ft. per second per second.}$$

The term average brake power is a little indefinite, but assuming it to mean the average power dissipated during braking, we have

$$\text{average horse-power} = \frac{319.260}{4\cdot09 \times 550} = 142\cdot2.$$

It may be noted that a small portion of this power will be due to the ordinary friction losses of the wheels and gearing, the remaining portion being due to the application of the emergency brake.—β^2.

Answer to No. 817 (*awarded* 5*s.*).—This question is only a matter of applied mechanics, and the first thing to find before it can be answered is the velocity of the car in feet per second. As the speed is given, no notice need be taken of the incline.

The velocity in feet per second $= \frac{20 \times 1.760 \times 3}{60 \times 60} = 29\frac{1}{3}$.

1. Having found this, the energy of the car due to its motion down can now be calculated. This is the kinetic energy, and is the dissipated or wasted energy, as it is not used in any way. The kinetic energy $= \frac{W v^2}{2 g}$, where W = weight car in pounds, v^2 = (velocity)^2, and $g = 32\cdot2$.

$\therefore$ K.E. $= \frac{10 \times 2,240 \times 29\frac{1}{3} \times 29\frac{1}{3}}{2 \times 32\cdot2} = 299,464\cdot1$ foot-pounds.

2. The car contains 299,464·1 foot-pounds of energy which have to be destroyed before it is brought to rest. In the question it is stated that the car was brought to rest in a distance of 20 yards = 60ft.

$\therefore$ average brake-power $= \frac{299,464\cdot1}{60} = 4,991\cdot6$lb.

3. When the brakes are applied to the car, its acceleration is gradually decreased to zero until the car stops. This negative or decreasing acceleration is called the retardation. To calculate it, take the formula $P = \frac{W a}{g}$, where P = braking power in pounds, W = weight of car in pounds, $g = 32\cdot2$, and a is the acceleration or retardation in feet per second per second.

If $P = \frac{W a}{g}$, then $a = \frac{P g}{W} = \frac{4,991\cdot6 \times 32\cdot2}{10 \times 2,240}$

$= 7\cdot17$ feet per second per second.

4. To find the time taken in pulling up take the same formula, $P = \frac{W a}{g}$. This must be modified by putting

$$a = \frac{\text{velocity}}{\text{time seconds}} = \frac{v}{t}.$$

Again, if $P = \frac{W v}{g t}$, then $t = \frac{W v}{g P}$

$$= \frac{10 = 2,240 \times 29\frac{1}{3}}{32\cdot2 \times 4,991\cdot6}$$

$= 4\cdot1$ seconds.

The time taken to pull up and the retardation may be found in two ways, both of which will give the same results.

Take the formula for a falling body or a body moving freely down an incline under the force of gravity. The formula is $h = \frac{v}{2} t$, where h = height of fall, or in this case the distance travelled by the car in feet. v = velocity feet per second, t = time in seconds.

$h = \frac{v t}{2}$. $\therefore t = \frac{2 h}{v} = \frac{2 \times 20}{29\frac{1}{3}} = 4\cdot09$ seconds.

Retardation.—This time the formula $a = \frac{v}{t}$ will answer our purpose nicely. This has just been stated.

$\therefore a = \frac{29\frac{1}{3}}{4\cdot09} = 7\cdot155$ft. per second per second.

—H. H. H.

Answer to No. 817 (*awarded* 5*s.*).—The whole energy dissipated is that due to (1) the velocity of the car, and (2) gravitation acting on the car while it moves down the incline from the time when the brakes are applied. Since the velocity is reduced from 20 miles per hour to zero, the velocity destroyed is, of course, 20 miles per hour.

Now, 60 miles per hour = 88ft. per second;

$\therefore$ 20 miles per hour $= \frac{88 \times 20}{60} = \frac{88}{3}$ feet per second.

Energy dissipated due to (1) in foot-pounds

$= \frac{1}{2} \frac{\text{weight in pounds}}{g} \times \text{square of velocity in feet per second}$

$= \frac{1}{2} \frac{10 \times 2.240}{32\cdot2} \times \left(\frac{88}{3}\right)^2 = 299,300$ foot-pounds.

Now, the slope is 1·5 in 100; hence, as the car moves 20 yards (= 60ft.) along the rails, it moves a distance in the direction of gravity

$$= \frac{1\cdot5}{100} \times 60 = \cdot9\text{ft.}$$

(Since the slope is small, it does not matter whether we measure the 20 yards along the rails or along the horizontal.) Hence work done due to (2) in foot-pounds = distance in feet through which the car moves in the direction of gravity × weight of car in pounds,

$= \cdot9 \times 10 \times 2,240 = 20,160$ foot-pounds.

$\therefore$ whole energy dissipated = 299,300 + 20,106 = 319,500 (say)

Average Brake Power.—The force exerted by the brake has to do 319,500 foot-pounds of work in 20 yards (60ft.).

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Let F = force in pounds,

$$\therefore F \times 60 = 319{,}500 \text{ foot-pounds}$$

$$\therefore F = \frac{319{,}500}{60} = 5{,}325\text{lb.}$$

Time in Pulling Up.—Assuming the retardation constant, the time average of the speed $= \frac{20}{2} = 10$ miles per hour, or $10 \times \frac{88}{60}$ feet per second.

Time taken in seconds

$$= \frac{\text{space described in feet}}{\text{speed in feet per second}}$$

$$= \frac{60}{\frac{88 \times 10}{60}} = 4\tfrac{1}{11} \text{ seconds.}$$

Retardation.—The retardation in feet per second per second

$$= \frac{\text{speed destroyed in feet per second}}{\text{time of destroying the speed in seconds}}$$

$$= \frac{88}{3} \div \frac{45}{11} = 7{\cdot}17 \text{ feet per second per second.}$$

—H. R.

Question No. 818.—I am anxious to study the wave forms in various parts of an alternating-current circuit. Can anyone describe the construction of a simple form of "oscillograph"?

Answer to No. 818 (*awarded* 10*s.*).—A simple form of oscillograph was described by A. Wehnelt in a paper before the German Physical Society some two years ago, and which is described in the *Electrical Engineer* of Oct. 9, 1903. The principle of the instrument is the same as that of the well-known Duddell oscillograph, and the author states that

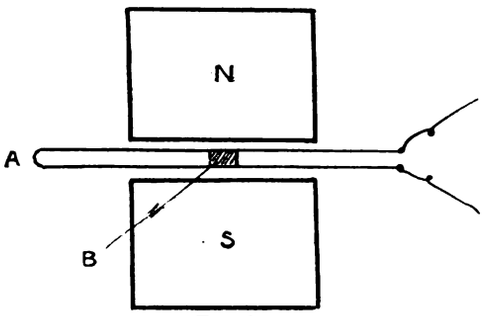

FIG. 1.

in the case of comparatively slow periodic charges, such as alternating currents at ordinary frequencies, it has proved quite successful. Fig. 1 shows a diagrammatic representation of the instrument. It consists essentially of a loop, A, of hard-drawn silver wire, tightly stretched between the poles, N and S, of an electromagnet. A small mirror, B, is stuck across the loop and lies midway between the poles. The sides of the loop, which should be parallel, are from 2mm. to 3mm. apart, and the gap between the poles should be just sufficient to allow free movement of the loop. When a current is sent through the wire with the magnets excited, the loop is deflected about its longitudinal axis by an amount approximately proportional to the current. If the current varies periodically, the instantaneous deflections will still be proportional to the instantaneous current values, provided that the natural period of the moving system is very small compared with the period of the current, and also that the damping of the system is great. By employing a powerful magnet and a tightly-stretched wire both these conditions may be fulfilled. Consequently, when an alternating current passes round the loop, the moving system is set into a state of rapid vibration exactly coincident with the alternations of the current.

Fig. 2 is a photograph of the apparatus as constructed by the author of the aforementioned paper. Two identical oscillographs are supported one above the other in an easily adjustable manner. The poles of the electromagnet are in each case bevelled, and the loop which stretches between them is mounted on an ebonite strip with a milled headed screw at one end for adjusting the tension. Each oscillograph is mounted on a base, and the ends of the loop brought down to two terminals. By means of two oscillographs mounted in the manner shown, two curves can be taken simultaneously. Thus, if it is required to investigate the current and potential wave forms of an alternate-current circuit under various conditions, one oscillograph is connected in series with a high non-inductive resistance (dependent in value on the potential of the circuit) across

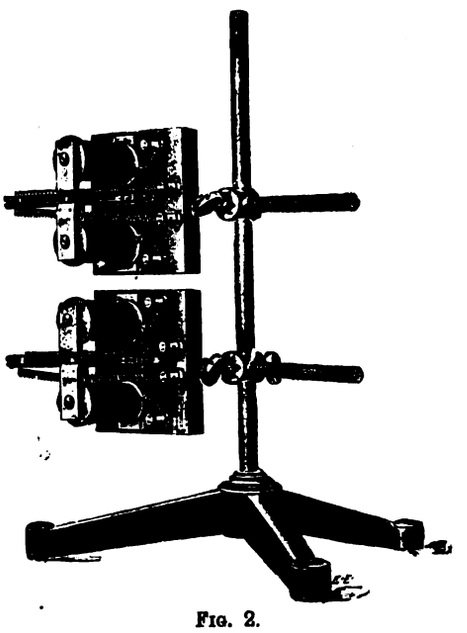

FIG. 2.

the circuit, and the other is connected across the ends of a small non-inductive resistance (dependent in value on the main current) connected in series with the load, so that it carries the main current. Obviously, the loop, A, being of very fine wire, the maximum current that it can carry will be very small, and in each case the current passing through it must be limited to this value.

The curves are exhibited on a screen by means of the arrangement shown diagrammatically in Fig. 3. A small 3½-ampere arc lamp, L, is used as a source of light and placed behind a lens, A, so that the rays which fall on the oscillograph mirrors are parallel. From these the light is reflected to a revolving mirror, Sp, and thence on to the screen, S. If the revolving mirror be at rest, two spots of light will appear on the screen, S, and by adjusting the position of either oscillograph these two spots should be made coincident. Everything is then ready for connecting the oscillographs in circuit in the manner previously indicated, and by rotating the mirror moderately fast the

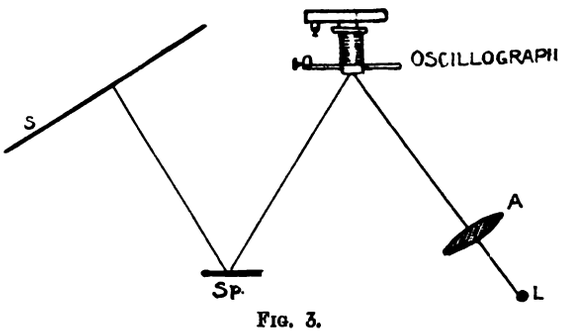

FIG. 3.

current and the potential waves will appear on the screen, S, developed along a vertical axis. It was found that if the periodic time of the changes to be considered was less than 0·1 second, the natural swing of the system will interfere with the results, as with such an instrument the natural time of swing is about ·003 second.

This instrument I think can be modified and much simplified in construction, and at the same time give satisfactory results, by combining the two oscillographs in one. To do this, two loops are placed between the poles of the electromagnet as indicated in Fig. 4, the loops being separated by a small piece of soft iron so that the field is practically uniform. To compensate for the increased air-gap, more ampere-turns would need to be put on the magnet core giving a field equally as strong as in the single instruments. Instead of using silver for the loops,

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phosphor-bronze strip No. 0 size would do quite well, and it would safely carry $\frac{1}{10}$ ampere. By means of this combined instrument two wave-forms could be readily compared, and if it is desired to make photographic records the instrument could be placed in a box in which the lens, A, is permanently fixed, and an aperture provided in the side of the box through which the light from the source, L, can pass, first through the lens, A, and then on to the mirrors of the oscillograph. The rotating mirror, Sp, would in that case be replaced by a drum round which the film can be wrapped, and the reflected light from the oscillograph mirrors would have access to the film by means of an aperture which could be opened and closed from the

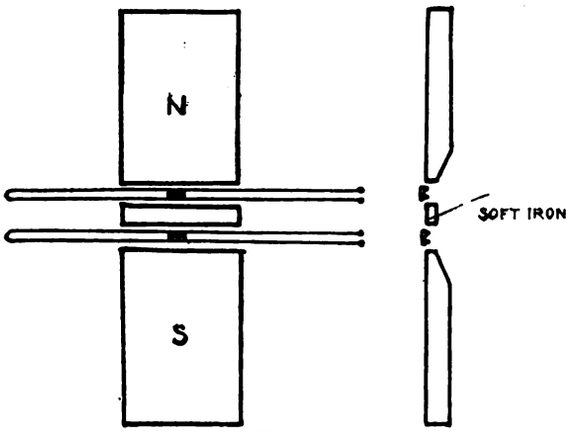

FIG. 4.

outside of the case. It is then only necessary to rotate the down at a uniform speed, which speed is dependent on the frequency of the alternations and the number of complete cycles that are desired to be recorded, and by opening the shutter for a period corresponding to one revolution of the drum you first obtain your zero line. Then connect the oscillograph in circuit and repeat. This will record the two waves, and the film can be developed in the ordinary way.—A. P. Y.

Answer to No. 818 (*awarded* 7*s.* 6*d.*).—The most perfect instrument for determination of wave-form at present available is the bifilar oscillograph as devised by Blondel and perfected by Duddell. Description of this is, however, here out of place, as it can scarcely be termed "simple," while its cost, complete, approximates to the inquirer's *nom de plume*. A simplified form has, nevertheless, been devised by Wehnelt, and of this a description appears in the *Electrical Engineer* of Oct. 9, 1903. As shown in Fig. 1 (this is the same as Fig. 2 of "A. P. Y.'s" answer—ED *E. E.*), upon a base board is mounted an electromagnet furnished with pole-pieces, the gap between which is a few centimetres long and about 4mm. across from pole to pole. For the purpose of concentrating the field in this gap, the pole edges are narrowed down to a few millimetres thickness. A loop of hard-drawn silver wire, tightly stretched on an ebonite bar, is adjusted in the polar gap, and carries a light mirror bridging across from wire to wire (Fig. 2). The two wires of the loop should

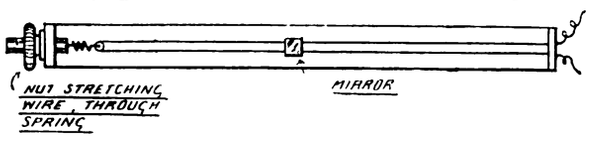

FIG. 2.

be from 2mm. to 3mm. apart, and it is advantageous to pass the looped end over a small pulley that their tension may be equalised. In use the current under investigation is passed through the loop, and the magnet is excited as strongly as possible. The further arrangements are as shown in Fig. 3. Rays issuing from a strong source of light, preferably an arc lamp or an optical lantern, are so focussed as to give an image on the screen after falling upon the oscillograph and rotating mirrors. If the latter be rotated synchronously with the alternations of current, so much the better, as a stationary image is obtained thereby.

This appliance may be purchased from Max Kohl, of Chemnitz, but is not, in all probability, beyond "Fifty-quida's" own constructive powers. Phosphor-bronze strip may be advantageously substituted for the silver wire, and this may be obtained at about 1*s.* a yard, while a suitable light and small mirror can be got by cutting down and silvering a microscope cover-glass. If the path of the light rays between the oscillograph and screen be a metre, an amplitude of 100cm. can be obtained on the screen, while the wire's natural period of vibration can be reduced to about ·003 second by due tension, and in this case fairly good results are given up to a current frequency of not greater than 100. Certain errors will be introduced with this simple instrument owing to the lack of damping, and these can only be avoided by enclosing the moving loop in some form of oil bath.

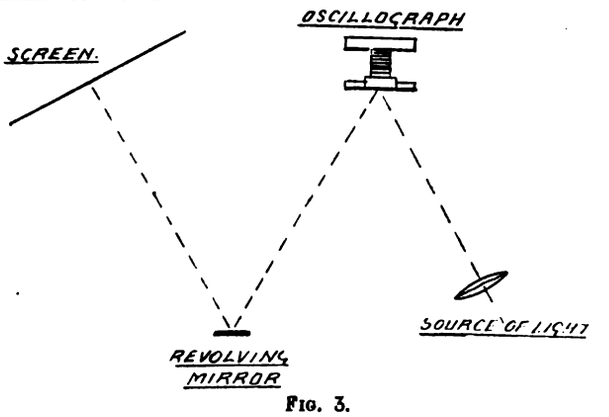

FIG. 3.

The Blondel soft-iron oscillograph is not extremely difficult to make, provided one can obtain the soft-iron band. In this instrument a soft-iron strip, about ·25mm. wide, ·05mm. thick, and a few centimetres long, is stretched between the poles of a powerful magnet. Coils carrying the current to be observed are disposed so as to give a field perpendicular to that of the magnet, and under the joint effect the iron band sets its breadth in the direction of the resultant field. The indications are obtained, as usual, by a tiny mirror attached by gum to the iron band. A complete description of this may be found in the *Revue Electrique* of April 12, 1902, and the essential disposition

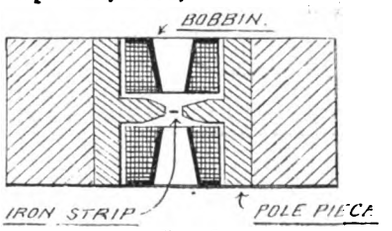

FIG. 4.

may be gathered from Fig. 4, which is a section across the gap.—ZERO.

Answer to No. 818 (*awarded* 5*s.*).—Owing to the extreme delicacy of the construction of an oscillograph, due to the rapid vibrations of the mirror, which demands as small a moment of inertia of the moving parts as possible, although the instrument is simple to understand, yet the writer is of the opinion that attempts to construct one by anyone who is not an expert will result in a disappointment. The piece of apparatus shown in Fig 1 will, he thinks, fulfil all requirements. The apparatus is for showing the shape of an E.M.F. curve. E D is an ebonite disc about 1ft. in diameter; T_1 and T_2 are connected to the terminals of the alternator; E V is an electrostatic voltmeter; B_1 and B_2 are two thin brushes, B_1 resting on the edge of ebonite disc, and B_2 on the brass collar, which is insulated from the shaft; S is a piece of brass let into the circumference of the ebonite disc, and is connected to the brass collar by the wire, W; *g* is the shaft of the alternator, and G S is a graduated scale by means of which the position of the brush B_1 can be noted. Now, as the alternator shaft rotates, the brush B_1 makes contact with S once in each revolution, and thus completes the circuit through the condenser. By the rapid succession of these very brief contacts, the condenser becomes charged to and is maintained at (provided there is no leakage) the same voltage

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as the alternator terminals, or between T_1 and T_2, at the instant when contact is made. By altering the position of the brush we obtain the shape of the E M F. curve. If the readings on the electrostatic voltmeter are too small to be read accurately, they can be obtained by placing a certain number of cells—preferably secondary cells—in series with the voltmeter, and afterwards deducting the voltage of the cells from the voltmeter reading. It is necessary to use the condenser, as the leakage of an electrostatic voltmeter is too great; also the brush, B_1, must be thin, so that the time of contact is extremely small. If it is desired to calibrate the condenser and voltmeter, apply a known potential difference to the terminals, with B_1 making contact with S, and note the voltmeter reading. Then run the machine up to speed, and again note the reading. If any leakage occurs, we can, by comparing the two readings, obtain a constant to correct future readings.

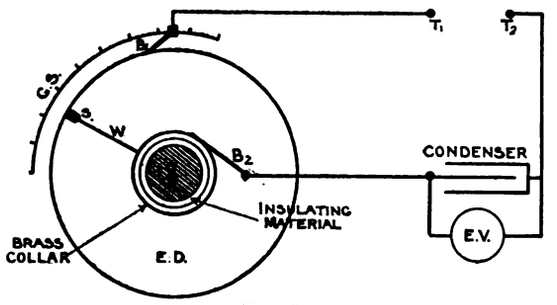

FIG. 1.

To obtain the shape of the current wave in an inductive circuit, the alterations as shown in Fig. 2 must be made, where R is a non-inductive resistance made as small as possible so that the working conditions of the circuit may not be affected, as it will be seen that R is in series with the inductive resistance of the external circuit, and that we are really measuring the potential difference between T_1 and T_2. Hence by Ohm's law we get $C = \frac{E}{R}$. G is a galvanometer, and T S is a two-way switch. A B is a wire along which passes a current supplied by a secondary cell. When working, the sliding contact, C, is adjusted until we get no deflection, when the potential difference at the condenser terminals will be proportional to the length

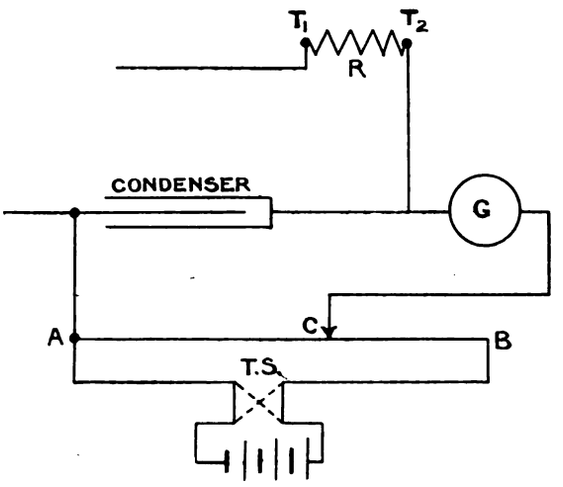

FIG. 2.

A C on the wire. To determine the constant to convert the scale reading of the sliding contact into amperes, a known current is passed through R, at the same time running the contact maker at the speed at which it is to be used, and the scale reading noted. If the alternator is not accessible, a synchronous motor driven from the alternator to be tested may be used for driving the instantaneous contact maker.—F. M. B.

Answer to No. 818 (*awarded* 5*s.*).—One of the simplest and cheapest forms of oscillographic wave tracers is that recently designed by Mr. R. Goldschmidt. Referring to Fig. 1, B and C are two solenoids which are energised by the alternating current of which it is desired to obtain the wave-form. A steel needle, A, is attracted and held by one of the magnets, and the other end being free the needle will oscillate, the amplitude of which depends on the wave form of the energising current. If the free end of the needle, A, is provided with a small mirror, a ray of light reflected from this mirror and projected to a screen will show a vertical line when the solenoids are energised. In order to obtain a movement of the needle representing the periodic time of the current, a further pair of solenoids, D and E, are provided, the axes of which are at right angles to the solenoids B and C (Fig. 2). The two pairs of solenoids are energised by the same current, and in parallel

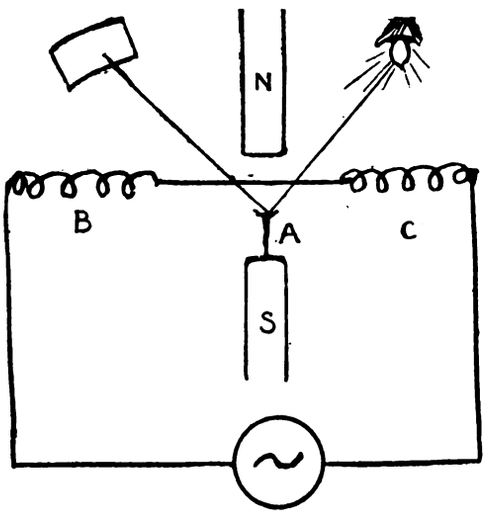

FIG. 1.

with one another. A non-inductive resistance, R, is placed in series with one pair, and a choking coil, I, is in series with the second pair. Now, if one pair of solenoids are energised the needle vibrates in a vertical or horizontal direction, as the case may be, but if the second pair is energised the needle vibrates in a vertical or horizontal direction, or at 90deg to the first movement. By energising both pairs at once a double movement of the needle is obtained. The use of the choking coil results in the current lagging about 90deg. in one pair of coils; therefore, one pair may be termed the voltage coil, and the

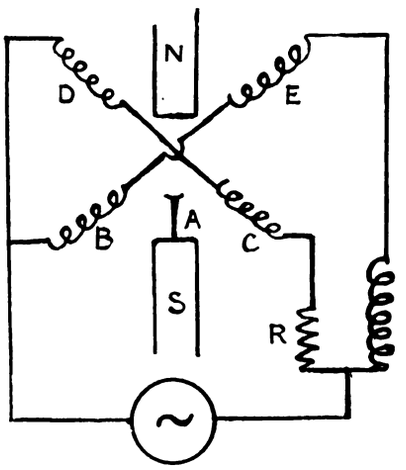

FIG. 2.

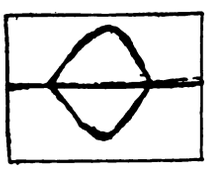

FIG. 3.

other the time coil. The resultant form of a sine curve projected on the screen will be as Fig. 3. The eddy currents induced in the solid pole by the needle vibrating prevents it showing a larger amplitude or periodic time than the actual current. In order to correct for any possible time error due to mirror, the light should be reflected on to a screen of semi circular form. It is, of course, necessary to obtain a current lag of 90deg. between the two pairs of coils, and this can easily be obtained by suitable connections of the choking coil or coils.—JUNO.

[Other replies to Question No. 818 will be given in our next issue.—ED. *E. E.*]

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NOVEMBER 3, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

QUESTIONS.

825. Is it necessary to have a complete circuit in order to have a flow of electric current? I have noticed that you can have shocks to earth off either the positive or negative rails of a certain electric railway, *both* rails being insulated. Is this due to defective insulation, or is it due to the fact that there is a difference of potential between *either* rail and earth?—WATTMAN.

ANSWERS.

Question No. 818.—I am anxious to study the wave forms in various parts of an alternating-current circuit. Can anyone describe the construction of a simple form of "oscillograph"?

Answer to No. 818 (*awarded* 5*s.*).—The shape of the wave of an alternating current has a very important influence on the way in which the current will behave, and it is important to consider how that shape may be determined. The general frequency now used is about 50 periods per second, and in order to obtain an idea of the way in which the current is changing, the instrument will be required to move with great rapidity. An instrument known as the "Duddell oscillograph" is one which has this property, and can be used to draw the wave-forms with the greatest accuracy. Fig. 1 shows the instrument,

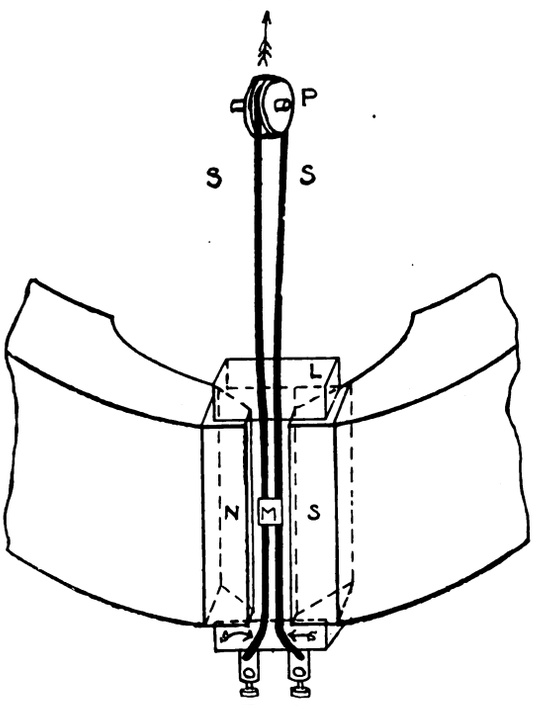

FIG. 1.

where S S are two strips of phosphor-bronze, which are stretched by means of a spring-balance applied to a pulley, P, between the poles of a powerful magnet, N S, and the circuit is arranged that the alternating current passes up one strip and down the other. When a current is sent through, both of the strips will be deflected, as it is well known that a conductor carrying a current, when placed in a magnetic field, tends to move in a direction perpendicular both to itself and to the direction of the field, but as the current flows up one strip and down the other the deflections will be in opposite directions, and in order to indicate the deflection of the strips a little mirror, M, is stuck on to them, so that when they are deflected the mirror will turn, the direction depending on the direction of current flowing in the strips. The moving parts of this instruments are made of such a size that they will be able to follow the rapidly changing forces that are made to act upon them, and therefore must move with great rapidity, or, in other words, their "free periodic time" must be very small. The strips, when deflected, will complete a back-and-forth movement in one three-thousandth of a second, and it is quite easy with this instrument to record accurately the wave-form of an alternating current with a frequency of 100 periods per second. It is not only essential that the moving parts and their free periodic time should be small, but they will require damping, otherwise the instrument will not record accurately.

In the Duddell oscillograph this damping is effected by enclosing the moving strips in a space filled with castor oil; this oil has great stickiness, and damps effectively the movement of the strips, so that the instrument will be deflected by its proper amount without any preliminary oscillations. When both of these conditions are fulfilled, the instrument will be deflected at any moment by an amount proportional to the actual value of the current flowing through it at that moment. When an alternating current is sent through the strips, all that is seen is a band of light reflected from the mirror on the screen, and in order to actually see the wave-form, some means must be devised of spreading the curve out; if the deflection be horizontal, the spot of light must be moved vertically, so that it is not in the same vertical position for every deflection. This is effected in a variety of ways, the simplest of which is by the use of a revolving mirror. The spot of light, when it has been deflected, is not viewed directly, but its reflection in a rapidly turning mirror is observed. In this case the motion of the spot is horizontal and the mirror is turned round a horizontal axis, so that an up or down vertical motion is given to the image of the spot as seen in the mirror.

Other methods of producing "time" motion have been employed, as has other oscillographs, and based on entirely different principles, but Duddell's is undoubtedly the best. The Blondel oscillograph is an instrument in which the moving part is a small soft-iron needle, which is deflected by a coil of wire carrying the alternating current. The fact that it depends for its working on a magnetic instead of an electromagnetic action necessarily entails a diminished accuracy for all waves that are not of a certain shape—a shape, however, to which in a great many cases a close approximation is made in practice.—J. P. S.

Question No. 819.—A three-phase plant generates current at 440 volts for power and transformed to 120 volts for lighting. The lighting circuit was originally wired for 240 volts continuous current. Could the transformers be dispensed with, and current taken from the mains and neutral point earthed, to obtain more light at about 250 volts? And taking, say, 100 amperes on each phase, what would be the current in the neutral wire?

Answer to No. 819 (*awarded* 10*s.*).—An almost complete answer to this question could be extracted from the information given in the article (on p. 492 of the issue in which it occurs) under the heading "Distribution by Three-Phase Currents." No doubt still more explanation will occur in the continuation of the article. But this answer will isolate the necessary information, and possibly allow it to be more easily followed than if it had to be sought for amongst other irrelevant matter. The wording of the question seems to indicate almost certainly that there is already a "neutral" point on the generating system—that is, that the generators are "star" connected. If this were not the case, it would be difficult, or impossible almost, to do what was wanted in any simple way. Reference to this will be made later. But assuming that there is a "star" connected generator, then the matter is comparatively easy.

In Fig. 1, let O, 1, 2, 3 be the generator, A B C and Z the three mains and neutral wires respectively, and O′ 1′, O′ 2′, and O′ 3′ the three lamp circuits as they would be connected up (one from each main to the neutral wire) after the transformers has been removed. The neutral wire, Z, is shown as a complete main from the lamps to the generator in the sketch, but it could be replaced as suggested, if desired, by an earth connection at the generator, and by a similar connection at each lamp or group of lamps as may be convenient. The power circuit is left out of the

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above diagram for clearness, and it does not really enter the question, as its connections to mains corresponding to A B C would be unaltered by the new arrangement of lighting. It is evident from the sketch that lamps connected as above will be lit; the point remains as to what voltage will be got at the terminals of the lamps. In other words, if 440 volts is the "line" voltage in a star-connected generator, what will the "phase" voltage be, or, given the potential difference from 1 to 2 at 440 volts, find V_P, the difference of potential from O to 1 or O to 2.

Drawing the three voltages, O 1, O 2, O 3, in a vector diagram (see Fig. 2) we have to get the voltage due to the difference of potential, 1 2, which is equal to 440 volts. This difference of potential 1 2, is equal to the vector sum of the two voltages $+$O 1 and $-$O 2, and can be obtained graphically by compounding O1 with 4 1, which is equal in magnitude to O 2, but acts in the opposite direction to it.

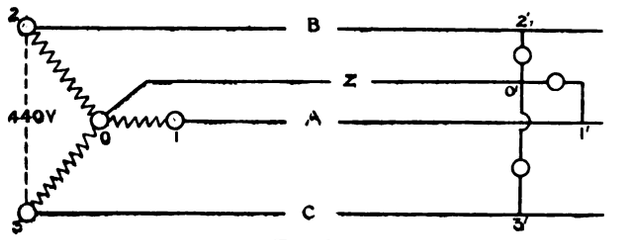

FIG. 1.

The resultant is 2 1 both in magnitude and direction, and this line bears to O 1 or O 2 (since these are 120deg. different in phase) the ratio of $\sqrt{3}$ to 1. Hence, if 2 1 represents 440 volts, the "phase" voltage is equal to $440 \div \sqrt{3}$, or 254 volts. That is to say, in the arrangement proposed the voltage available is 254 at the lamp terminals (assuming a negligible loss in the lines), which meets the case very very well. So far, then, it is all right, and 250-volt lamps can be coupled from mains to neutral point as desired. A little more light will be got than was originally possible at 240 volts owing to the higher pressure, and, provided the mains were fully loaded at the old continuous-current pressure, evidently it will be possible to get fully double the amount of light compared with what the mains were good for at 120 volts from the transformers.

As regards the latter part of the question concerning the amount of current in the neutral wire when each phase is taking 100 amperes—that is, when the phases are symmetrically loaded—the answer is that there will be no current in the neutral wire at all. For if, in Fig 3, O C_1 O C_2, O C_3, are the three currents of 100 amperes each (or of any other amount so long as they are equal), O being the neutral point, then the current flowing into the neutral

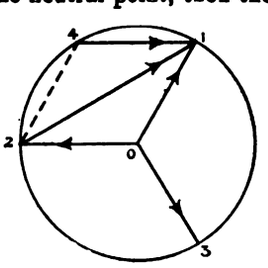

FIG. 2.

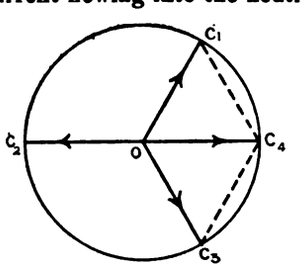

FIG. 3.

wire connected to O (but not shown in Fig. 3) will be equal to the sum of the currents—O C_1, O C_2, O C_3—since the sum of all currents flowing to and from O is zero, according to the usual rule. We have, therefore, to get the value of O C_1 + O C_2 + O C_3, considered as vectors. The sum of O C_1 and O C_3 is the diagonal O C_4 of the parallelogram O C_1, C_4, C_3; and, therefore, O C_1 + O C_2 + O C_3 = O C_4 + O C_2, which is equal to zero, since O C_4 is equal and opposite to O C_2. Hence, if one could be sure of always having balanced phases, there need be no middle wire at all. This, however, is not practicable unless three lamps, one in each phase, can always be used together and switched in or out as a group. As this is probably undesirable, one must consider the conditions due to unbalanced phases. The most extreme case—though very unlikely to occur—is when only one phase is loaded up to 100 amperes. The neutral wire current is then 100 amperes, of course, in phase with the current in the lamps. If O C_1 and O C_3, say, were each 100 amperes, the current in the neutral wire would again be 100 amperes, since O C_4, the vector sum of O C_1 and O C_3, is equal to either of them; and in phase it would be 60deg. ahead of O C_3 and 60deg. behind O C_1. If O C_1 were 100 amperes and O C_3 only 50, say, the current in the neutral wire would again be the vector sum of O C_1 and O C_3, which can easily be shown to be $50\sqrt{3}$, and to be, in phase, 30deg. behind O C_3 and 90deg. before O C_3.

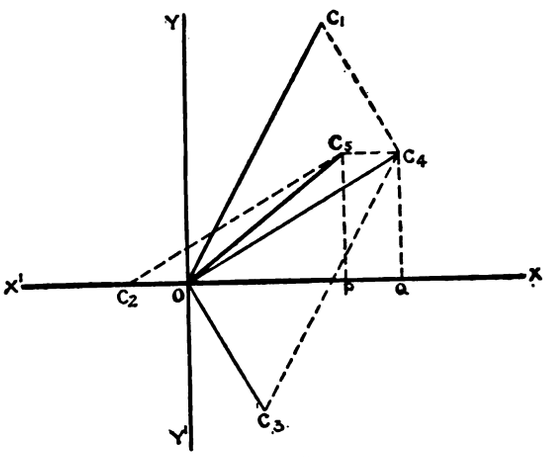

FIG. 4.

Similarly, if there be current in each phase, which will be the case always if the installation be well designed—and the better the design the more nearly equal will O C_1, O C_2, and O C_3 be—the current in the middle wire will be the sum of the three vector expressions for the individual currents. Suppose, for example, O C_1 is 100, O C_2 is 20, and O C_3 is 50, and neglect for simplicity the fact that these will no longer, owing to their want of equality, be exactly 120deg. apart. The arrangement is shown in Fig. 4. O C_4 is the sum of O C_1 and O C_3, and is, by the usual trigonometrical rule, equal to

$$\sqrt{100^2 + 50^2 - 2 \cdot 100 \cdot 50 \cdot \cos 60\text{deg.}}$$
$$= 50\sqrt{3}.$$

O C_5 is the sum of O C_4 and O C_2, and is, therefore, the sum of O C_1, O C_2, and O C_3, or the required result. Its value is

$$\sqrt{(50\sqrt{3})^2 + 20^2 - 2 \cdot 50\sqrt{3} \cdot 20 \cdot \cos 30\text{deg.}}$$
$$= 70.$$

Its inclination to O X is $\tan^{-1} \frac{C_5 P}{P O}$ or $\frac{C_4 Q}{Q O - Q P}$

or,
$$\frac{O C_4 \sin 30\text{deg.}}{O C_4 \cos 30\text{deg.} - O C_2} = \frac{50\sqrt{3} \times \frac{1}{2}}{50\sqrt{3} \times \frac{\sqrt{3}}{2} - 20}$$
$$= \frac{50\sqrt{3}}{110},$$

and
$$\tan^{-1} \frac{50\sqrt{3}}{110} = \tan^{-1} \cdot 787, \text{ or } 38^\circ\ 12'.$$

Thus the current in the neutral wire is 70 amperes, lagging 21° 48′ behind O C_1, lagging 141° 48′ behind O C_2, and leading 98° 12′ before O C_3. Other combinations could be similarly treated, and the current in the neutral wire found graphically for any set assumed.

Just one word, in closing, about a mesh-connected generator (see Fig. 5). Here the neutral point in the generator is imaginary, but a neutral point for the system might be artificially created by coupling up three resistances, O R_1, O R_2, O R_3, in star grouping, and using the point O as the return for the common lead from the lamps, or the earthed point. This would, of course, be economically inadmissible, owing to the waste current always flowing, and it would further necessitate the use of lower voltage lamps, as one resistance of the set would be in series with all the lamps of the corresponding set which happened to be switched in. This would cause great fluctuation in the lamps, owing to varying loss of volts in the resistances. The arrangement is practically impossible, but is mentioned because it is possible to employ it in some special cases of a different

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nature from the one here. Of course, if the phases could be kept balanced by the arrangement before suggested of always having three lamps, one in each set, switched in or out at a time, the lamps could be star connected to a mesh-connected generator without feeling the want of a neutral wire, as the currents in any two branches would combine to form the equal (in numerical value) current for the third branch, and the volts per branch of lamps would be 254 as before, if the generator voltage were 440, as assumed. But only in this case is it practically possible to run lamps at a

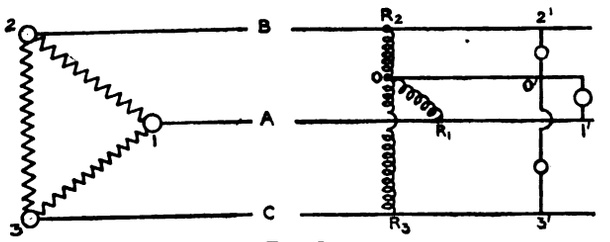

FIG. 5.

lower voltage from a mesh-connected generator. With a star-connected machine it is always possible.—T. C.

Answer to No. 819 (*awarded 7s. 6d.*).—The method suggested in the question of working a combined power and lighting system has often been adopted with success. The arrangement which is shown in Fig. 1 consists of the

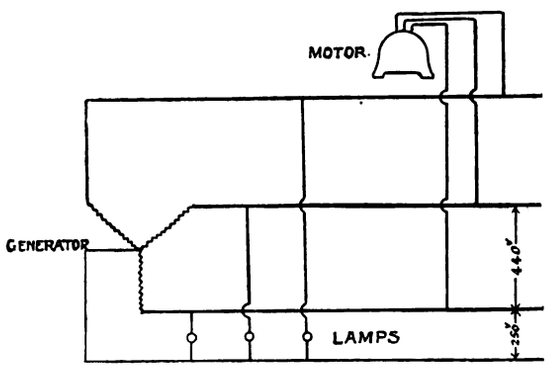

FIG. 1.

three line wires of equal cross-section and a neutral wire usually earthed, the lamps being connected between the neutral and any of the three line wires. The motors take their supply from the three line wires in the ordinary way, and work at the full pressure of 440 volts, while the voltage between the neutral and the outers—*i e*, that across the lamps—will be about 250. The clock diagram in Fig. 2 will explain this. Let the voltages between the

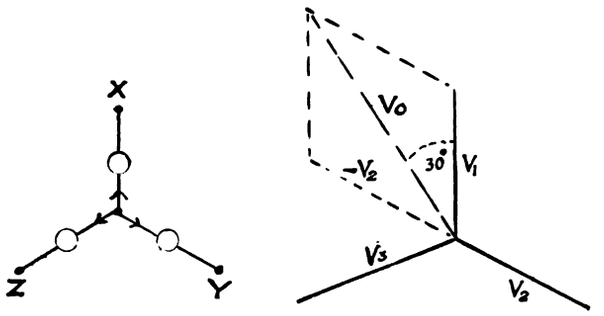

FIG. 2.

neutral and the outers be V_1, V_2, and V_3 respectively, counted positive when they act from the neutral point. The voltage between X and $Y = V_1 - V_2$. Drawing in $-V_2$ and completing the parallelogram, we have the voltage between X and Y = resultant $V_0 = 2\ V_1 \cos 30\text{deg}$.

$$= \sqrt{3}\ V_1.$$

Hence the voltage across the lamps

$$= \frac{440}{\sqrt{3}} = 254.$$

It must be assumed that the lighting circuit originally wired for 240 volts continuous current has sufficient insulation to withstand the increased voltage, which will reach a maximum instantaneous value of $250 \times \sqrt{2} = 350$. It is unlikely that an equal number of lamps will always be connected to the three outers, and, therefore, the neutral wire which will carry the out-of-balance current should be connected to the neutral point of the generating plant, which must be star wound.

If the neutral point of the generating plant is not available, an equaliser can be placed at a suitable point on the system. This is simply a three-phase star-connected choking coil, and the neutral wire is connected to the neutral point. However, the presence of motors on the circuit would have a similar equalising effect. It is supposed in the question that the lamps are taking 100 amperes per phase; the circuits, therefore, are perfectly balanced, and there will be no current in the neutral wire.—H. O. B.

Answer to No. 819 (*awarded 7s. 6d.*).—The method of distribution suggested of using an earthed neutral is quite common in the case of three-phase lighting circuits, and corresponds to the three-wire distribution of continuous current where the middle wire is earthed and used as the common return. Fig. 1 gives a diagrammatic view of the arrangement. The voltage between any two lines being 440 volts, that between either line and the earthed neutral will be $\frac{440}{\sqrt{3}} = 254$ volts, which is the voltage supplied to the lamps. The current flowing in the earthed neutral will depend on the way the phases are loaded relatively to each other. For supposing there are the same number of lamps connected across each phase and the neutral, so that the current in each line I., II., and III. is the same, then

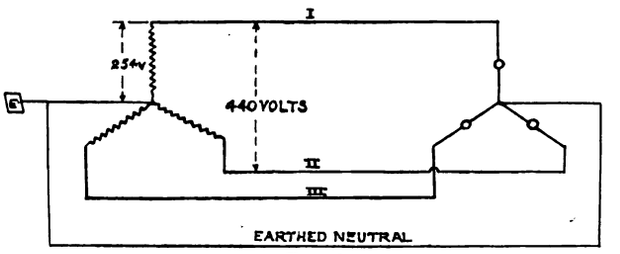

FIG. 1.

there will be no current in neutral. This is readily seen by reference to Fig. 2, in which O 1, O 2, and O 3 represent the currents in each of the three lines I., II., and III., and each being the radii of a circle they are equal in magnitude,

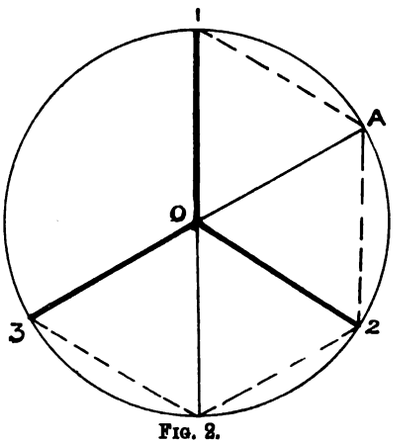

FIG. 2.

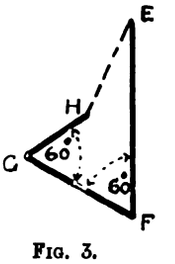

FIG. 3.

and are displaced from each other by 120deg. Now the current flowing in the earthed neutral is the resultant of these three currents O 1, O 2, and O 3, and in the case we are considering is obviously zero. Thus with 100 amperes on each phase the current in the neutral will be zero, and it is quite easy to see that no matter how the load on either phase is varied, provided the load on any one phase does not exceed 100 amperes, the maximum current that will flow in the earthed neutral will be 100 amperes, so that the cross-section of this main need be no greater than that of either of the three mains, I., II., or III. For supposing that O 3 and O 2 are zero, and that O 1 is 100 amperes—*i e*, there is 100 amperes on phase I, and no load on either phases II. or III.—then the

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current in the neutral must equal O 1—*i.e.*, 100 amperes. Now suppose that the load on phase II. is increased to 100 amperes, the load on phase III. still remaining zero. The current in the neutral will now be the resultant of O 1 and O 2, equal to O A, equal to 100 amperes, and it is readily seen that for any value of O 2 less than 100 amperes, O A will correspondingly be less than 100 amperes. If now load be put on phase III. while the current in phases II. and I. is still 100 amperes, the current in the neutral will decrease in value, for this must always be the resultant of O A and O 3—*i.e.* (O A – O 3)—because, from the symmetry of the diagram, O A and O 3 lie in the same straight line. When O 3 = O A—*i.e.*, when all the phases are equally loaded—the current in the neutral will be zero, as was shown to be the case previously.

Fig. 3 shows a rapid vectorial method of arriving at the value of the current in the earthed neutral. In this diagram we have

E F = current in phase I.,
G F = current in phase II.,
G H = current in phase III.,
then E H = current in the neutral.

The voltages across the phases should be very evenly balanced, no matter how each phase is loaded, for the employment of an earthed neutral tends to equalise the voltages.—A. P. Y.

Answer to No. 819 (*awarded* 5*s.*).—In this three-phase plant the lighting could be satisfactorily and more economically carried out without the use of transformers by adopting the method illustrated in Fig. 1. As the

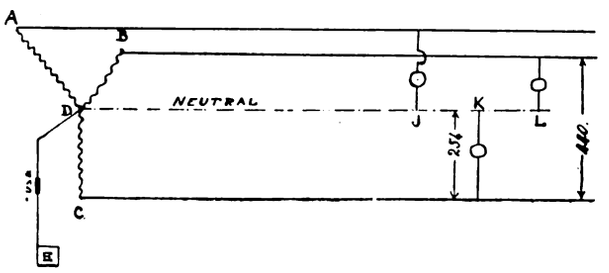


FIG 1.

generator has a neutral point (which it is intended to earth), it must be "star" wound; then

Voltage between any two line wires = 440.

Voltage between any line wire and neutral

$$= \frac{440}{\sqrt{3}} = 254.$$

So, while motors would be connected across the 440-volt leads, lamps could be run between the neutral and either A, B, or C at 254 volts. When the lighting load is 100 amperes on each phase, then current returning to generator by the neutral is zero, and the only currents in neutral would be between the points J, K, L.

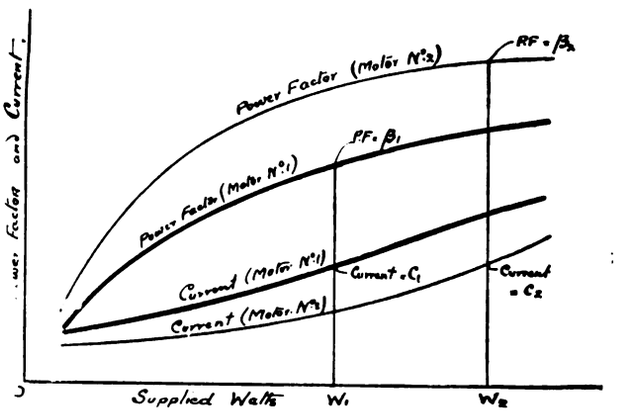
The lighting load, if properly distributed between the three phases and neutral, would produce no voltage regulation difficulties at the generator end.

It would be well to place a fuse between the point D on generator and earth-plate, so that if one feeder became earthed at any point the fuse would blow, but the system would still continue to work satisfactorily, and the fault could be repaired at leisure.—W. C. S.

Question No. 820.—Two single-phase induction motors of exactly same horse-power but by different makers, when doing similar work require exactly same current and same voltage. Wattmeter, however, on motor No. 1 registers only two-thirds that of meter on No. 2. (1) Is this because power factor of first motor is only two-thirds that of power factor of No. 2? (2) As current × voltage is much greater than watts paid for, who pays for lost energy? (3) Does not the above point to the suggestion that if two motors of similar amperage give same torque, but that one has lower power factor than the other, the lower power factor one is cheaper to run from consumer's standpoint?

Answer to No. 820 (*awarded* 7*s.* 6*d.*).—The watts supplied to either motor, after deducting the losses occurring in the motor itself, represents the power required to do the particular work with which that motor is connected. Although no idea of the size of these motors is given in the question, we can safely assume that the losses occurring in either motor at full load will be something of the order of 5 per cent. of the full-load output. As the motors will doubtless be working very near their full-load horse-power, we may neglect the losses and assume that the watts supplied to each motor is a measure of the work done by that motor. If both the wattmeters are reading correctly, then we must conclude that the work done by motor No. 1 is only two-thirds of that done by motor No. 2; and, further, if the motors are doing similar work—*i.e.*, the torque exerted by each is the same—then the only way we can explain this difference in the supplied watts is that the speed of motor No. 1 is only two-thirds of the speed of motor No. 2. This would be the case if motor No. 1 had $1\frac{1}{2}$ times as many poles as motor No. 2, or supposing No. 1 was a six-pole motor and motor No. 2 a four-pole motor.

If the above supposition be correct, we can easily show how it is possible that the current taken by each motor is the same, although the work done by one motor is only two-thirds of the work done by the other. In the diagram curves are shown which indicate how the power factor and current vary with the supplied watts in the case of each motor. These curves are shown slightly different for the two motors for the purpose of arriving at the desired result, and as the motors are by different makers this assumption is not unwarranted. The thick-line curves are for motor



No. 1 and the thin-line curves for motor No. 2, and supposing the watts supplied to motor No. 2 to be represented by O W_2, then the watts supplied to motor No. 1 will be represented by O W_1, where O $W_1 = \frac{2}{3}$ O W_2. We also have that, corresponding to W_2 watts supplied to motor No. 2, the power factor is β_2 and the current C_2, and, further, corresponding to W_1 watts supplied to motor No. 1, the power factor is β_1 and the current C_1. For this particular set of curves we see that $C_1 = C_2$, and consequently $\beta_1 = \frac{2}{3}\beta_2$, which means that the current supplied to each motor is the same and the power factor of motor No. 1 is only two-thirds of the power factor of motor No. 2, which is the result observed by "Amateur."

Parts (2) and (3) of the question will be easily answered if "Amateur" remembers that

$$\text{power factor} = \frac{\text{supplied watts}}{\text{current} \times \text{volts}},$$

or, $$\text{supplied watts} = \text{P.F.} (\text{current} \times \text{volts}).$$

What his meter registers and what he pays for is *supplied watts*, and not current, and if the power factor in one case is smaller than in the other, the current in each case being the same, it only means that the watts supplied in the one case is smaller than that in the other, and the motor, of consequence, is doing less work, as was shown to be the case previously. As a matter of fact, a small power factor is a disadvantage, in so far that for the same supplied watts the current varies inversely as the power factor, so that with a small power factor the current is unnecessarily large, giving appreciable C^2R losses, which are paid for by the consumer.—A. P. Y.

[Other replies to Question No. 820 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"

NOVEMBER 10, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

826. What is meant by the all-day efficiency of a transformer? What are the factors to be taken into account in the design of the transformer in order to secure a high all-day efficiency?—T. J. M.

837. Explain clearly, with diagrams if necessary, the "La Cour" system of compounding motor-generators.—M. G. TWEEDIE.

ANSWERS.

Question No. 820.—Two single-phase induction motors of exactly same horse-power but by different makers, when doing similar work require exactly same current and same voltage. Wattmeter, however, on motor No. 1 registers only two-thirds that of meter on No. 2. (1) Is this because power factor of first motor is only two-thirds that of power factor of No. 2? (2) As current × voltage is much greater than watts paid for, who pays for lost energy? (3) Does not the above point to the suggestion that if two motors of similar amperage give same torque, but that one has lower power factor than the other, the lower power factor one is cheaper to run from consumer's standpoint?

Answer to No. 820 (*awarded* 7*s.* 6*d.*).—The fact that both motors take the same current when doing the same work indicates that the product of power factor × efficiency is the same in the two cases. The motor which takes the lower number of true watts must be doing so simply because its efficiency (ratio of output watts to true input watts) is higher than that of the other motor in the ratio of 3 : 2, so that with only two-thirds of the input watts the output at the pulley is the same. Since the product of power factor × efficiency is constant, the power factor of the high-efficiency (low true watt) motor must be lower than that of the other motor in the ratio of 2 : 3. In the design of induction motors it is often possible to alter the power factor at the expense of the efficiency in this way. Thus, supposing that whilst retaining approximately the same diameter and length of rotor, one of the makers employs a considerably shorter air-gap than the other. The number of stator turns in the small air-gap motor could then be reduced so as to work at a higher flux density, and yet the power factor would be higher than in the other motor. The fewer turns would somewhat reduce the stator $C^2 R$ loss, but the higher flux density would decidedly increase the iron loss, which is usually the more important, so that the efficiency would, on the whole, fall. The net result would be a motor of higher power factor but lower efficiency, though so large a difference as in this case (in the ratio of 2 : 3) is quite unusual between motors by recognised makers.

With regard to the second part of the question, the true watts (as shown on a wattmeter) are the only ones usually paid for, as they are the only ones which directly require engine power to produce them. The "idle current," which is out of phase with the voltage and causes the difference between the product of volts × amperes and the true watts, is objectionable in the way of causing drop in the leads and drop in the alternator voltage through armature reaction, but it is essentially a wattless current and requires no expenditure at the generating station. In some stations it is the custom to make a small additional charge, based on the amount of this wattless current, over and above the ordinary charge for the true watt-hour consumption. When no such charge is made, it is obvious that the motor with the highest true watt efficiency (quite independently of whether it has a high or a low power factor) is the best from the consumer's point of view, as this will be the one which for a given useful output takes the least true input watts.—Q.

Answer to No. 820 (*awarded* 5*s.*).—I think the great difference in the readings of the two wattmeters must be due to their inaccuracy, and not to the motors. One could understand a difference of 1 or 2 per cent. in the motors, but hardly 33 per cent., as "Amateur" states. A simple method to test this would be to change over the meters. If this be done, I expect it will be found that the motor which was before registering most is now registering least. It will now be necessary to have one or both of them recalibrated. If the above is not the cause (but I rather expect it is), we must look elsewhere. Now, inasmuch as the current to the two motors is the same, it would appear that the work done by the two machines is about equal, providing the power factors and efficiencies are also about the same, and, therefore, the inputs are expected to be about similar, under these ordinary conditions. As they are not, we must look for the cause to either the power factor or the efficiency. The power factor of an induction motor such as this may be anything up to about ·8, depending on the size of the machine and its load, the aim of the makers being to get as high a power factor as possible. Assuming that in the case of motor No. 2 the power factor = ·7, and the input is x_2 kilowatts, then motor No. 1 must have a power factor of only $\frac{2}{3}$ of ·7 = ·47, because $x_1 = \frac{2}{3} x_2$ and the volts and amperes are the same in both cases. If the two motors are anything like fully loaded, I don't think it likely that one of them will only have a power factor of ·47. A motor is designed to have as good a power factor as possible so as to keep down other losses and improve the efficiency. One could understand a small variation of 5 or 6 per cent. in this owing to the difference in make, as one machine may be more liberally designed than the other and one may be designed for best power factor at full load whilst the other might be at three-quarter load, and so on. The fault must lie in the accuracy of either the wattmeters or the ammeters, either of which could account for this discrepancy.

Turning now to the second portion of the question as to who pays for lost energy, the answer is the electricity works. This lost energy all goes in heat in the machines and lowers the station efficiency. The lower the power factor of the whole system the greater must be the current supplied for the output required, hence the losses which are proportional to the current are increased. The chief of these is the $C^2 R$ loss. It is these extra losses over and above what there would be supplying the same output with a power factor of unity which represent the lost energy, which has to be met by the electricity works.

The last part of the question as to the advisability of using motors of low power factor from the consumer's point of view is certainly a novel one. If with unity power factor it takes a certain current at the supply pressure to do a certain amount of work with a certain efficiency, then with a lower power factor it will take more current at that pressure to do the same work; hence the current losses in the machine are now increased, and the efficiency must go down, and so we have in no way bettered things, but the reverse. The following will make this plain:

$$\text{Watts input} - \text{losses} = \text{watts output},$$
$$E \times C \times \cos\phi - C^2 R = \text{watts output}.$$

Now, assuming E constant, it will be seen that in the first expression C is inversely proportional to $\cos\phi$, the power factor. If we halve $\cos\phi$ we must double C, the current to keep the input the same, but the losses $C^2 R$ will now be four times as great as before, and, therefore, for the same output to make up for the added losses the input must be increased, and hence our efficiency is lowered. Of course, if two motors can be found to do the same work, taking the same current at the same pressure, one having a lower power factor than the other, from the consumer's point of view it is advisable to use the one with the lower power factor, but it will be found that in reality there is very little to be made out of it this way, and it would be well to see that really you are improving the efficiency. I think the above should have made all the points in the query quite plain.—E. R. ALEXANDER

Answer to No. 820 (*awarded* 5*s.*).—As a basis to work upon, let us assume that the power factor of motor No. 2 is unity and that the true watts are 100. Then the true watts will equal the apparent watts, as

$$\frac{\text{true watts}}{\text{apparent watts}} = \text{power factor},$$

that is,

$$\frac{100}{100} = 1{\cdot}00.$$

Now, in motor No. 1 the true watts (according to meter) are only two-thirds of the (true watts on other motor, or

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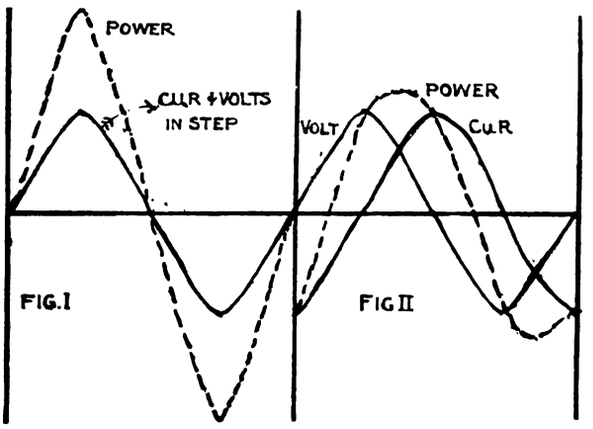
apparent watts on other motor, and apparent watts on each machine are alike) apparent watts.

$$\therefore \text{ the power factor will be } \frac{66{\cdot}6}{100}, \text{ which is } {\cdot}66.$$

Here we have two motors supposed to be doing the same amount of work, and the one with the worst power factor only costing to run it two-thirds of the price that the other costs with a power factor of unity. Which is absurd. Either the motors *cannot* be doing the same amount of brake horse-power or the meters are wrong. An increase in the power factor always means an increase in the economy of working. If a motor is taking full load current and the power factor is ·50, then the motor is only



doing half load, but full-load losses are going on in the machine, so that the consumer will have a little disadvantage; but the main trouble of inefficiency will fall upon the power station, and it is in their own interest to keep the power factor as near unity as possible all over the system. For a given load and potential difference the current varies inversely as the power factor. Hence, the rate at which energy is dissipated by heating of the circuit will vary inversely as the square of the current. In Fig. 1 the power curve is shown with the volts and current in step. In Fig. 2 the current lags 45deg. and the power factor is ·5. It will readily be seen the importance of a good power factor.—F. B. M.

Question No. 821.—In a certain power station it is desired to test a 700-kilovolt-ampere two-phase alternator, direct coupled to a triple-expansion Belliss engine, for the steam consumption—*i e*, pounds of water—per kilowatt-hour. There is available a water resistance capable of taking 1,200 kw., if required. The set has its own condenser—steam-driven air and circulating pump. There is a feed tank 12ft. by 7ft. by 6ft., into which several condensers discharge, the temperature being from 80deg. to 120deg. F. The feed to the boilers being pumped from this tank through an economiser to the boilers (Babcock and Wilcox, Meldrum Koker stokers, and forced draught), the steam for the jets can, if necessary, be supplied from an independent boiler. It is not required to take into account the steam used by the condensing plant. It is proposed to run the test for five hours. Is this long enough? Please give full details of the usual method of conducting such a test, especially the best way of measuring the water at the hot-well, the various readings required, etc. Also name any good practical books dealing with engine and boiler tests (not American). The steam pressure at the engine stop valve is 170lb. with about 100deg. F. of superheat.

Best Answer to No. 821 (*awarded* 10*s.*).—From the reading of question it is taken that the steam set only is to be tested. As this is so, it will not be necessary to interfere with the usual working of the boiler-house, and steam can be taken from either ring-main or header, as the case may be. The steam for jets can make no possible difference, the test being for steam used, not for coal burnt or water evaporated. It is stated that steam used for condensing plant is not to be taken into account. This is a bit difficult if the exhaust from air-pump, etc., is led into condenser, and can only be calculated approximately by taking indicator cards from pump engines and working out the steam consumption from same. The method for doing this can be found in any text-book on steam. If steam from auxiliaries is put through a feed-water heater, then they have to be left out of account altogether.

With regard to duration of test, a lot depends on reason for testing the set, but it is certain, if a thorough test is to be made, five hours will not be sufficient. It is impossible to get any satisfactory readings with less than one hour's run on each different load. Assuming that five hours is all that can be spared, the run should be as follows: 1½ hours quarter load condensing, 1½ hours half load condensing, 1½ hours full load condensing, ½ hour overload condensing.

In describing test it will be advisable to list the various instruments and appliances necessary, then to place the observers with the readings to be taken, afterwards giving a short description and analysis. Starting at engine, the following instruments are necessary: (1) steam pressure gauge on boiler side of stop valve; (2) steam pressure gauge on high-pressure steam chest; (3) intermediate-pressure receiver gauge; (4) low-pressure receiver gauge; (5) vacuum gauge on exhaust pipe; (6) mercury-cup with thermometer reading to 500deg. F. Nos. 1, 2, 3, and 4 are usually supplied by the engine builders, and No. 5 either by engine makers or condenser manufacturers; Nos. 1 and 5 should be checked before commencement of test by other standard gauges. (7) Six high-speed indicators for each end of all three cylinders, with magneto attachment to same; (8) mercury-cup, with thermometer reading up to 200deg. F. on air-pump discharge; (9) tachometers and steam indicators for steam ends of pumps; (10) two tanks, which have previously been calibrated and marked off (see Fig. 2); (11) one two-way cock or two-lever sluice valves, interlocked, say, 6in., with all pipes necessary from air-pump to the two tanks mentioned above; (12) a large quick-acting sluice valve, say 10in., on each tank, with pipes leading to hot-well mentioned in question.

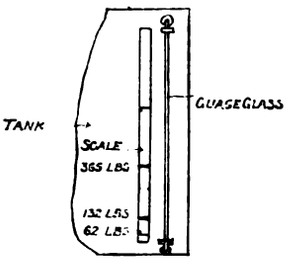


FIG. 2.

This is a fairly complete bit of mechanical apparatus. The electrical portion of test is as follows: On the supposition that the machine in question is connected to the 'bus bars and has previously been in use, it will be necessary to disconnect the 'bus-bar side of switch from the bars. The leads should be taken from switch through any instruments that are on panel to the water resistance. Between the switch and water-box a load panel should be inserted. This load panel should be fitted with properly calibrated and guaranteed instruments, which probably will be supplied by the alternator makers, or could be loaned from a firm of instrument manufacturers. The following is a list of electrical apparatus: (13) main switch, capable of breaking 1,000 kw.; (14) field switch; (15) field ammeter; (16) synchronising appliances. The above will be on machine panel of main board, if same is used. (17) two ammeters, one on each phase; (18) two voltmeters, one on each phase; (19) two single-phase wattmeters; (20) an oil switch capable of breaking the maximum load. Nos. 17, 18, 19, and 20 should be on load panel. From here leads can be taken to the water resistance. This should be adjustable with leather thongs from top of rod, over a pulley down to within reach, so that the load can be altered whilst the tanks are alive. If the machine is of high voltage, the attendant should wear rubber gloves as an additional safeguard.

Method of Test.—When all connections are complete and have been made, including a trial run, it will be necessary to place the various assistants in their positions. It is not possible to state exactly how to place the men without knowing the locality, capability of assistants, etc. The various observation sheets properly marked off and ruled, as shown under, should be handed to each observer. With each set of sheets should be included a board fitted with clips to hold sheets, and a place assigned for same to be placed. The various sheets for different observers are marked A, B, etc. A list is given herewith. The engine

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driver should be quite capable of looking after engine and reading the various gauges on same, including the temperature of steam. These readings to be entered on sheet A. An experienced assistant must be on engine-platform to take indicator cards. These should be marked at once "L P.," "I.P.," and "H P.," and top or bottom end also numbered and time noted (sheet B). It will be necessary to have an observer on the condenser to read the vacuum, speed of pumps, and also to take indicator cards if necessary (sheet C). Another observer must be at the two tanks, 10, to work the interlocked sluice valves and take

minute intervals are used, it is very easy to convert same into hours. Of course, it will be noted that E and F are a check on one another, and that the readings entered on F sheet are readings from correct instruments. The results are very easily worked out, and do not need explaining, being

$$\frac{\text{Water in 6 minutes} \times 10}{\text{average kilowatts in one hour}} = \text{steam per kilowatt-hour.}$$

The steam consumption can also be worked out per indicated horse-power and per electrical horse-power.

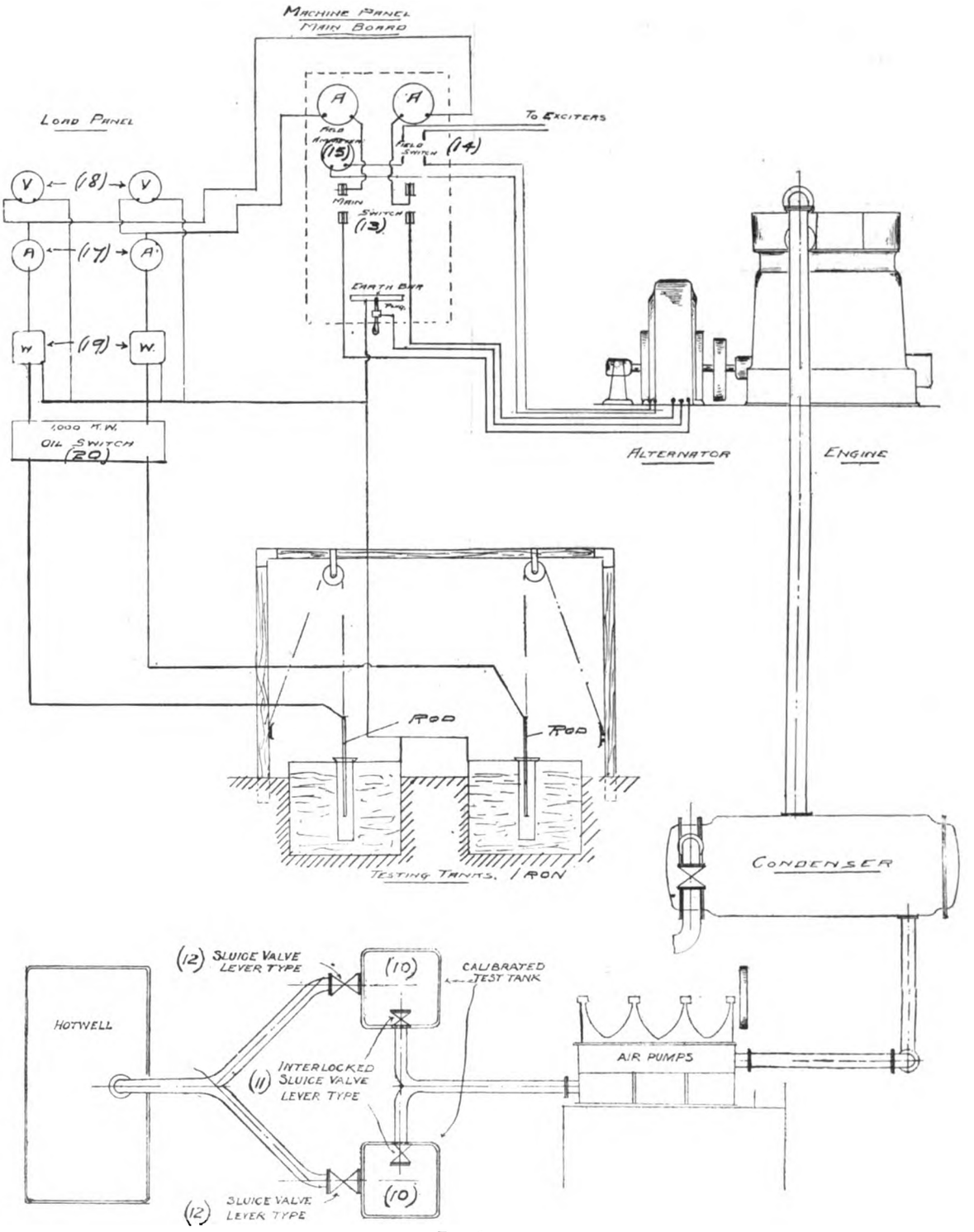

FIG. 1.

the readings on tank before opening the sluice valve to let the water into hot-well (readings sheet D). An observer will be required on the machine panel of main board to take readings as on sheet E, and also to operate switches in case of need and to adjust field. An experienced assistant must attend to load panel and enter readings on sheet F, also to control a man in charge of the water resistance.

All being ready, it should be agreed to start at a certain time and to take observations every six minutes. If six-

OBSERVATION SHEET.

A.

Time.	Steam.	Pressure. H.P. chest.	I.P. receiver.	L.P.	Vac.	Tem.

B.

Time.	Card Nos.	Revs.	Remarks.

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C.

Time.	Vac.	Speed or Revs. Circ.	Air.	Card Nos.

D.

Time.	Lbs. tanks. 1.	2.	Wt. net.*

* If a few inches were left in tank after emptying, it is necessary to note it.

E.

Time.	Amps. A.	B.	Volts. A.	B.	Field amps.

F.

Time.	Amps. A.	B.	Volts. A.	B.

A good work on engine and boiler testing is by Prof. Pullen, and is published by the Scientific Publishing Company, Manchester.—J. H. S.

Answer to No. 821 (*awarded* 7*s.* 6*d*)—The test which "Electron" proposes to take upon his plant is the simplest it is possible to take, and yet the results to be obtained are the most important, since pounds of water per kilowatt-hour represents the true efficiency of the combined plant, and upon this result the performance of the plant is always judged. There are two sets of readings to be taken: the first on the steam side, and the second on the electrical side. I will deal with the steam side first. The thing, of course, to be measured is the water taken by the engine. This can be best done by measuring the discharge from the condenser. "Electron" states that several other condensers discharge into the tank into which our condenser discharges. This, of course, will not do. If the other condensers are not in operation at the time of taking the test, all well and good, but if they are in use, either their discharge must be diverted or another tank must be obtained into which our condenser may discharge. This latter will, I think, be the better plan, because it must be understood that as we are going to measure the discharge from the condenser we cannot straightway take the water again for feed purposes until it has been measured. The arrangement will then be this: the condenser will be discharging into tank A, from which the water is periodically discharged into a special measuring tank, B, and after measurement the water is run from B into tank C, from which the boilers feed. The measuring tank, B, will, of course, have to be accu-

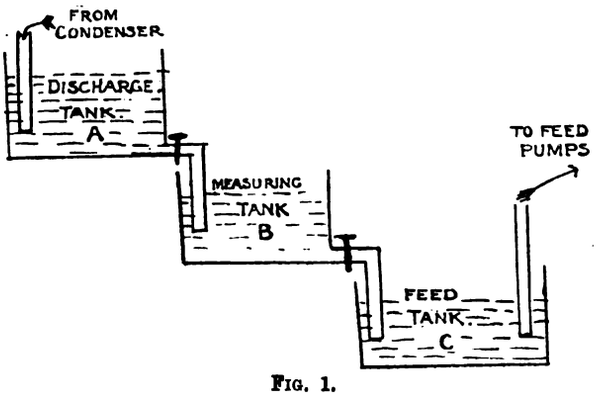

FIG. 1.

rately calibrated previously, and an easily distinguished mark made upon it indicating that up to this mark represents a certain known weight or volume of water. The procedure during the test will then be to fill the measuring tank, B, at intervals from the tank A up to the mark, then cut off the supply from A, and empty tank B into tank C, and, when empty, turn off the tap and refill again from A when necessary. All leakages *on the exhaust side* of the engine will have to be carefully collected and weighed during the time the test is on. Now, as regards the readings to be taken on the electrical side. In circuit with the alternator will be connected an ammeter, voltmeter, a two-phase watt-hour meter, or two single-phase meters. The above watt-hour meters must be of great accuracy. The connections are shown in Fig. 2. It will, of course, be necessary during the test to keep the load as constant as possible. The reading of the watt-hour meter must be taken before and after the test, the difference, of course, giving the power generated. In Fig. 2 A represents an ammeter, V a voltmeter, W the two-phase watt-hour meter, and R the water resistance.

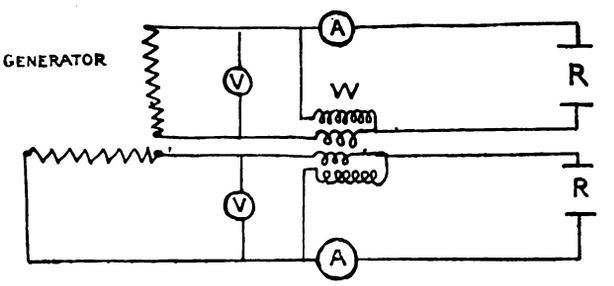

FIG. 2.

I will now proceed to describe the general procedure in taking a test. First of all, I would remind "Electron" that we are not taking a boiler test, and therefore it is absolutely unnecessary to prolong the test for five hours. Half an hour's duration is quite long enough for a test once everything is in full swing, but, of course, it is as well to repeat the test once or twice in order to check the results obtained. Half an hour's test will give results quite as accurate as five hours. The first thing to be done is to make everything ready for the test, as I have previously described. The machine, of course, will be plugged on to a spare set of 'bus bars or temporary leads taken from its terminals to the testing tank outside. Then the engine is started up and the generator put on to its full normal load, or any other load at which it is desired to test it, by means of varying the distance apart of the plates of the water resistance. The boiler pressure, the vacuum, etc, must all be at their normal values, and kept as constant as possible. The set had better be run half an hour before any test is taken, to allow everything to reach its normal condition. There is one small difficulty which presents itself, and that is the method of turning the condenser discharge into tank A at the precise instant of commencing the test. The best way of doing this is, I think, by means of a flexible pipe connected to the condenser discharge pipe. The water discharged is allowed to run to waste until the signal to commence the test is given, when the operator puts the end of the flexible pipe over the tank A, allowing the discharge to run into this tank.

The signal to commence the test had better be given by means of an electric bell to the operator in charge of the water measurement. Then, on the signal being given, the water is allowed to run into the discharge tank, the reading of the watt-hour meter taken, and also the time of the commencement of the test. The test should be run for about half an hour; the actual time is not particular. At the end of the test the signal to stop is given, and the condenser discharge is diverted from the tank A. The watt-hour meter reading is also taken. As I have previously described, during the test the water is run from the tank A into tank B and measured. Shortly after the finish of the test the operator in charge of the condenser discharge will be able to give the weight of water discharged. The differences of the meter readings will give the kilowatt-hours used, and then, of course, we have that

$$\frac{\text{Total condenser discharge}}{\text{kilowatt-hours}} = \text{pounds of water per kw.-hour.}$$

All leakages on the condenser side of the engine are, of course, as I have described, included in the numerator. A second and third test may now be taken. I myself have often used this method, and I think it the best one to use.

"Engine Tests and Boiler Efficiencies," by J. Buchetti, is a good book on the subject.—ERNEST P. HOLLIS.

[Other replies to Question No. 821 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
NOVEMBER 17, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

840. Is there any formula giving for a magnetic blow-out the connection between sparking distance, voltages of supply, current to be broken, distances of the pole-pieces, and number of ampere-turns on blow-out coils?—J. S.

ANSWERS.

Question No. 821.—In a certain power station it is desired to test a 700-kilovolt-ampere two-phase alternator, direct coupled to a triple-expansion Belliss engine, for the steam consumption—*i.e.*, pounds of water—per kilowatt-hour. There is available a water resistance capable of taking 1,200 kw., if required. The set has its own condenser—steam-driven air and circulating pump. There is a feed tank 12ft. by 7ft. by 6ft., into which several condensers discharge, the temperature being from 90deg. to 120deg. F. The feed to the boilers being pumped from this tank through an economiser to the boilers (Babcock and Wilcox, Meldrum Koker stokers, and forced draught), the steam for the jets can, if necessary, be supplied from an independent boiler. It is not required to take into account the steam used by the condensing plant. It is proposed to run the test for five hours. Is this long enough? Please give full details of the usual method of conducting such a test, especially the best way of measuring the water at the hot-well, the various readings required, etc. Also name any good practical books dealing with engine and boiler tests (not American). The steam pressure at the engine stop valve is 170lb. with about 100deg. F. of superheat.

Answer to No. 821 (*awarded 7s. 6d.*).—In order to carry out this test, we have two measurements to make: (1) the output of the generator, (2) the steam consumption of the engine. The first of these measurements presents no serious difficulties. The machine would be loaded on the water resistance, care being taken to see that both phases are equally loaded, and readings taken on the

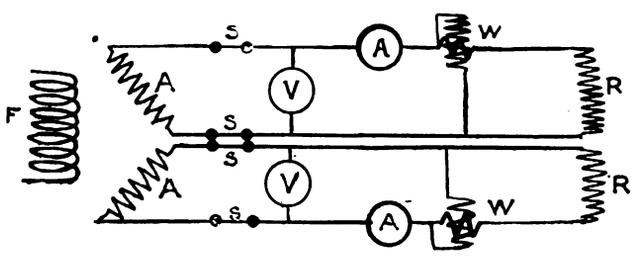

FIG. 1.—F, Alternator Field; A A, Alternator Armature; S S S, Switches; V V, Voltmeters; A A, Ammeters; W W, Wattmeters; R R, Water Resistance.

necessary instruments; the latter might be arranged as in Fig. 1. If the set is already installed, the instruments will probably be found already connected up on the switchboard. The idea of inserting a wattmeter as well as a voltmeter and ammeter is to enable the power factor to be determined. This will be fairly high, as the only inductive resistance in circuit will be that in the machine itself. The second item is not so easily obtained. There are several methods open, and we shall proceed to discuss a few of the most promising ones. In order to make a continuous measurement of the steam consumption over the whole test, one of the following methods may be employed: (1) two separate tanks on separate platform weighing machines; (2) two separate calibrated tanks, or one with a divided partition; (3) weir; (4) measuring tube; (5) meter. If it be deemed sufficient to measure the steam consumption by alternately filling and emptying a single tank, single tanks may be used in Nos. 1 and 2. When considering the above methods in rather more detail, we must remember that we have a flow of something like 250lb. per minute to provide for.

Weighing-Machine Method.—As we must have a tank capacity for at least five minutes, we shall require two tanks 3ft. by 3ft. by 3ft. and two weighing machines with a range up to three-quarters of a ton, and as continual weighing is necessary it will be seen that this method is far from convenient. If two tanks are employed, some device must be used to facilitate changing over from one tank to the other. A very satisfactory arrangement is shown in Fig. 2. The pipe, A, is clamped to the side of one of the

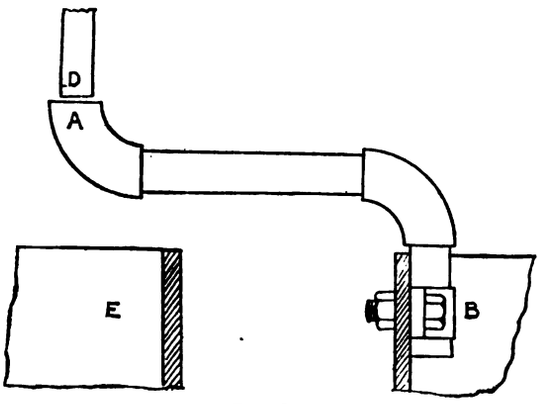

FIG. 2.

tanks, B, in such a manner that it can be moved at right angles to the plane of the paper, and so by swinging the end, A, under the delivery pipe, D (a temporary diversion of the pipe from condenser to hot-well), or clear of it, the water can be diverted into the tank B or fall direct into the tank E. The connection A should be made amply large in comparison with D in order to allow the water a free passage. If one tank only is employed, the drain pipe or pipes should be as large as possible so that a minimum amount of time is lost while emptying the tank. A modification of the one-tank method, which enables continuous measurements to be made, is shown in Fig 3 Here the

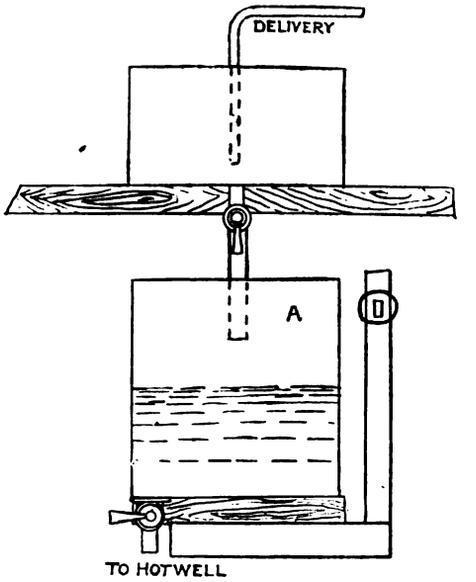

FIG. 3.

water delivered while the lower tank, A, is being weighed and emptied is stored in the upper tank, B, and afterwards allowed to enter the lower tank and be weighed. Of course, this auxiliary tank need only have about half the capacity of the weighing tank. With regard to the weighing machines, these are sometimes arranged so that when the weighing lever rises it makes an electrical contact and rings a bell. The jockey weight is set at, say, 100lb., plus the weight of the tank; then, as soon as 100lb. have

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entered, the lever rises and rings the bell, on hearing which the observer notes the time. The jockey is then moved another 100lb, and so forth.

By Means of Calibrated Tanks.—Where a large platform weighing machine is unavailable, it may be found convenient to measure the water by volume rather than by weight. A divided tank arranged for experiment is shown in Fig. 4. To calibrate the tanks, known weights of water

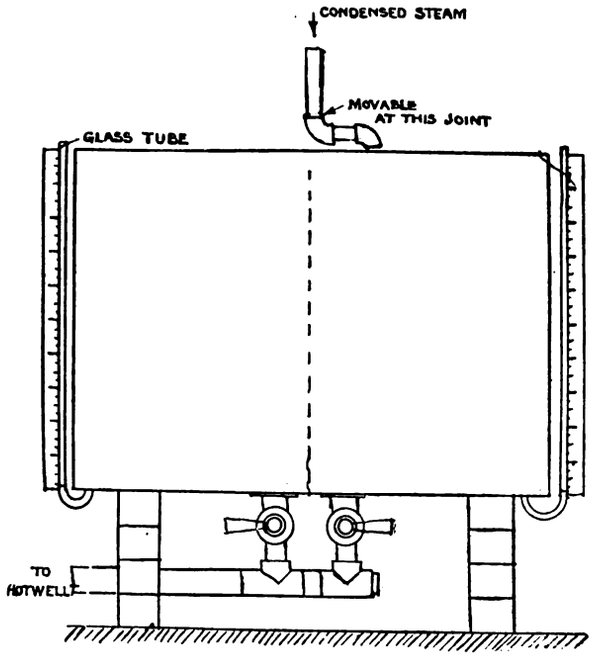

FIG. 4.

are introduced, and the height of the water in the tanks observed by means of ordinary inch scales placed alongside the gauge glasses. These scales may either be made permanent and a calibration curve co-ordinating weight of water and height in tank used, or a scale (on paper will do) may be made which will read pounds of water directly. This latter method is preferable.

By Means of a Weir.—Both the foregoing methods require constant attention, and No. 1 is especially tedious in working. By means of a weir, which is easily and inexpensively constructed, a continuous measurement of any quantity of water (condensed steam), however large, can easily be made. A suitable arrangement is shown in Fig. 5.

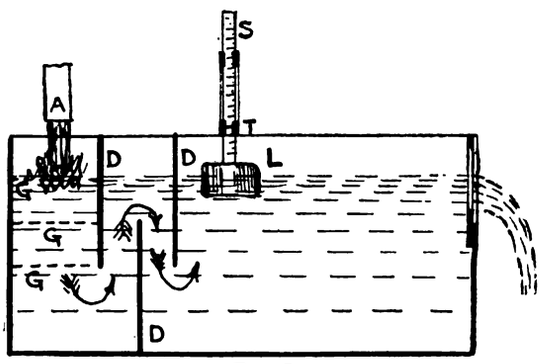

FIG. 5.

The water enters at A, and immediately encounters two or three horizontal sheets of perforated zinc, through which it passes; it then moves under and over the diaphragms, D, and after passing slowly over the rest of the tank falls over the weir, which *must* have sharp edges. The width of the tank should not be less than three times the width of the weir, and the depth of the tank not less than three times the maximum head over the weir. A float, L, made of thin sheet copper attached to a boxwood, brass, or aluminium scale indicates the position of the water-level in the tank. For good results, L should not be less than 2ft. from the weir. The scale may be guided in any suitable manner, remembering that friction must be minimised as much as possible, and an index fixed to the tank must also be provided. A fine brass or copper wire soldered to one of the guides is very suitable for this purpose. The quantity of water passing over a rectangular weir is given by

$$\text{pounds per minute} = 320{\cdot}6\ C\ d\ b\ h^{\frac{2}{3}},$$

where h = head of water above the bottom edge of the weir in feet;

b = breadth of the weir opening in feet;

d = density of water in pounds per cubic foot;

C = coefficient of discharge.

Unfortunately C varies with the head and the width of the weir, so that each weir must be separately calibrated. The method of doing this is perfectly simple: water is allowed to flow over the weir under various heads, and the flow determined by catching and weighing the amount discharged in a certain time. One point, however, requires notice, and that is the determination of the zero reading or level of the lower edge of the weir. Fig. 6 shows the method of doing this. The screw, Q, which is supported

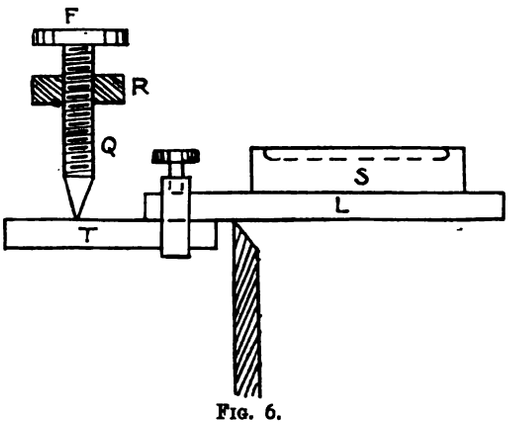

FIG. 6.

from a bar, R, attached to the tank, is screwed down until the level, S, indicates that the strips, L and T, are level; T, L, and S are then removed, and the tank filled until the surface of the water just touches the point of the screw; the zero reading on the scale is then taken. A V notch might be used instead of a rectangular weir; this gives a more constant coefficient of discharge, but is rather more difficult to make satisfactorily.

By Means of a Measuring Tube.—This is an extremely cheap and convenient method, and in practice is found to give very fair results. The arrangement is shown in Fig. 7, which practically explains itself. Although the scale, which reads directly in pounds per minute, can be made from theoretical considerations, it is best made experimentally. For the purposes of this test a 5ft. tube, having three $\frac{1}{2}$in. holes in the bottom plate, would probably be sufficient.

By Means of a Meter.—It may be found convenient to measure the condensed steam by means of a water-meter, though it should only be used where other methods are impracticable. A positive meter should be employed, and should be carefully calibrated before and after a trial. Both Kennedy's and Schonheyder's are good types; the latter is made to take water up to a temperature of 300deg. F.

With regard to the trial as a whole, five hours is ample; in fact, four hours only should be devoted to taking observations, the set being run on load for about an hour to get everything settled down. After starting up the set, the load should be put on and adjusted to the required value, and the set allowed to run about an hour, during which time the steam-measuring appliances, whichever selected, should be tested and all the drain cocks, etc., closed. At the end of this time observations should be commenced; the observer on the generator should take readings every five or ten minutes, keeping the load as steady as is possible. The observer measuring the steam, if methods (1) or (2) be chosen, should plot his meter on a time base as soon as taken. Should this curve depart greatly from a straight line, the probability is that something has gone wrong, and attempts should be made to locate it. In any case, by drawing the best average straight line through all the points, the average pounds of steam per hour throughout the trial is easily obtained. If either of the other methods be used, readings should be

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taken every five or ten minutes. In calculating the final result the average of both these and the generator readings should be used.

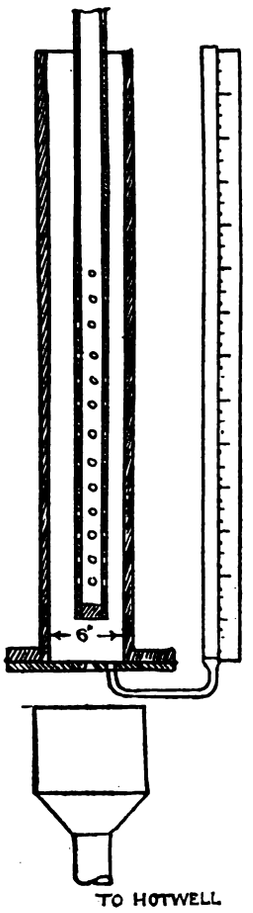
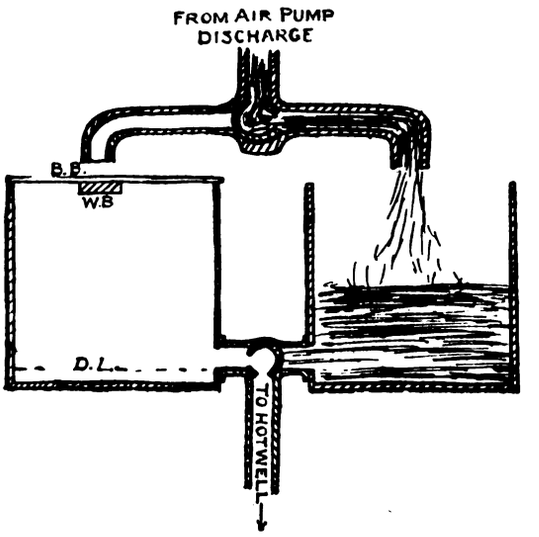


FIG. 7.

The best English work on the testing of engines and boilers is "Experimental Engineering—Vol. 1, Engines and Boilers," by Prof. W. W. F. Pullen, 654 pages, published by the Scientific Publishing Company at 15s. net.—B.Sc.

Answer to No. 821 (*awarded 7s. 6d.*).—The best way for "Electron" to make the desired test will be by attaching a special discharge pipe to the air-pump discharge of the condenser which is isolated on to the set under test, and by collecting the condensed steam in two calibrated tanks. Five hours will be long enough to give reliable results, the object of specifying eight-hour tests being that after six hours' running it has been found that the parts do not then increase in temperature under normal conditions; the last two hours are then used for taking overload and working to atmosphere tests. The sketch shows the arrangement of tanks, etc., for conducting the test. The pipe fitted with the two branches is from the air-pump discharge, and is fitted with a cock enabling it to deliver to either tank. Both tanks are connected to a common outlet pipe, which can be led away to the hot-well, or elsewhere, as desired, and which is also fitted with a cock to enable it to empty either tank. The two tanks are calibrated as follows: Fill up to the discharge level, D L, and then fill up with a 10-gallon measure (carefully noting the number used) until the water just touches the underside of the wooden block, W B. This block is attached to a thin flat batten, which can be laid across the top of the tank, and the block, W B, should be planed down until an exact number of gallons is registered between D L and W B. In getting the set ready for testing, go round all drains, trap discharges and drippings from rod and spindle glands, and see that they are all either led into the exhaust pipe or collected and measured; and if a grease separator is used in between engine exhaust and condenser, the water collected in the separator must also be measured, together with the steam used to pump it away from the separator. All connections should be made, if possible, the night before testing, and the alternator leads should be led away to the water resistance, and all necessary connections completed. A reliable ammeter and voltmeter, reading virtual amperes and volts, should be used, and a standard kilowatt-hour meter put in series with each phase. If the water resistance is out of sight of the place of testing, it is a good plan to signal by means of lamps, worked from switches at the testing place, a red lamp being lit up when the load is exceeding the correct load, and a white one when the load is dropping below the correct load. The set should be run up about half an hour previous to the test being taken; this will enable things to be well warmed up and a flying start to be made. If it is



desired to indicate the engine as well as to ascertain the water used per kilowatt-hour, the indicator gear should have been overhauled and three indicators be fixed—one on each cylinder—connected to a three-way cock communicating with the top and bottom ends of the cylinder as desired. A high-reading thermometer should be placed just before and a tested steam gauge just after the main engine stop valve. All glands should be gone round and *slacked* off as far as possible without blowing resulting. A reliable tachometer and a revolution counter should also be used on the engine and alternator shaft. One person and one watch should be regarded as the standard through the test, and two reliable men should be stationed on the tanks. As soon as all is ready, the readings of the counter, kilowatt-hour meter, and barometer should be noted, and the temperature and pressure of the steam at the stop valve taken, and the load put on the engine, and at the next quarter of the clock take the first reading. The water is, of course, collected in the calibrated tanks as soon as the test is started, and each observer should independently mark down the number of tanks filled. As soon as one tank is full the cock must be thrown over and the other started to fill, the first being emptied at once and the discharge closed ready for the next time of filling up. The discharge pipe from the tanks should be much greater than the discharge pipe from the air-pump. The readings to be taken should be as follows: To be taken every half-hour, starting at the first quarter after test commences. Time to be noted of each reading.

Steam pressure at stop valve and degrees superheat.	Load as shown by ammeters and voltmeters.	Vacuum in inches.	Revolutions per minute.	Time of reading.

Also any remarks as to conditions.

In between each of these readings a set of cards should be taken, the three cards from the top ends to be taken simultaneously, and the three cards from the bottom ends of cylinder to be taken also simultaneously, and as soon after the top set as possible, the load being kept as absolutely constant as possible. On the back of the cards mark down the following: generating set number; cylinder (high pressure, intermediate pressure, low pressure, and which end); steam pressure at stop valve; degrees superheat; reading of voltmeters; reading of ammeters; revolutions per minute; pressure in each receiver; vacuum in inches; temperature of discharge water from air-pump; taken by (and time); piston stroke; piston diameter; piston rod diameter; percentage of clearance volume to

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cylinder volume; scale of diagram; any remarks as to conditions thought necessary.

Of course, if "Electron" simply wishes to know the water used per kilowatt-hour, he can omit the indicating part of the test, but as it involves very little extra trouble, and will give a great deal of information of a valuable nature, it should not be omitted. The total number of revolutions made by the counter should be taken down and the tachometer checked against it. All that "Electron" wishes to know is: units generated, water used, and

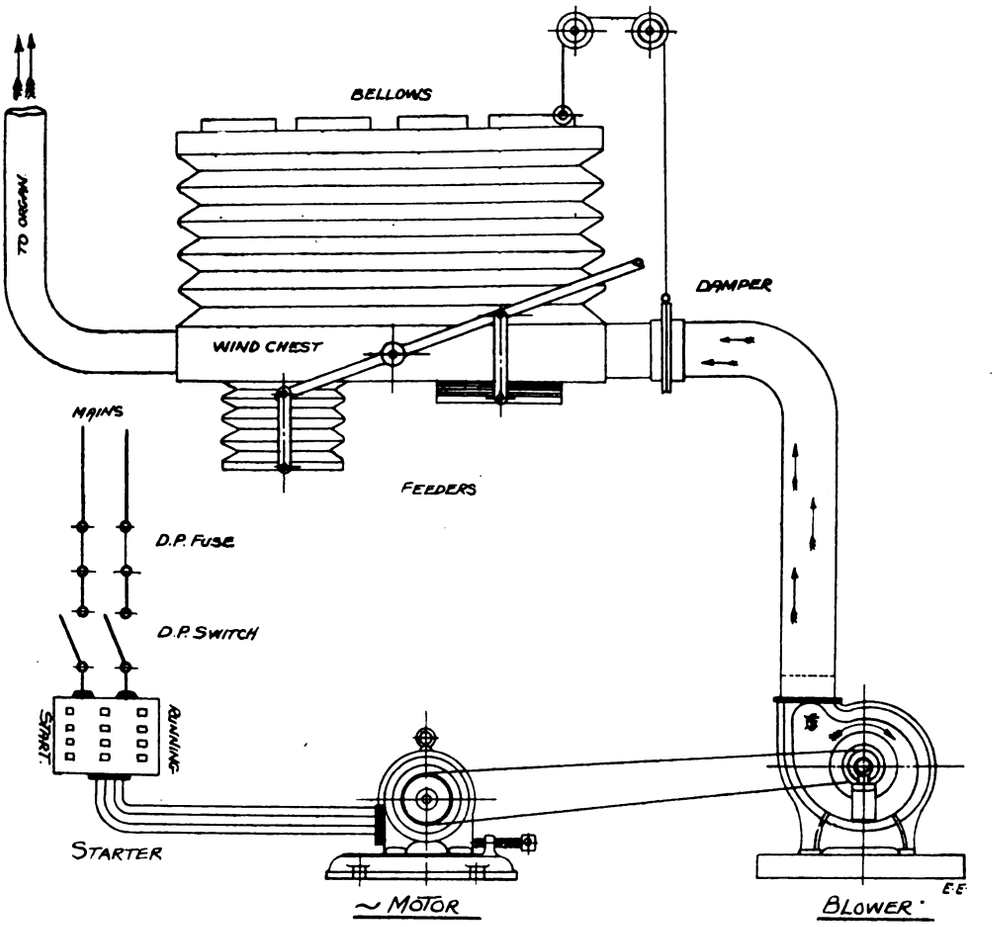
$$\frac{\text{Water used}}{\text{units generated}} = \text{water per kilowatt-hour.}$$

The writer has used the above methods in larger sets than 700 kw. with good results. The calibrating tanks, if of 130-140 gallons capacity, will be quite large enough.

A good book on the subject is "Indicator Diagrams and Engine Testing," by C. H. Day (4s. 6d.), published by the Technical Publishing Company, Deansgate, Manchester.—W. T. W.

of speed to keep a constant supply of air, and would not start with the load without the aid of a special friction clutch in connection with the worm gear. There still remain the extra cost of the reducing gear and the necessary motor-controlling switch. The best and most suitable way is to employ a centrifugal blower in the manner shown in the sketch, thus obviating the use of any special electrical controlling gear. The main advantages being ease of starting and entirely automatic wind control, also the motor and fan may be placed at any distance from the organ. The motor runs at constant speed, and in the case of a continuous or alternating supply there is no loss due to series regulating resistance.

The bellows are supplied with wind at a constant pressure by the fan, which is in turn driven by belt from the motor, the volume of air being automatically controlled by the sliding damper. The weight on the bellows causes depression when empty, and this movement raises the damper, allowing sufficient air to pass to fill them again, when the damper again closes. The motor may be left running for



Question No 822.—It is desired to work the bellows of a church organ by a single-phase motor. Describe the best way of doing this, and sketch the automatic starting and regulating switch. The motor would require to be of about 1 h.p.

Answer to No. 822 (*awarded* 7*s.* 6*d.*).—The application of electricity for working the bellows in connection with church organs is recognised as one of the cheapest and best methods if applied in the right manner. There are two or three methods of applying it, one being to have the motor driving a crankshaft (through reduction gear), on to which are connected at the various angles the connecting rods from the feeder bellows. This method resembles a two or three crank steam-engine, the feeders taking the place of the pistons. This is quite suitable where continuous or three-phase current is available, but with a single-phase supply it is more difficult.

It is generally known that a single-phase induction motor is not self-starting against any load, and is, moreover, very difficult to regulate for speed, a 10 per cent. or 20 per cent. variation being the maximum (except where a series-wound commutator repulsion motor is used).

These are the main disadvantages of this system, as the motor would have to be regulated over a large range any length of time without harm, and when the bellows are full a minimum of power is expended in driving the fan. The motor may be of the short-circuited rotor type, and started by means of a four-pole throw-over switch, which first puts into circuit the starting winding in series with a resistance. This starting coil is fixed on the stator, and causes sufficient phase displacement to start the motor. When nearly maximum speed is obtained the switch is thrown over to the running position, cutting out the starting winding entirely and putting the stator across the mains. As the output of this type of fan increases with the speed, no great load is put on the motor until maximum speed is obtained, and by that time the switch will be in the running position. The feeder bellows and hand gear need not be detached, and would be found useful should the electrical supply at any time fail. Care should be taken in choosing the driving belt, as this item in many cases creates a lot of noise. It should be of a very soft nature, either of raw hide or laminated leather, and made endless.—P. DEAN.

[Other replies to Question No. 822 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
NOVEMBER 24, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

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QUESTIONS.

841. When a conductor is charged with electricity, the whole charge resides on the surface of the conductor; when, however, the conductor is carrying a current, the whole cross-section of the material is in use. How can these two commonly accepted facts be reconciled?—SUPERHEAT.

ANSWERS.

Question No. 822.—It is desired to work the bellows of a church organ by a single-phase motor. Describe the best way of doing this, and sketch the automatic starting and regulating switch. The motor would require to be of about 1 h.p.

Answer to No. 822 (*awarded* 7*s.* 6*d.*).—Electricity affords the best and most suitable means of driving bellows to furnish wind for organs. There are objections to all other mechanical systems which do not apply to electricity. The gas or oil is noisy; the steam-engine requires constant attention; the water motor cannot be depended upon to provide a regular supply of wind, and in frosty weather the pipes are liable to freeze. Electricity, properly applied, contains none of these objections. The electric motor remains unaffected by changes of temperature, requires no attendant, occupies small space, and is quiet in action.

There are one or two things to be taken into consideration in answering this question: (1) For variable-speed work, where constant stopping and starting are required, the single-phase motor with short-circuited rotor is not so readily adaptable for this class of work as is the shunt-wound direct-current motor. (2) There is difficulty inherent with single-phase motors in starting under load, so that if wind-chest or reservoir is to be supplied by feeder bellows from a crankshaft, this will have to be specially arranged with fast and loose pulleys, which can be worked automatically from air reservoir by chains or ropes. (3) The argument in favour of the single-phase motor of this type is its simplicity and the absence of wearing parts.

Fig. 1 shows an arrangement which should work very well. The various parts are shown diagrammatically, and the various positions are suggestive only. "J. A. M." will be able to follow the outlines of the scheme from the sketch and the following explanation: A is wind-chest; B and C are two feeders connected to crankshaft, to the end of which is fitted a fast cone pulley, D, also a loose pulley, G. A corresponding cone pulley, E, is fitted to countershaft, C S F F are fast and loose pulleys, with a hand arrangement, H^1, for putting the belt on to the fast pulley after the motor is started. This could be arranged to work from the keyboard. When commencing the play, the organist starts the motors in the usual way, with belt on loose pulley, pulling belt on to fast pulley when motor is up to full speed. As the wind-chest will probably be empty, the belt will be on thick side of cone pulley, E, and *vice versâ* on D. The wind-chest will begin to expand, the ropes connected to wind-chest at

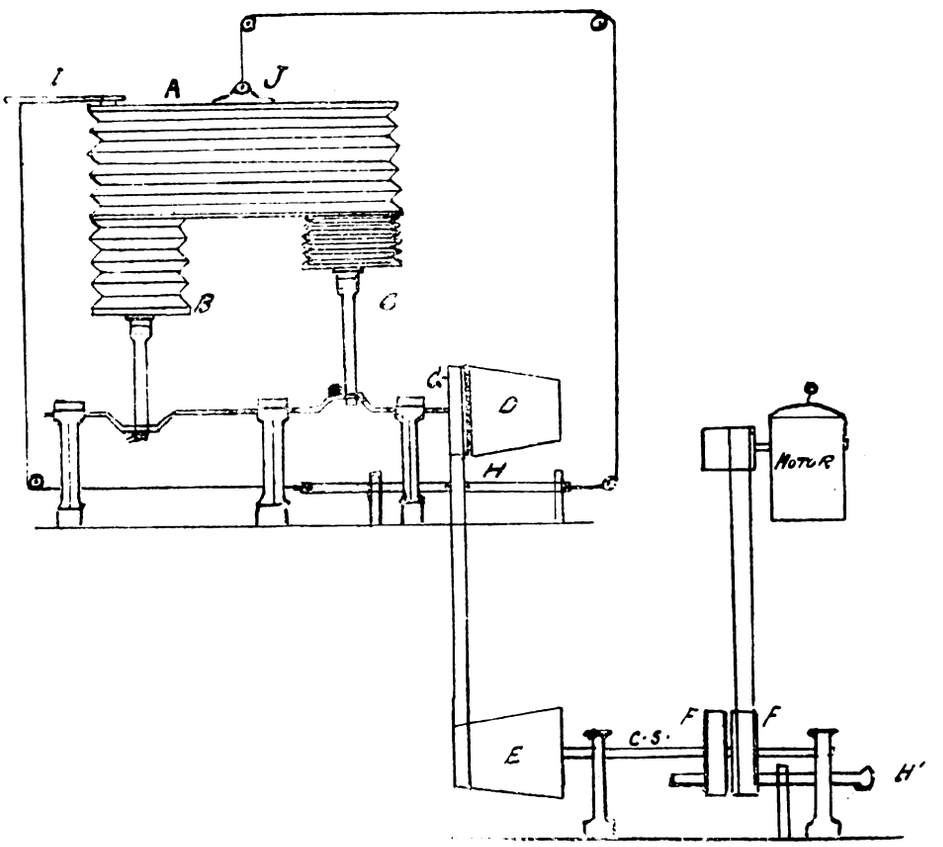

FIG. 1.

I and J and rod, H, will draw the belt to thick side of cone pulley, D, and finally on to loose pulley, G, stopping the feeders, B and C. The wind-chest will now slowly collapse, drawing belt on to slow speed of cone pulley, D. This arrangement will regulate the speed of feeders,

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B and C, in accordance with the demand for wind. A little more than 1 h.p. will be required for this. Now I should advise the putting down of a combined set of motor and centrifugal blower, feeding direct into wind-chest, A, the feeders, B and C, being left for hand blowing in case of accident or stoppage to motor. The motor in this case, as in above, will run at constant speed, the pressure from blower, which is regulated by S V, being just sufficient to keep reservoir always full. E V is over switch, M motor, B blower. F is a flexible connection to wind-pipe to prevent noise from motor and blower being heard at keyboard.—C. W. HOLMAN.

Answer to No. 822 (*awarded* 5*s.*).—This query comprises two sections—viz: (1) the transmission of power from the shaft of the motor (running at a comparatively high speed) to the organ lever moving at, say, 35 complete (one up and one down) strokes per minute; (2) the automatic control of the driving power, and consequently the amount

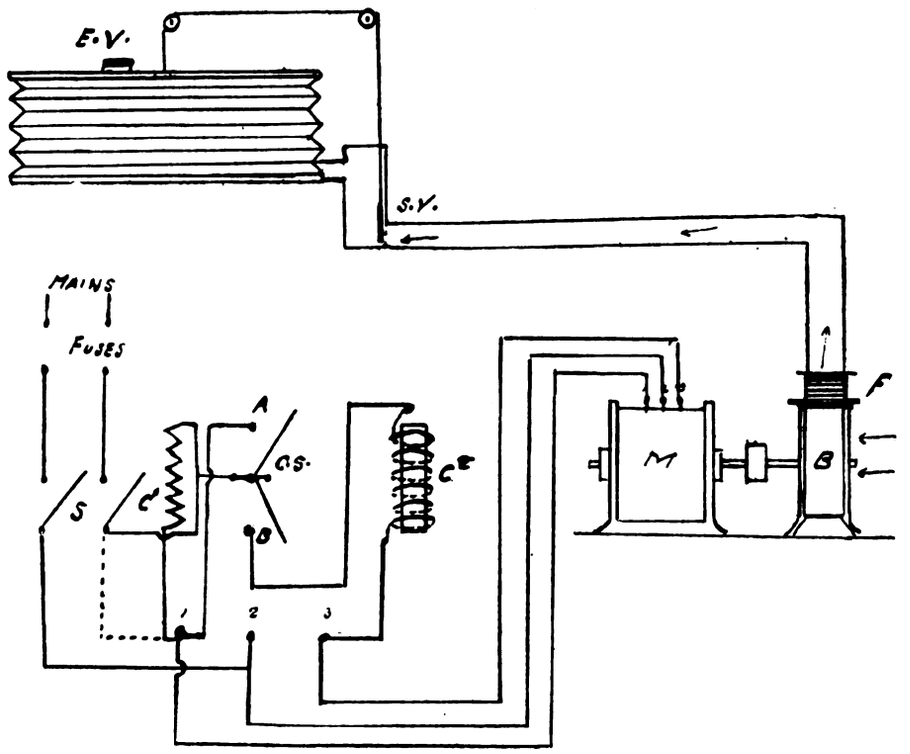

FIG. 2.

an escape valve. The author has known this to give better satisfaction with continuous-current motors than the variable-speed controlling arrangements, which give constant annoyance through burning of contacts and regulating resistance.

Fig. 2 shows this arrangement with starting switch connections for motor in both cases. The stator is provided with an auxiliary winding in parallel with the main winding. In series with the former (while the motor is being started) is inserted an inductive resistance, C^2, whilst

of air to be supplied according to the requirements of the player. The first section does not require a deal of explanation. Without doubt the best way to drive is by means of worm gearing. By this means a speed of 35 r.p.m. can easily be obtained on the worm-wheel shaft with the motor running at, say, 1,450 r.p.m., which is the usual figure for a 1-h.p machine on a 50 cycle circuit. The worm-wheel shaft must be provided with a crank, and will drive as shown in Fig. 1. Of course, if the circumstances of the case permit, the speed reduction could be obtained

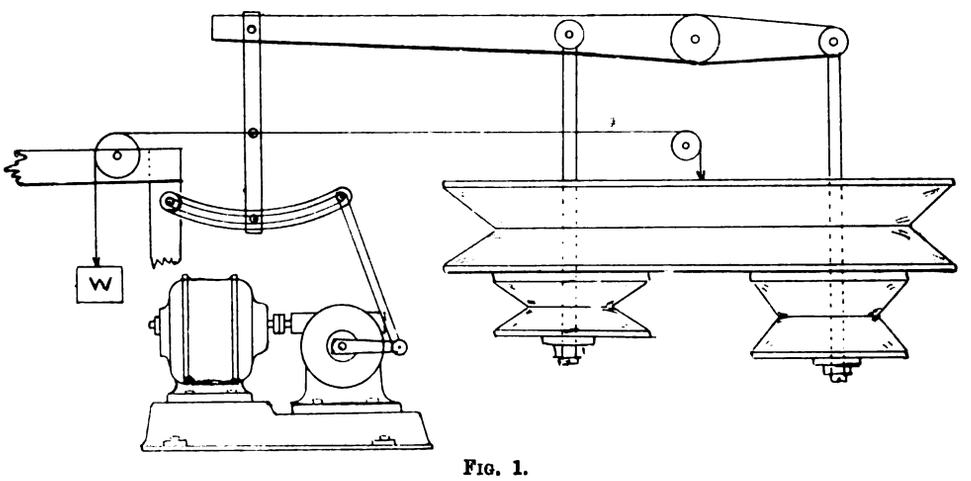

FIG. 1.

the main circuit is placed in series with a non-inductive resistance, the result being that a difference in phase occurs between the two circuits, thus producing a rotating field. As soon as the rotor has attained its maximum speed the auxiliary circuit is opened, and the non-inductive resistance short-circuited. The machine then continues to run as a single-phase synchronous motor. S is double-pole main switch, B is the starting position, A is the running position, C^1 non-inductive resistance, C^2 choking coil, C S change

by means of spur gearing (which would probably have to be double) or by countershafts and pulleys, and perhaps by a combination of both. With such an arrangement, however, there would be the risk of noise, and this is quite inadmissible unless the motor and gear could be placed in an adjoining room or basement away from the organ chamber. Another way of adapting an electric motor for organ blowing is to dispense with the ordinary lever handle and feeders, and deliver air direct into the reservoir

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from a centrifugal fan. Such a motor-driven fan can be constructed to work quite silently, and, as will be seen from the remarks under the next section, the question of control is much simplified. This method of working is being used very successfully in the case of many large organs.

Coming now to the next section—viz., the method of controlling the amount of wind to be supplied—this can be accomplished in two or three ways. Firstly, the motor (which for the purpose should be of the wound rotor type with slip-rings) can be controlled by the insertion of resistance in the rotor windings. For this purpose, special starting and regulating resistances will have to be provided, and Fig. 2 shows how the apparatus would be arranged. In starting up, the double-pole main switch is first closed and the starting resistance moved round slowly in the usual manner. The motor then runs up to speed, and the starting coils are cut out of circuit by means of the auxiliary switch, *y*, as shown. All this time the regulating switch operated by the reservoir remains in the top position with no resistance in circuit, but as soon as the reservoir has risen a certain amount, the bar carrying the contacts on the regulating resistance begins to move downwards, thereby inserting resistance in the rotor circuit and reducing the speed of the motor. With an ordinary single-phase induction motor the speed could not be reduced by more than 40 per cent. without risk of the machine falling out of step and coming to a standstill, but with a repulsion or reactance motor the necessary speed regulation could be obtained satisfactorily. For this arrangement it will, of course, be necessary to have a motor starting with considerable torque, of which there are now several on the market.

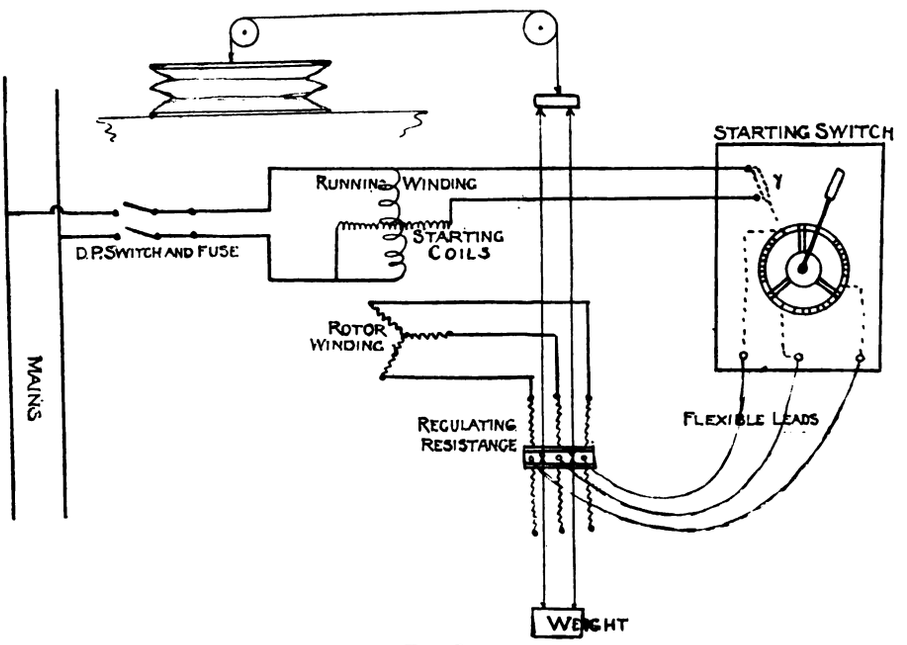

FIG. 2.

Another method of arranging matters is shown in Fig. 1 Here the motor and gear drive on to a quadrant, which in turn is connected to the organ lever as shown. By means of the weight, W, and the flexible cord attached to the reservoir, the position of the rod connecting quadrant and organ lever is adjusted automatically at the lower end, so that the length of stroke, and consequently amount of air supplied by feeders, depends upon the position of the reservoir. In practice the parts will adjust themselves to the needs of the wind supply, and when no or very little wind is required the stroke should be quite small, and the motor will be running practically light under these conditions. With such an arrangement the ordinary starting switch and resistance will be quite good enough, but the motor will have to be capable of starting with load. If a very cheap installation is wanted and the organ not used much, so that efficiency does not count, then the motor could be arranged to work always at practically full load with no automatic gear whatever. The excess of air would be allowed to escape by a valve worked from the reservoir in a similar way to the ordinary over-blowing valve. This is not so uneconomical as it would seem at first sight, because the power required from the motor is considerably less than the full-load power when the organ reservoir is over-blowing. The motor would, of course, be stopped when the wind is not actually required.

In connection with the fan blowing arrangement mentioned above the control is very simple. All that is necessary is a valve between the blower (preferably by the fan) and the reservoir, this valve being arranged to open when the reservoir falls and close when the reservoir reaches its full capacity. With this blower arranged in such a way the consumption of energy is proportional to the work done. When the organ is at rest the motor runs practically light, and when a little wind is required the current consumption of the motor increases. With the maximum wind supply the motor would be running under full load.

A further advantage of the motor-driven blower is that the motor can start quite light (there being practically no load until the fan attains at least half speed) thereby enabling a cheaper motor to be used, while the starting switchgear can be quite simple, and, if necessary, could be conveniently arranged near the organ keyboard.—P. W. F.

Answer to No. 822 (*awarded* 5*s.*).—The best type of single-phase induction motor for the purpose specified will be one having an auxiliary stator winding. This winding

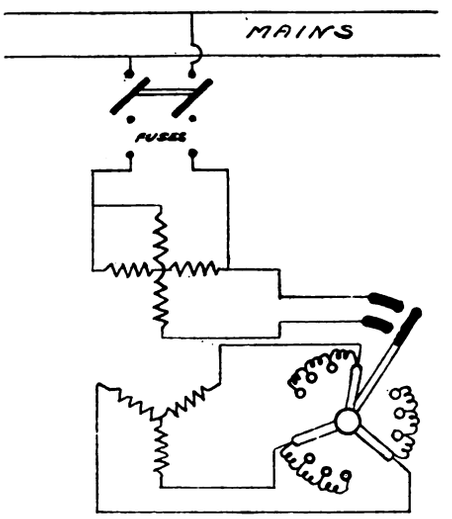

FIG. 1

is only used while starting, being cut out when the motor has attained its full speed. Fig. 1 is a diagrammatic sketch of the connections of such a motor. It will be seen that the starting switch, after short-circuiting the rotor resist-

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ances, cuts out the auxiliary winding by means of the long arm, leaving the running winding only across the mains. The current can be completely cut off the motor by means of the double-pole switch, but before starting the starting switch must be turned so that all the resistance is in rotor circuits and the auxiliary winding joined up in parallel with the running winding. Such a motor will give difficulty with regard to starting and speed regulation; to get over this the writer suggests an arrangement as shown in Fig. 2. The motor when started is kept running at full speed; a worm on the rotor spindle engages with a worm-wheel which runs loose on the main shaft.

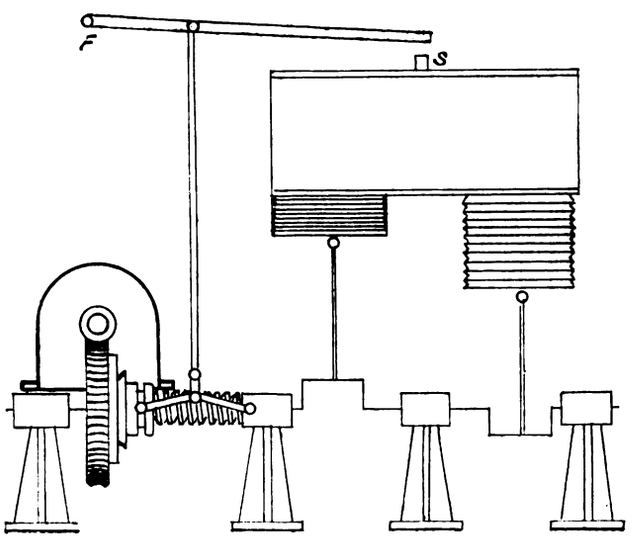

FIG. 2.

This worm-wheel has a recess, in which fits a coned friction clutch; the clutch works freely on the main shaft, and turns with it by means of a "feather." Between the clutch and the bearing is a helical spring, which, when the bellows are working, presses the clutch firmly against the worm-wheel. When bellows are full, the stop, S, engages with lever working round the fulcrum, F. This lifts the links and draws back the friction clutch against the action of the spring. Motor then simply drives the worm-wheel. In the sketch only two links are shown, but there are also two on the other side. This is arranged so that they do not interfere with the spring, and the pull on the clutch is well distributed when being withdrawn. The upward motion of the lever closes the spring and frees the friction clutch. The reduction by means of worm and wheel should give a speed of from 20 to 30 per minute. Belting has not been suggested, as belts are often troublesome on account of their noise. A 1-h.p. motor will only be suitable for driving the bellows of a comparatively small church organ. More power is required for this purpose than is generally supposed.—M. M.

Question No. 823.—In a station with which I am connected there is installed a turbo-generator with compensating coils in series, with the armature wound in slots in the pole faces. The object of these coils is to enable the machine to commute sparklessly with a fixed position of the brushes at all loads. Will someone please explain exactly how this is effected?

Answer to No. 823 (*awarded* 7*s.* 6*d.*).—A few remarks on the theory of sparkless commutation will not be out of place before we explain the action of the compensating coils. Fig. 1 represents diagrammatically the armature coils, the commutator segments, and a brush. In the position shown, no current passes in the short-circuited coil, A, but when the commutator moves in the direction of the arrow, the brush will come out of contact with segment B. Now, the self-induction of coil A (the ohmic resistance also, but in a small measure) will oppose a resistance to the passage of the current, and sparking will occur between brush and segment B. This is what happens when coil A is in the neutral zone, so that no E.M.F. can be induced into it by rotation. Now, if we displace the brushes in the direction of rotation, the coils short-circuited by the brushes will be in a field of a certain strength, and an E.M.F. will be induced in them by rotation. This E.M.F. opposes the E.M.F. of self-induction, so that the resistance offered by coil A to the passage of the current when the brush leaves segment B will be reduced and the sparking as well.

Now let us examine the effect of the armature reaction. Fig. 2 must be familiar to who have studied sparkless commutation. M C D N represents the field produced by the magnet, M E F N the field produced by the armature current, half of which is opposed to the main field and half of which assists it. The superposition of these two fields gives the resulting field, M G H N. Now, as the load increases, the armature reaction increases also, and, there-

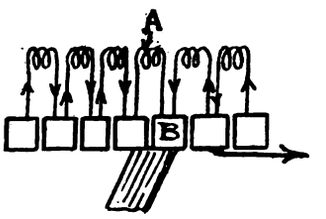

FIG 1.

fore, the distorting effect. The resulting field will be strengthened on the right-hand side and weakened on the left. We have seen that, in order to obtain sparkless commutation, the E.M.F. induced by rotation in the short-circuited armature coils must oppose the E.M.F. of self-induction, and that these coils must be placed in a field *sufficiently strong* These coils must also be in the weaker field on the left-hand side, so that any increase of load will increase the sparking.

Turning, now, to Fig. 3, we can explain the action of the compensating coils. The pole is fitted with two coils, R and T, which each embrace half the pole width. These coils are in series with the armature, but wound in opposite directions so as to produce a field somewhat like

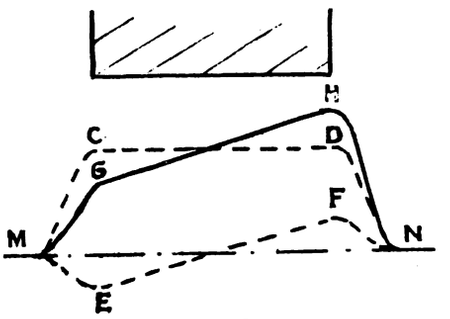

FIG. 2.

M K L N. This field will naturally increase with the load, just as the armature reaction which it opposes. In this way the total flux remains constant, and the weakening on the left-hand side (Fig. 2) is prevented. The coils can even be made to more than compensate the armature reaction so as to strengthen the field on the left-hand side

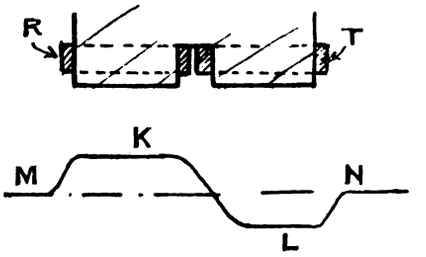

FIG. 3.

when the load increases. In this way the E.M.F. of self-induction, which increases with the load, will always be opposed by an E.M.F. induced by rotation, which increases in a similar way, so that the position of the brushes will be the same at all loads.—ALTERNATOR.

[Other replies to Question No 823 will be given in our next issue.—ED. *E. E.*]

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QUESTIONS AND ANSWERS.

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QUESTIONS.

830. A dynamo is to supply lamps and also charge a secondary 50-volt battery of six cells. When dynamo is not working, the battery will feed the lamps. Describe a "fool-proof" arrangement so that, whether dynamo or battery feeds the lamps, a V.M. and an A.M. should always remain in circuit. Also arrange that three or more cells may be thrown into the circuit as required.—K. C. N.

ANSWERS.

Question No. 823.—In a station with which I am connected there is installed a turbo-generator with compensating coils in series, with the armature wound in slots in the pole faces. The object of these coils is to enable the machine to commute sparklessly with a fixed position of the brushes at all loads. Will someone please explain exactly how this is effected?

Answer to No. 823 (*awarded 7s. 6d.*).—This question is purely one of armature reaction in dynamos and the means of overcoming it. The present practice invariably calls for dynamos and motors with fixed brush position at all loads without sparking, but until recently this was not the case, the brushes having to be moved with the load on the machine to prevent sparking. The increased sparking with rise of load is due to the interference of the magnetic field set up by the current flowing in the armature, the tendency of the latter being to produce a cross magnetisation through the armature core at right angles to the useful flux, resulting in a distortion of the main dynamo field in the air-gap.

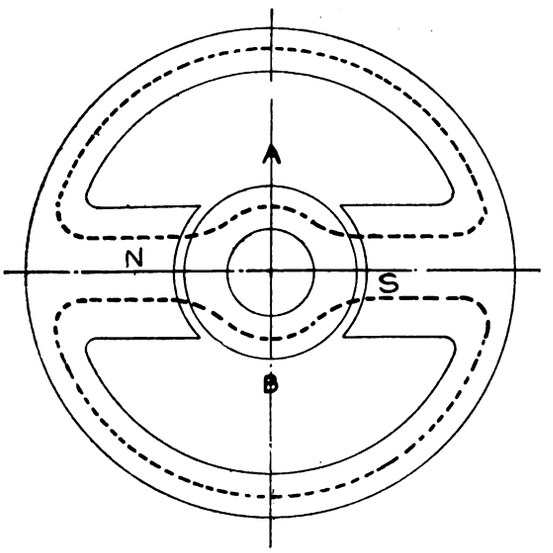

FIG. 1.

Fig. 1 shows the direction of the useful field from gap to gap when no current is flowing in the armature winding, the neutral line or diameter of commutation, A B, being perfectly vertical and midway between the pole corners. When a heavy current flows through the winding, the resultant cross flux so interferes with the main field as to completely shift it round in the direction of rotation in a generator, and against it in a motor. The result is a crowding of lines under the trailing pole corners and a falling off under the leading ones. With the shifting of the main field the neutral line will also have to be moved into a proper reversing field for commutation.

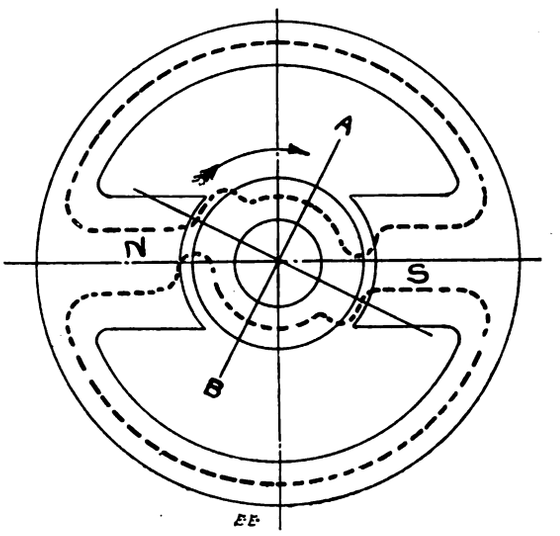

FIG. 2.

Fig. 2 shows the displacement of the flux when the armature is loaded. It is obvious from the above that to obtain a fixed brush position for all loads the armature distortion or reaction will have to be checked, or, better still, made a negligible amount in proportion to the main field. For sparkless collection, the armature ampere-turns per pole should not be more than 50 per cent. of the field-turns—namely, ampere-turns required to drive the flux through the gap and teeth. Under the leading pole-horn the density should not be allowed to fall below 13,000 lines per square inch. The main object to consider when designing a generator is to get a good stiff field in the gap which cannot be very easily shifted, and one or two ways of doing it is as follows: specially shaping the pole-shoes; boring the pole-faces eccentric to the armature, thus forming an air-gap of unequal length, the shortest distance being at the centre of pole, where the main field is strongest; using poles with slots cut in them running parallel with the axis of the armature, thus increasing the reluctance of the cross magnetisation path and preventing crowding at the corners. Balancing the cross magnetisation by means of special winding on the poles and compensating armature winding due to Sayers.

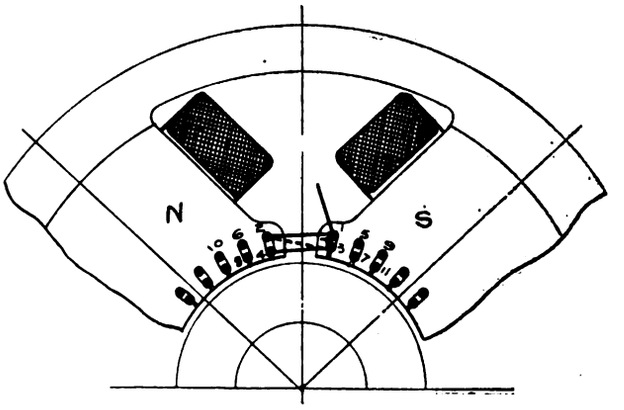

FIG. 3.

The method referred to in the question is apparently Ryan's method of balancing winding, as shown in Fig. 3. This consists of surrounding the armature with a stationary winding, exactly equal in its magnetising effects to the

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armature, but directly opposed to the latter, thus balancing all armature reaction. A number of coils are wound in the manner shown into slots cut on the pole face, and connected in series with the armature; thus the same current will flow through both armature and field, and, as the number of turns are the same, the resultant flux will be equal, and the two magnetomotive forces, working in opposition, will balance and neutralise each other, leaving the main field and neutral line unaltered. It may be added that the above method of obtaining sparkless commutation is seldom used, the present tendency being to design the machine with a low reactance voltage and depend upon an auxiliary magnet placed between the poles to provide the necessary reversing field for commutation.—P. DEAN.

Answer to No. 823 (*awarded* 7*s.* 6*d.*).—It is well known that in a continuous-current generator there is a field induced by the current flowing through the armature which is superposed on the main exciting field, the result being that the latter is distorted by the former. In the case of a generator the net result is that the resultant field is shifted slightly round in the direction of rotation of the armature—*i.e*, the leading pole-tips are weakened and the trailing tips are strengthened. Now, in order to commutate satisfactorily, it is necessary for the coil which is undergoing this operation to be just entering a field of opposite polarity to that which it is leaving, so that there may be induced in it an E.M.F. in the opposite direction of such a magnitude that, during the time it is short-circuited under the brush, it may make the original current flowing therein die down and a new current of the same magnitude but opposite direction grow up. This reversing field is that due to the leading pole-tips. The current through the armature is proportional to the load, and hence the distortion of the field due to the armature reaction is also proportional to the load, and so the leading pole-tips under which commutation takes place are weakened more or more as the load on the machine rises. In order to have the coil in a sufficiently strong field to reverse the current in it, it is necessary to move the brushes forward as the load on the machine rises. This brings up one or two other matters, such as the demagnetising effect of the armature on the field, etc., but it is hardly necessary to touch on these in this answer. Fig. 1 explains this armature reaction

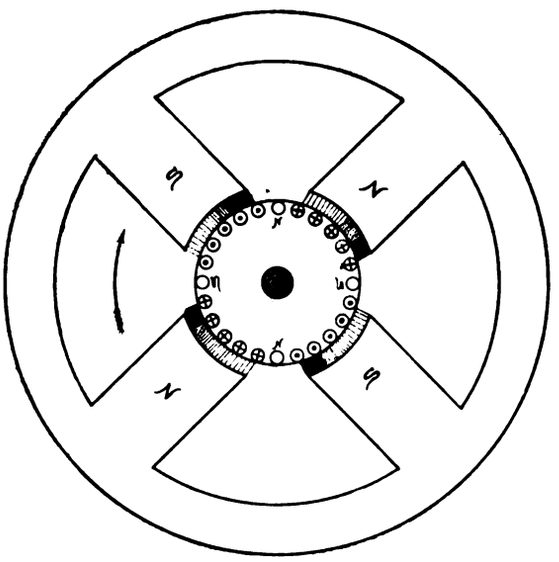

FIG. 1.

For the purpose of overcoming this necessity for moving the brushes forward several devices may be adopted, one of which is by using these compensating coils wound through the poles of the field magnet. All the current from the machine passes through these, or else a fixed percentage of it, and, therefore, the field induced by them is also proportional to the load on the machine. They are connected up so as to counteract the armature flux, which, it will be seen, is at right angles to the field-magnet flux, and hence their flux is also at right angles to the main flux. By suitably designing these coils, their flux may be made exactly equal to the armature flux, and, being opposite it in direction, may be made to completely wipe this out. If this be done, it will be seen that the main flux will not be distorted by the currents flowing in the armature, and hence it will not be necessary to rock the brushes forward, whatever the load be. Also, it may be adjusted so that the flux due to the compensating windings be slightly in excess of that due to the armature ampere-turns, resulting in a slight increase of flux through the *leading* pole-tip, which will still further assist commutation. The important point to note is that

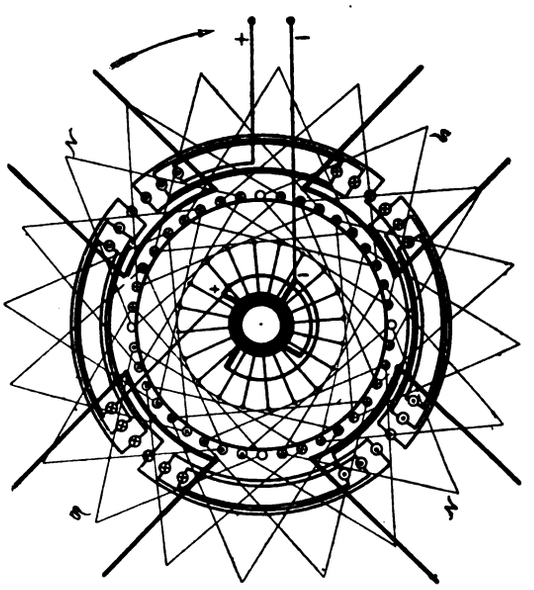

FIG. 2.

the compensating ampere-turns must be equal or slightly in excess of the armature ampere-turns. Fig. 2 explains this, and though at first sight a little complicated, is really not so. I have shown a four-pole machine, and we are supposed to be looking at the commutator end of it. The small circles represent slots in the armature and poles, those with a small black circle in indicate that the current in those wires is coming towards the observer, and those with a cross that the current is flowing down. The connections at the commutator end are shown as straight lines from one wire to another, and those at the back end are shown by the lines drawn outwards. It will be seen that all the current from the + brushes goes through slots in the poles forming the compensating winding all in series, and thence to the external circuit, returning direct to the − brushes. The above shows the type of winding adopted for a turbo-generator which the writer saw under construction.—E. R. ALEXANDER.

Answer to No. 823 (*awarded* 5*s.*).—Before explaining the effect of the compensating coils it will be better to explain, first, the reason why the brushes have to be shifted to obtain sparkless commutation when there are no compensating coils used. When the armature of the generator is caused to rotate, and the current traverses the coils of the armature, the field, due to the field magnets, becomes distorted. This distortion is due to the fact that the armature itself becomes a powerful electromagnet with distinct poles, having lines of force which do not coincide with those of the field magnets. The armature core is magnetised by the currents passing round it in such a manner that poles are produced midway between the poles of the field magnets, and in the accompanying diagram the direction of the lines of force due to the armature magnetisation is represented by O N_1 and O S_1. The actual field in the armature is, therefore, the resultant of these two fields both in magnitude and direction, and when the armature current varies, the component of the field due to the armature magnetisation likewise varies preportionately, so that the resultant field varies in direction, and to obtain sparkless commutation the brushes have to be shifted accordingly.

Now, to avoid this distortion of the field, the compensating coils, connected in series with the armature, are so

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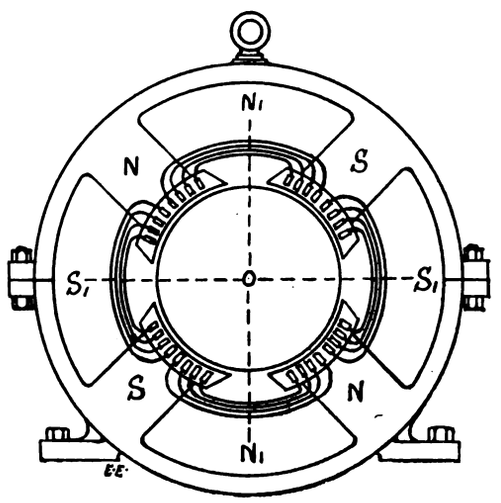
placed that their axes coincide with the axes of the poles produced by the armature magnetisation—that is, midway between the field-magnet poles. The number of turns of these coils is calculated so that, for a given current through the armature, the strength of field produced by them is equal to that produced by the armature coils; but being arranged so that the direction of the field produced by them is opposite to that of the armature magnetisation, the distorting effect of the armature current is completely counterbalanced. Whatever variation there is in the armature magnetisation, due to any variation in the load



on the generator, the field produced by the compensating coils always varies proportionately, and thus sparkless commutation is produced at all loads with the brushes in one fixed position.—POM.

Question No. 824.—What modifications, if any, may be made in the design of the *mechanical* parts of a rotary converter in comparison with a motor-generator of the same capacity?

Best Answer to No. 824 (*awarded* 10*s.*).—A motor-generator consists of a motor and a generator having their shafts coupled together. The motor has to develop all the power that the generator delivers plus the losses of the two machines. All this power, except the motor losses, has to be transmitted through the shaft to the generator. Hence we see that the armature spiders and shaft must be strong enough to transmit the full power to either machine. In a rotary converter, however, the power never leaves the surface of the armature, and the only torque the shaft is subject to is that due the friction losses. If this were the only factor affecting the size of shaft, a rotary converter would only require a very small one, but in designing a

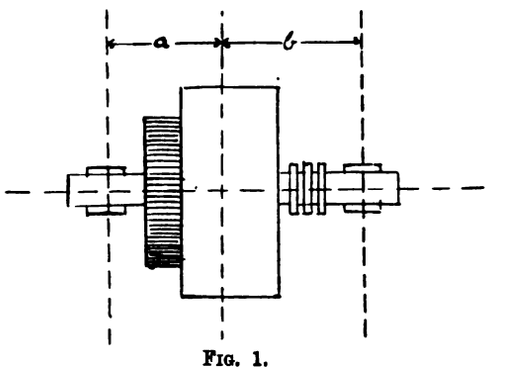


FIG. 1.

shaft we must consider the bending moment it is subject to as well as the twisting moment.

Let T_e = equivalent twisting moment;
T = torque transmitted;
M = maximum bending moment;

then $$T_e = M + \sqrt{M^2 + T^2}.$$

Now, it is the equivalent twisting moment which determines the size of shaft required. Thus we see that although the torque to be transmitted by a rotary converter is practically negligible, yet we may require a good big shaft to withstand the bending moment it is subject to. Now, the bending moment on a rotary converter shaft is necessarily greater than that on a motor-generator, whose direct-current armature is the same weight as the converter's one, owing to the fact that distance between the bearings is greater, for, as well as having a commutator on one side of the armature, it must have slip-rings on the other side.

Reverting to Fig. 1, let W = weight of the rotating parts, and a and b be the distances of their centroid from the two bearings. Then the bending moment on the shaft = $W \frac{a\,b}{a+b}$. In the motor-generator the maximum bending moment is on the direct-current side, as the

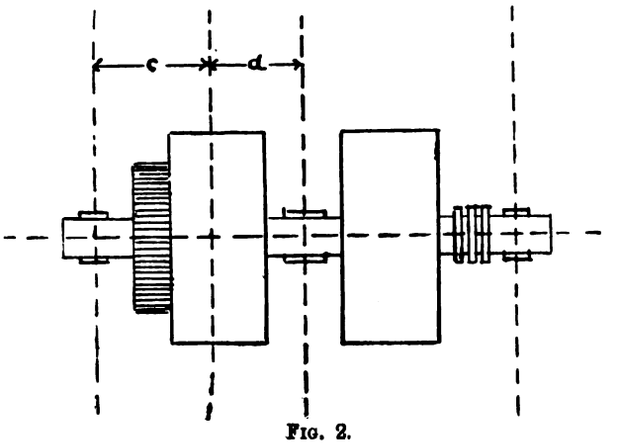


FIG. 2.

rotating part there is heavier and the distance between the bearings greater owing to the commutator. Hence, referring to Fig. 2, and using the same notation, we get the maximum bending moment on the motor-generator shaft = $W_1 \frac{c\,d}{c+d}$. Now $c = a$, and d is less than b; hence, if $W = W_1$, the maximum moment on the motor-generator shaft is less than that on the rotary converter. In most modern machines the ratio of the diameter of shaft in a motor-generator to that of a rotary converter of the same output is about 3 : 2. This alteration in the shaft and lightening the armature spider are the only mechanical modifications which can be introduced in the design of a rotary converter as compared with a motor-generator.

There is another type of motor-generator in which both windings are carried on one armature, but owing chiefly to insulation difficulties this type of machine is never made now, and does not require to be considered.—R. H. G.

Answer to No. 824 (*awarded* 5*s.*).—The greatest difference in construction is owing to the fact that, while the motor generator requires two, the rotary converter has only one magnetic system. The rotary is then the lighter and more compact of the two for any given output. The motor-generator really consists of two separate machines, either having the rotating parts on one common spindle or with their spindles mechanically connected together so that they revolve in unison. Generally, the two magnetic systems are mounted on one bed-plate provided with a third bearing between the direct and alternating current sides. This arrangement forms a long and more or less cumbersome combination. In order to do away with the middle bearing, some makers place the two systems close together on one bed-plate, and by fitting a very stiff spindle employ two bearings only. This makes a decidedly more compact machine, but it is questionable whether anything is saved in mechanical friction, and the combination is hardly so get-at-able from an attendant's point of view. There are two types of motor-generator to be considered—namely, synchronous and asynchronous. If the alternating (or motor) side is to run as an inductfon or asynchronous motor, there must be less clearance than if intended for synchronous running; therefore, it will be safer to have three bearings, in order that there shall be little danger of the spindle "whipping." The rotary converter with its one magnetic system is practically a direct-current dynamo with tappings from the armature winding brought out to slip-rings. In either rotary con-

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verter or motor-generator it will be noticed that both commutator and slip-rings are required, but as the rotary has only one armature—or, perhaps, we had better say rotor—two bearings suffice. When a rotary is driven from the alternating-current side as a synchronous motor, there is not so great a necessity to reduce the air-gap. The small clearance that is required for the satisfactory running of induction machinery demands consideration from a mechanical standpoint; the design must be good and the workmanship excellent. With regard to the brush gear, in each case this will be much the same, but with a motor-generator having three bearings the designer will not be so much inclined to contract the commutator and slip-rings as he might be in the case of a similar machine fitted with two bearings only, or even with a rotary converter. Every designer is well aware of the danger attending any increase in the distance between bearings. Although the form of driving in both rotary and motor-generator is ideal, care should be taken to fit "ring-oilers" to the bearings; in any machine having more than two bearings, these bearings must be absolutely in line. In the case of a motor-generator, there should be a slide rail under the bed-plate below each magnet system. The general lines to be observed in machine design are always governed by the cost—the almighty dollar is a most potent factor. We are never in a position to criticise any piece of machinery without knowing at what price it was designed. Broadly, for either machine have the base ample and the centre of gravity as low as possible, large diameter of spindle with long bearings, and the space between bearings as small as allowable. Generally, the higher the speed the greater the output for a given amount of material, and the higher the efficiency.—M. M.

Answer to No. 824 (*awarded* 5s.).—In comparing the mechanical design of a continuous-current motor-generator with that of a rotary converter of the same capacity and speed, practically no modifications of the empirical rules governing the design may be made. Of course, if the speed is altered the diameter of the shafts will also differ. It is assumed that the motor-generator consists of a separate dynamo and motor coupled together and mounted on a common bed, the same arrangement being used for the rotary converter. Generally, the latter is used for transforming high-tension alternating current down to 500 volts or thereabouts continuous, but if transforming in the reverse direction—that is, the alternating-current side acting as the dynamo—provision must be made for the small dynamo used for excitation. This may be driven by belt from the converter or mounted on the extended shaft,

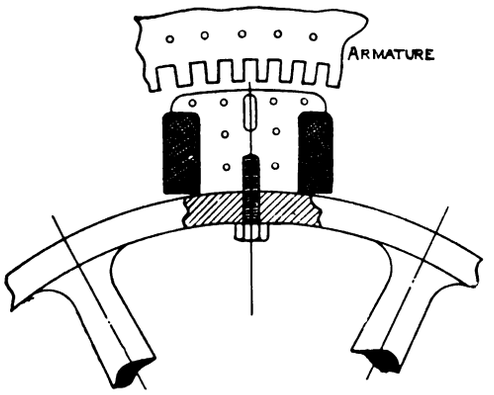

FIG 1.

a bracket being bolted on to the outer bearing to carry the field frame. The design of the field and armature system will, of course, be altered on the high-tension side, depending on the type of machine used. Should it be the revolving field type, in place of the armature core will be the magnet wheel, securely keyed to the shaft, the rim acting as the magnetic yoke. On to this will be mounted the magnet cores.

The method of constructing and mounting these differs with many makers, some bolting the complete laminated pole on to the yoke by means of bolts from the inner periphery of rim (Fig. 1), others making the yoke and pole-pieces entirely laminated, and fixed in the manner shown in Fig. 2. The armature in this case will be stationary and the core composed of laminations, slotted and built up in segments and bolted to a cast-iron shell.

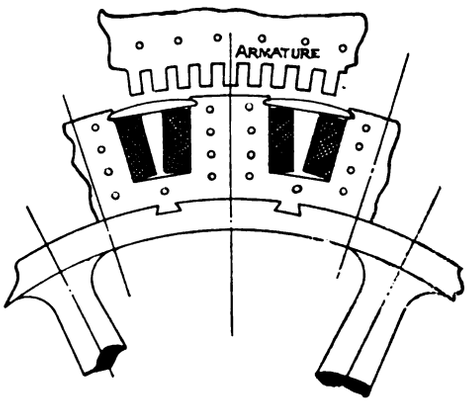

FIG. 2.

In either type of machine slip-rings will be used, and Fig. 3 shows a method of mounting them on the shaft, the brush arms being spaced at various angles and carried in the manner shown. The cables leading from the winding can be fastened to the flywheel arms and terminate in sweating sockets bolted to lugs cast on the inner periphery of the rings. The rings may be mounted on to an extended shaft outside the bearing, if necessary, and completely

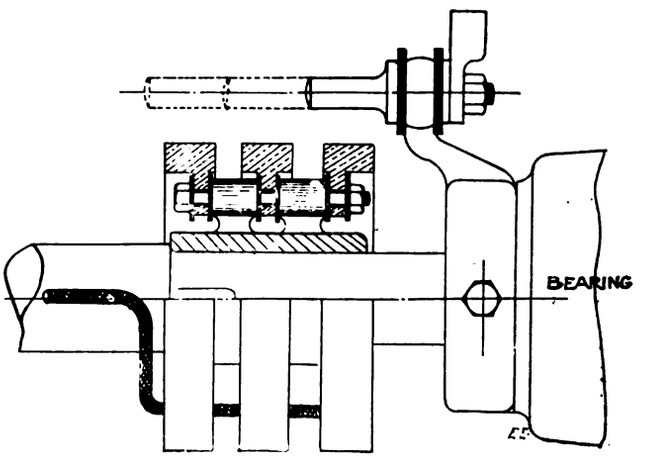

FIG. 3.

enclosed, the cables from the coils being brought through the shaft and out at the end. The latter method is generally used where the alternating-current machine is the motor, and short-circuiting devices are used to connect all the rings together and lift the brushes when the machine is up to speed. It may be mentioned that three bearings only are necessary, the centre one being close up the coupling. The coupling may be either solid or flexible, depending on the fluctuations in load and the alignment of the shafts.—P. DEAN.

Electrical Conductivities of Salt Solutions.—The *Proceedings* of the Chemical Society recently issued contains an abstract of a paper on "The Electrical Conductivities of some Salt Solutions in Acetamide," prepared under the joint authorship of Mr. James W. Walker and Mr. Frederick M. G. Johnson. The salts examined were mercuric chloride, potassium chloride, iodide, and cyanide. Of these the first is the only normal electrolyte, the others showing a maximum of molecular conductivity at about 30 or 40 litres, which then falls to about half value on dilution. Mercuric chloride is known to give a compound with acetamide, and potassium iodide is found to yield the compound $K1,6CH_3{\cdot}CO{\cdot}NH_2$. The migration ratio of the iodion is found to be greater than in aqueous solution, a fact which points to combination of ions with the solvent.

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DECEMBER 8, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

831. A low-tension alternating-current distributing system is fed by two transformers in parallel. If after one transformer has been idle for a time (disconnected from both high-tension and low-tension 'bus bars) its secondary (low tension) is switched in, a *kick* is noticed on the ammeter of the other. Why is this?—H. R.

832. In a 200-kw. triple-expansion Belliss type engine running at 365 revolutions and taking saturated steam at 180lb. per square inch there is considerable vibration and knocking, although all bearings are reasonably tight. Indicator cards show that there is hardly any compression or cushioning effect in any of the cylinders at the end of the stroke. It is desired to know: (1) what are the causes and effects of this absence of compression; (2) how it may best be remedied?—B. S.

ANSWERS.

Question No. 825.—Is it necessary to have a complete circuit in order to have a flow of electric current? I have noticed that you can have shocks to earth off either the positive or negative rails of a certain electric railway, *both* rails being insulated. Is this due to defective insulation, or is it due to the fact that there is a difference of potential between *either* rail and earth?

Best Answer to No. 825 (*awarded* 10*s.*).—The fact of it being possible to receive shocks from either rail to earth is due to both conditions mentioned by "Wattman," for in order to obtain a shock there must be a difference of potential between the rail touched and earth, and the insulation of the other live rail must be defective in order to allow a flow of current through the body. It follows that, in the particular case mentioned, the insulation of both rails is defective. It is necessary to have a complete circuit for a flow of current, the circuit in this instance, assuming the + rail is touched, being as follows: From + brush of dynamo through cables and + rail to body, and through body to earth, from earth through various leakage paths, such as dirty or defective insulators, to − rail, thence through cables and − brush of dynamo and armature to + brush, completing the circuit. If the − rail is touched, the current flows from earth through body to − rail, the rest of the circuit remaining unaltered. (Of course, it is understood that + and − signs are merely conventions, and as such serve their purpose; we have no proof that current flows even, but it must be assumed that "Wattman" will be satisfied with these conventions, otherwise the first part of the question is equivalent to "What is electricity?").

The body of the man in contact simply forms an additional leakage path in parallel with the others. No shock can be experienced unless there is a complete circuit, as may be readily observed when handling live trolley wire from a tower wagon. On a fine day the wires may be handled with impunity, but on a wet day a nasty shock may be obtained due to the fact that in the latter case the insulation resistance of the wagon has been materially reduced by the wet on the woodwork, and sufficient current flows to earth through the body to cause a "shock."

When both rails are insulated, the potential of either rail in relation to earth, or the potential difference between either rail and earth, depends on the state of the insulation.

Let v = potential difference between rails;
V_1 = potential difference between one live rail and earth (1) (+ rail);
V_2 = potential difference between the other live rail and earth (2) (− rail);
f_1 = insulation resistance of (1) rail;
f_2 = insulation resistance of (2) rail.

Then $v = V_1 - V_2$; and $V_1 = v + V_2$; and $-V_2 = v - V_1$.

Current flowing to earth and from earth must be equal by law of conservation of energy, and by Kirchoff's law this is expressed in the following manner:

$$\frac{V_1}{f_1} = \frac{V_2}{f_2} = 0. \quad \therefore \frac{V_1}{f_1} = \frac{-V_2}{f_2} = \frac{v - V_1}{f_2}. \quad \therefore V_1 = \frac{v f_1}{(f_1 + f_2)}$$

and

$$\frac{V_2}{f_2} = \frac{v \div V_2}{f_1}. \quad \therefore V_2 = \frac{v f_2}{(f_1 + f_2)}.$$

The equations show that the potential difference between either rail and earth depends on the relative values of the insulation resistances of the rail. As an example, suppose the insulation resistance of the + rail to be three times as high as that of the − rail—*i.e.*, let $f_1 = 3 f_2$ and suppose line volts to be 500

$$V_1 = \frac{500 \times 3 f_2}{4 f_2} = 375$$

$$V_2 = \frac{500 \times f_2}{4 f_2} = -125$$

From this example it is easy to see that a shock could be obtained from either rail.

It may also be remarked that the potential differences on either rail fluctuate considerably, so that a rail which would be safe to touch one day might have a higher potential difference next day, owing to a fault developing on the other rail.—97.

Answer to No. 825 (*awarded* 5*s.*).—In electric railways there is always leakage current flowing from one rail to the other through earth, which varies according to the weather, being considerably greater in damp and foggy weather due to the insulators becoming coated with a thin film of moisture, producing surface leakage. The rails, insulators, and earth may be looked upon as condensers, a, b (Fig 1),

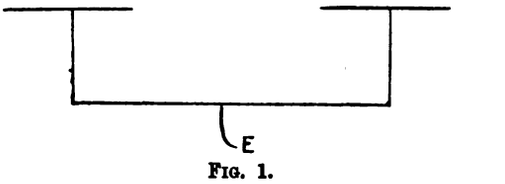

FIG. 1.

having a common earthed connection, E, of zero potential, A+ and B− representing the rails themselves, and the insulators of A and B serving as the dielectrics of the condensers, a and b respectively. For simplicity we shall suppose the insulation resistances between A and E and B and E are equal. Let the difference of potential between A and B = V. Then the voltage between A and E will be V/2, and the same between E and B. Suppose now that someone standing on earth touches A. Being (comparatively speaking) of fairly low resistance, he practically connects A to E through a conductor and receives a shock of V/2 volts due to the discharge of the condenser a, through his body. At the same time the rail A is brought to zero potential and B reduced to a potential of −V volts relative to the earth. No further shock would be experienced if the insulators had an infinite or very high resistance, but in practice the insulation resistance is sufficiently low to allow a current to

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pass which would maintain a shock perceptible to most people, depending, of course, upon the value of V. If R is the resistance of the person in question and r_a r_b the insulation resistances to earth of A and B respectively, the condition of affairs may be represented in Fig. 2. The

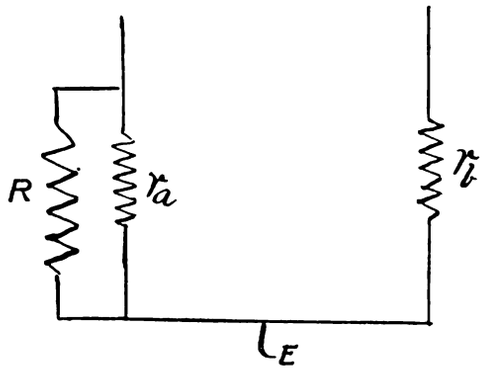

FIG. 2.

current will divide itself through the resistances according to Ohm's law, and he will experience a maintained shock of

$$V - r_b\left(\frac{V}{r_b + \frac{R + r_a}{R\, r_a}}\right) \text{ volts.}$$

If he now removes his hand from A, the latter will return to its original potential of V/2 volts relative to earth, and the first conditions will again hold on the assumption that $r_a = r_b$. It is evident that the same events will take place if he touches rail B. In some cases the maintained shock will be very much less than the shock obtained at the first touch. In cases where no shock is experienced off one line and a large one off the other, it must be assumed that the former is either dead earthed or has a very much lower insulation resistance than the latter.—R. D. A.

Answer to No. 825 (*awarded* 5*s.*).—In order that an electric current may flow, the essential conditions are that there must be a complete circuit, and that a difference of potential must exist between the points in the said circuit. If such a difference of potential exists between any two points, the value of the current which will flow between these points may be ascertained by the application of Ohm's law, which states that $C = \frac{E}{R}$, or the current in amperes is equal to the value obtained if the potential difference in volts is divided by the resistance in ohms, measured between the points under consideration. It should be mentioned that a complete circuit is not necessarily what is commonly known as a closed circuit, and need not be metallic throughout. For instance, two covered wires may only have a small insulation resistance, each to earth, and a leakage current may be caused to flow when a difference of potential is applied between the two wires. In this case, although apparently insulated from each other, there must be a complete circuit between the wires, and from these wires to the source of supply, for otherwise no current could flow. It should, however, be stated that, in order that all the leakage current may pass through the supposed insulating medium between these wires, the remainder of the circuit must be of high insulation, as otherwise a shunt circuit would be provided for the leakage current. It will thus be seen that, unless the insulation resistance of a circuit is high, a certain leakage of current will take place, and that this leakage increases as the potential difference in the circuit is increased, and as the insulation resistance is decreased.

In the question under consideration it is stated that shocks to earth may be obtained off both the positive and negative rails, and it will be clear from what has already been said that, although both rails are insulated, the shocks must be due to defective insulation on both poles. A little consideration will show that if contact is made with either rail, the body not being insulated from earth, and a shock is obtained, a current must flow through the body to earth. This current has to return to the other pole, since otherwise there would not be a complete circuit, and in order for it to do so the insulation of the other pole must be defective, and *vice versâ*. The insulation of both poles must, therefore, be more or less defective, and the amount of leakage current flowing will depend upon the potential difference and the total resistance through the earth between the poles. It will be seen that (neglecting the resistance of the earth itself to the flow of the current) since the potential difference of the supply exists between the ends of the earth circuit, there must be between the two rails and earth a sum potential difference equal to that of the supply, the two potential differences, as well as the shocks received from the two poles, being directly proportional to the insulation resistance of each of the latter to earth. The cause of the potential difference between either rail and earth is the defective insulation, and it should be pointed out that if the insulation of both poles were sound no potential difference would exist between either rail and earth, and it would be perfectly safe to touch either rail without fear of receiving a shock. Such a condition, however, is seldom met with in practice except with very low voltages, and a certain amount of leakage generally takes place except on the very smallest of systems.

In order to ascertain quickly the state of the insulation of a system, a useful test to apply is to insert between either pole and earth an incandescent lamp or batch of lamps in series requiring for full glow the same potential difference as that of the supply. The brilliancy of the light obtained will indicate the nature of the insulation resistance, full glow showing a bad earth on the opposite pole, and no glow showing good insulation on the opposite pole to which the lamps are connected.—H. A. N.

Answer to No. 825 (*awarded* 5*s.*).—It is necessary to have a complete circuit in order to have a flow of current. If direct current is being used, the whole of this circuit must be of conducting material. With alternating current, however, part of the circuit may be composed of non-conducting material or dielectric. A circuit containing a condenser is an example of this. In order to distinguish between the current flowing through a conductor and that flowing through a dielectric, it is usual to call the latter a "displacement current" and the former a "conduction current." It must be clearly understood that these names have reference only to the nature of the medium through which the current passes, and do not imply that there are two *kinds* of current.

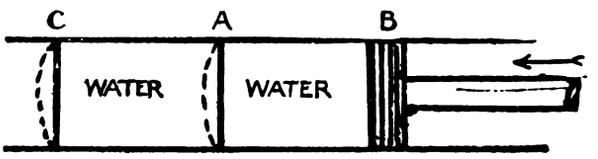

FIG. 1.

Some idea of the nature of a displacement current may be obtained from the consideration of the following hydraulic analogy. In Fig. 1, A B C represents a cylinder; B is a well-fitting piston; A and C are pieces of elastic membrane stretched across the cylinder. The space between A and B and A and C is quite filled with water. On applying pressure to B, in the direction shown by the arrow, the membrane, A, will bulge out as shown by the dotted line, since the space between B and A is entirely filled with water. Now, it is obvious that this bulging of A will cause a similar bulging out of C for the like reason. It is seen, then, that the yielding of A produced a slight flow of water towards C. In the electrical case, A and C would correspond to the insulator or dielectric between the plates of a condenser, while the water occupying the spaces between these would represent the plates. The force acting on B would represent the E.M.F. applied to drive the current through the condenser.

The yielding of the membrane or the dielectric constitutes the displacement current. Of course, if the force applied to B in Fig. 1 were sufficiently great, the membranes would be stretched until they reached the rupturing point, when they would rupture, and the water would then flow through in the ordinary way. In the electrical case, if the E.M.F. (either direct current or alternate current) applied to a condenser circuit be sufficiently great, it will rupture

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or puncture the dielectric, and then the current will have a continuous passage by the arc so formed.

If the rails of the railway referred to are supplied with current from a three-wire system at the outer voltage, then, of course, a person touching one rail receives a shock to earth at about half the working voltage of the system.

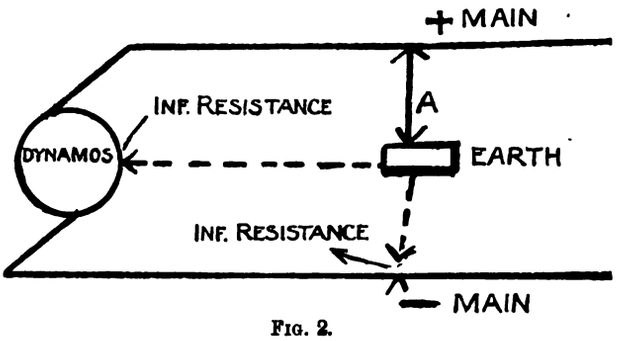


FIG. 2.

Supposing that the insulation resistance of the network were infinite, and that the machines, etc., were perfectly insulated from earth, it would be absolutely impossible to receive a shock upon touching either rail, because there would not be a complete circuit (Fig. 2 makes this point clear; "A" represents the man). With the same insulation resistance on the rails, suppose there is a leak on the machine, then a person touching either rail would complete a circuit from the rail through earth to the machine and round again, and would, of course, receive the shock.

Now, in practice no network has an insulation resistance of infinity, at least for long. Therefore, when any conductor (and all living animal tissue conducts electricity) is connected from either rail to earth, it simply closes a circuit which causes current to flow from that main through the conductor to earth, and from earth either back to the machine or to the other main. This flow of current is due, of course, to the difference of potential existing between either pole of a system and earth.—H. A. CARNEY.

Question No. 826.—What is meant by the all-day efficiency of a transformer? What are the factors to be taken into account in the design of the transformer in order to secure a high all-day efficiency?

Answer to No. 826 (*awarded 7s. 6d.*).—The "all-day" efficiency of a transformer is the ratio of output to input during 24 hours. This ratio may be written thus:

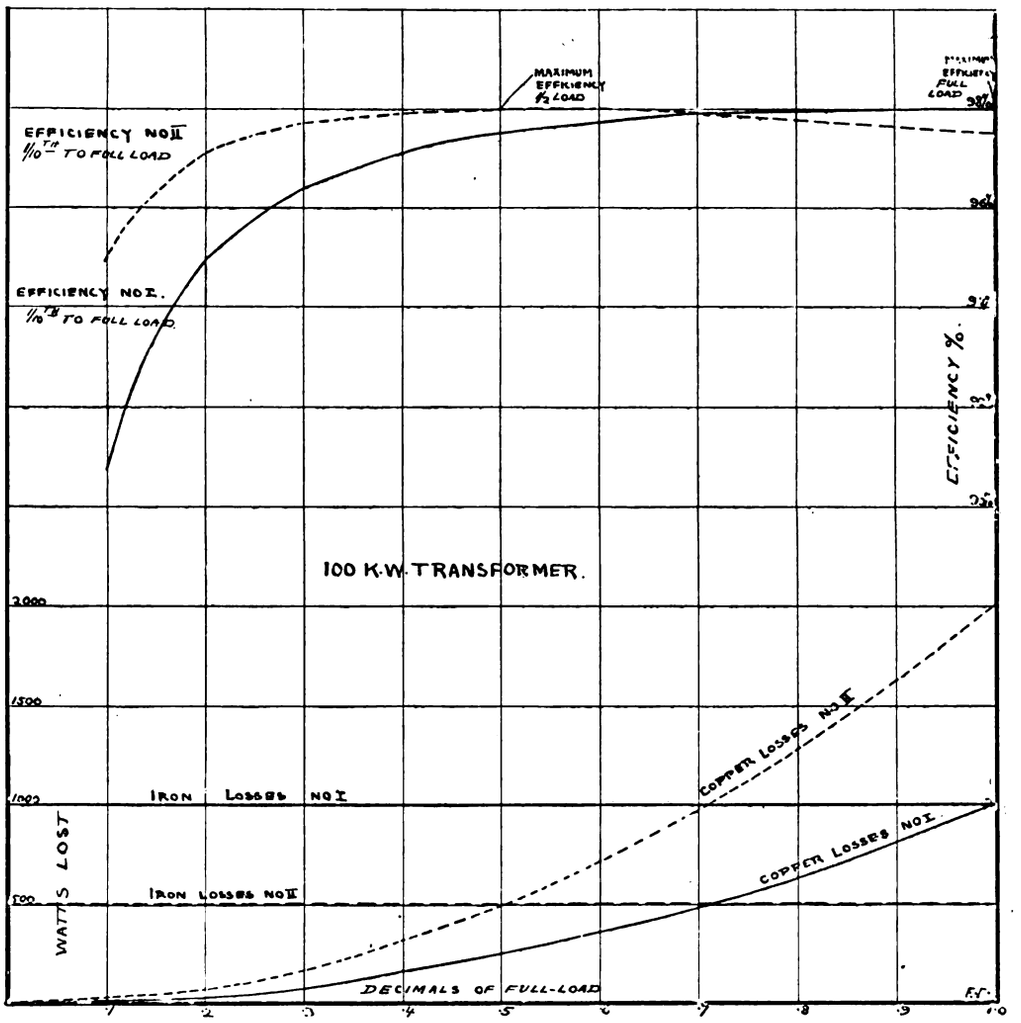
Output of secondary/output of secondary + losses in transformer during a period of 24 hours.

Now, the losses in a transformer may be divided into two sections—copper losses and iron losses. The former vary as the square of the load, but the latter, for all practical purposes, remain constant from no load to full load. A slight consideration will show that in a transformer which is idle during most of the day the constant iron losses have a greater effect in lowering the all-day efficiency than they would have if the transformer was loaded up during a long period. This brings us to the question of load factors, and it is by adjusting the relative amounts of copper and iron losses to suit the load factor of the transformer that a maximum all-day efficiency is obtained.

The curves given in the figure represent the copper and iron losses and efficiency curves of two transformers. Transformer No. 1 has equal copper and iron losses at full load. Transformer No. 2 has equal copper and iron losses at half load, but at full load the copper losses are four-fifths and the iron losses one-fifth of the total losses. It is a well-known fact that the point of maximum efficiency occurs when copper and iron losses are equal, so that, as may be seen from the figure, transformer No. 1 is most efficient at full load and transformer No. 2 at half load. From these curves, knowing the load factor, it is possible to calculate the all-day efficiency as shown below. The load factor is easily arrived at by using the following formula:

$$\text{Load factor} = \frac{\text{actual output of transformer}}{\text{full-load capacity} \times 24},$$

the actual output in this case being taken over a period of 24 hours.



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Three typical load factors will now be taken, and the all-day efficiency of the two transformers calculated for each load factor.

Load Factor (*a*).—Ten hours full load, 14 hours no load. L.F. = ·4166. 41·66 per cent.

Load Factor (*b*).—Two hours full load, 4 hours three-quarter load, 18 hours no load. L F. = 20·83 per cent.

Load Factor (*c*).—Twelve hours full load, 8 hours three-quarter load, 4 hours no load. L F = 75 per cent.

The all-day efficiency is calculated thus from values in curves :

Load Factor (*b*) *Transformer I.*—

2 hours full load	2 × 2,000 losses	20,000 output.
4 ,, ¾ ,,	4 × 1,562·5 ,,	300,000 ,,
18 ,, no ,,	18 × 1,000 ,,	—
Total losses	28,250	} for 24 hours.
,, output	500,000	

$$\text{All-day efficiency} = \frac{500{,}000}{528{,}250} = \cdot 946 = 94\cdot 6 \text{ per cent.}$$

The losses and outputs are in watt-hours. The following table gives the results :

Load factor.	All-day efficiency. Transformer I.	Transformer II.
41·66 per cent.	96·7	96·9
20·83 ,,	94 6	96·0
75·00 ,,	97·7	97·5

It is evident, then, that transformer No II. is most suitable for a low power factor, and there is not much difference between the all-day efficiencies in the medium and high power factors. It must be remembered, however, that a transformer with low iron losses is bulkier and more expensive than it would be for the same power with losses more evenly distributed, and although this is not part of the question, it should be mentioned that unless the cost of the watt-hours saved per annum by the installation of a low iron loss transformer is greater than the interest on the extra capital necessary to purchase such a transformer no economy will result. As a general rule, however, transformers for power should have iron and copper losses equal at full load, and those for lighting should have the copper and iron losses at full load distributed in the ratio of copper two-thirds, iron one-third of total losses.

It is only intended to indicate by what means high all-day efficiencies may be obtained. The question of actual design to proportion these losses is too large a question to be tackled here.—D. M. HUTCHISON.

Answer to No. 826 (*awarded* 5*s.*).—The losses which tend to lower the efficiency of a transformer are those taking place in the iron and copper circuits. The iron loss represents the energy required to overcome hysteresis and eddy currents in the core, and to magnetise it sufficiently to generate the normal secondary voltage. This loss is practically constant, whether the secondary circuit is open or supplying full-load current, but varies inversely as the frequency of the supply current. The copper loss is caused by the resistance and heating in both windings. It only takes place when the transformer is supplying a useful current, and varies as the square of the current. Now, the losses which affect the efficiency of any transforming system are those which occur at light load, consequently the ratio of the iron to the copper loss in a transformer has an important bearing on its running efficiency. A small iron loss necessitates a more or less large copper loss, and a large copper loss is not desirable, as it affects the regulation in a transformer. Transformers that are only running on full load for a small number of hours during the day, as is the case with a lighting system employing transformer distribution, should have a small iron loss, especially if the cost of energy is high. On the other hand, when energy is cheap, and the transformers are running at or near full load for many hours during the day, they should have a small copper loss. This is where the all-day or running efficiency of a transformer comes in, and this is of greater importance than its testing efficiency in the case of transformers which are only working at full load for a comparatively short period. In practice it is usual to take into account the all-day efficiency on a basis of 20 hours' light-load and four hours' full-load run of a transformer. This means that the copper losses in one day = copper loss at full load for four hours, the iron loss going on during the whole time the transformer is in circuit.

Therefore, the all-day efficiency of a transformer equals

$$\frac{\text{Full load in kilowatts} \times \text{four hours}}{(\text{Full load} \times 4) + (\text{copper loss} \times 4) + (\text{iron loss} \times 24)}$$

And as an example might, perhaps, simplify matters, we shall consider the case of a 6-kw. transformer having iron loss = 95·5 watts, copper loss = 108 watts, and the full-load testing efficiency $= \frac{6}{6 + \cdot 0955 \times \cdot 108} = 96\cdot 6$ per cent.

Now, substituting these values in the formula mentioned above, we get $\frac{6 \times 4}{(6 \times 4) + (\cdot 108 \times 4) + (\cdot 0955 \times 24)}$, which gives an all-day efficiency of 89·8 per cent. As the difference between the all-day and testing efficiency in this example is not very great, it will be interesting to work out what the annual running efficiency would be for the same transformer. Suppose the transformer is working at full load for 1,000 hours during the year. Then the useful work done = 1,000 × 6 = 6,000 kilowatt-hours. Copper loss = ·108 × 1,000 = 108 kilowatt-hours. Iron loss = 8,760 × ·0955 = 836·6 kilowatt-hours. ∴ Total work = 6,000 + ·108 + 836·6 = 6,944·6 kilowatt hours. ∴ Annual running efficiency $= \frac{6{,}000}{6{,}944\cdot 6} \times 100 = 86\cdot 3$ per cent.

This example shows a difference of 10·3 per cent. in the annual running and testing efficiencies of a 6-kw. transformer having a 1·6 per cent. iron loss and a 1 8 per cent. copper loss. It may be shown in a very simple manner that a small decrease in the iron loss, even when accompanied by a relatively large increase in the copper loss, has the effect of substantially increasing the all-day or annual running efficiency of a transformer. For this purpose we shall again consider the case of a 6 kw. transformer, and suppose the copper loss has been increased to 4 per cent., and the iron loss decreased to 1 per cent., the period of full-load working being 1,000 hours as before.

Under these conditions the copper loss $= \frac{6{,}000 \times 4}{100}$ = 240 watts, and iron loss = 60 watts. Then useful work done during 1,000 hours = 6 × 1,000 = 6,000 kilowatt-hours. Total copper loss $= \frac{240 \times 1.000}{1{,}000} = 240$ kilowatt-hours. Total iron loss $= \frac{60 \times 8{,}760}{1{,}000} = 525\cdot 6$ kilowatt-hours. Total work done = 6,765·6 kilowatt-hours. ∴ Annual running efficiency $= \frac{6{,}000}{6{,}765\ 6} \times 100 = 88\cdot 7$ per cent., and testing efficiency $= \frac{6}{6 + \cdot 24 + \cdot 06} \times 100 = 95\cdot 2$ per cent.

Comparing these results with those obtained in the first example we find a decrease in the testing efficiency of 1·4 per cent., and an increase in the annual running efficiency of 2·4 per cent, which is of much greater importance, taking into account the conditions of working. As regards the factors to be taken into account in the design of transformers, the conditions under which they have to work should be known beforehand. The testing efficiency is highest when the iron and copper losses are equal, but as this is quite a secondary consideration in some cases, the distribution of losses must be suited to the conditions under which a transformer is to work. The aim in the design of transformers which will only be occasionally fully loaded is to keep the iron loss as low as possible, as this loss is continuous whether the transformer is doing useful work or not.—W. ROGERS.

[Other replies to Question No. 826 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
DECEMBER 15, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

833. What is the method of determining the conversion ratio (alternate current to direct current) of a rotary circuit?—W. A. J.

834. A correction is made for heating when using an electromagnetic voltmeter, but not when using an ammeter of the same type. Why is this? Give a method by which it is possible to determine the error per cent. due to heating in an electromagnetic voltmeter?—METER.

ANSWERS.

Question No. 826.—What is meant by the all-day efficiency of a transformer? What are the factors to be taken into account in the design of the transformer in order to secure a high all-day efficiency?

Best Answer to No. 826 (*awarded* 10*s.*).—Many alternating-current transformers are only partially loaded for a great part of the time that they are in circuit. The full-load efficiency of the transformer does not in such a case give the engineer a satisfactory indication as to whether the transforming plant is working under the most economical conditions, as although the full-load efficiency may be very high, the no-load loss may be relatively large. Although a transformer may be on open circuit or no load, energy is taken from the mains to supply the no-load loss occurring in the laminated iron core due to the periodic reversals of the magnetic flux, which loss is at constant voltage a constant at all loads. If the transformer is only fully loaded for a comparatively short period of the time it is in circuit, the energy required to supply the constant no-load loss amounts to a relatively large percentage of the useful output from the transformer, and as this is not paid for by the consumer it is thus a dead loss to the system. Hence, in order to secure economical working of the plant, a knowledge of the no-load loss is required, and also the time during which the transformer is loaded. These factors are included in the term "all-day" efficiency, which may be defined as the ratio: Output of transformer in kilowatt-hours extending over the whole day/input to transformer in kilowatt-hours extending over the whole day.

For approximate calculations the ratio may be written:

$$\frac{100\ \mathrm{L}\ .\ \epsilon}{10{,}000\ \mathrm{L} + x\ .\ \epsilon\ (1-\mathrm{L})},$$

where L is the "load factor"—*i.e.*, the ratio: Number of hours transformer is fully loaded/number of hours transformer is in circuit—ϵ is the percentage full-load efficiency, and x the percentage iron or no-load loss (reckoned on the full-load output).

It will be observed that with 100 per cent. load factor—*i e*, full load for the whole time the transformer is in circuit—the all-day efficiency has its maximum value, which is equal to the full-load efficiency of the transformer, while with zero load factor the all-day efficiency likewise becomes zero. If, however, the transformer is run for a long period at, say, quarter load, the results obtained by using the above formula will be a few per cent. lower than the true all-day efficiency.

The formula is deduced as follows: Let W denote the full-load output in kilowatts of the transformer, c the number of hours corresponding to full load—*e.g.*, if the transformer is loaded for, say, 1½ hours at actual full load and three hours at three-quarter load this may be considered (for all practical purposes) as equivalent to 3¾ hours at full load). The output from the transformer for the day will be $\mathrm{W} \times c$ units, while the "all-day" input will be $\frac{110\ \mathrm{W}\ c}{\epsilon} + a\ (24 - c)$ units, where ϵ is the percentage full-load efficiency and a the no-load loss in kilowatts. Introducing the load factor, L, and remembering that $\mathrm{L} = \frac{c}{24}$, we have all-day efficiency

$$= \frac{\mathrm{W} \times \mathrm{L}}{\frac{100\ \mathrm{W} \times \mathrm{L}}{\epsilon} + a\ (1 - \mathrm{L})}.$$

Now, if x and y represent the constant and variable losses—*i e*, iron and copper losses—at full load in per cent. of the full-load output, we have $\epsilon = 100 - (x + y)$, and $a = \frac{\mathrm{W}\ .\ x}{100}$. Hence the expression becomes: All-day efficiency

$$= \frac{\mathrm{W} \times \mathrm{L}}{\frac{100\ \mathrm{W} \times \mathrm{L}}{100 - x - y} + \frac{\mathrm{W}\ .\ x}{100}(1 - \mathrm{L})}$$

$$= \frac{100\ \mathrm{L}\ (100 - x - y)}{10{,}000\ \mathrm{L} + x\ (1 - \mathrm{L})\ (100 - x - y} = \frac{100\ \mathrm{L}\ \epsilon}{10{,}000\ \mathrm{L} + x\ .\ \epsilon\ (1 - \mathrm{L})}.$$

Data will be found in Table I. relating to four designs for 50-kw. 50 ~ transformers, the maximum efficiency being 98 per cent. in each case, this occurring at quarter, half, three-quarter, and full load respectively. The all-day efficiency is also given for various load factors, that of 12½ per cent. being typical for lighting circuits, while the higher values apply to power circuits. It will be observed that in design A the all-day efficiency is very nearly constant for a great range of the load factor. Although this design shows the highest all-day efficiency (at a low load factor) of the series, the all-day efficiency does not, however, improve at the high load factors, being only 95·75 per cent. for unity load factor, while design D shows an all-day efficiency of 98 per cent. at this load factor. This shows that for economical results transformers should not be used indiscriminately, as a transformer designed for lighting loads, such as designs A and B, will give a poor all-day efficiency on a power load, and, conversely, a transformer designed for a power load such as design D will give uneconomical results on a lighting load.

In the design of transformers we have the following points to take into account—viz., temperature rise, efficiency, regulation, and cost. For lighting circuits a high efficiency is required on light loads, while for power supply high full-load efficiency and good regulation are required. In the former case the no-load loss must be as small as possible, and the C^2 R or copper loss should be as high as is consistent with suitably low temperature when running on full load and with suitable regulation in the secondary circuit. In large transformers heating is generally the limit, while in small transformers the required regulation—*i.e.*, percentage drop in volts from no load to full load with constant applied voltage—is more often the limit. These limitations of heating and regulation are encountered when an attempt is made to secure a low no-load loss, and it is a considerable help to the designer that lighting loads are non-inductive, as with a power or motor load good regulation under these conditions would still be more difficult on account of the wattless component of the current. The most successful direction in which to decrease the no-load loss would be to increase the number of turns in the windings and decrease the cross-section and weight of iron in the magnetic circuit. The relation between turns, flux, and voltage is given by

$$\mathrm{E} = 4{\cdot}44\ \mathrm{T}\ .\ \mathrm{N}\ .\ \mathrm{M} \times 10^{-8},$$

where E is the R.M.S. value of the "internal" E.M.F., T the number of turns, M the magnetic flux linked with

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TABLE I.

Design.	Core loss.		Copper loss.		Efficiency of various loads (per cent.).				Load factor (per cent.).	All-day efficiency (per cent.)	Load at which maximum efficiency occurs.	Ratio— Constant losses / Variable losses
	Watts.	% of full-load output.	Watts.	% of full-load output.	Full.	¾	½	¼				
A.	125	·25	2,000	4	95·75	96·6	97·5	98	12·5*	95·2	¼	·0625
									50†	95·4		
									75‡	95·7		
B.	250	·5	1,000	2	97·5	97·8	98	97·5	12·5	94·7	½	·25
									50	97		
									75	97·4		
C.	375	·75	666	1·333	97·9	98	97·8	96·6	12·5	93·5	¾	·564
									50	97·2		
									75	97·6		
D.	500	1·0	500	1·0	98	97·9	97·5	95·75	12·5	92	Full.	1·0
									50	97·2		
									75	97·7		

* Four hours at three-quarter load, 20 hours at no load. † Twelve hours at full load, 12 hours at no load. ‡ Eighteen hours at full load, six hours at no load.

TABLE II.—DATA RELATING TO COMMERCIAL TRANSFORMERS FOR LIGHTING AND POWER.

Kw. output	Lighting.								For power.					
	% iron losses *	% copper losses *	Ratio— constant losses / variable losses at full load.	Full-load efficiency (per cent.).	Maximum efficiency (per cent.).	Load at which maximum efficiency occurs.	Regulation on full non-inductive load (per cent.).	All-day efficiency on a load factor of 12½ % † (per cent.).	% iron losses. *	% copper losses. *	Full-load efficiency (per cent.).	Regulation. On full non-inductive load (per cent.).	Regulation. On full inductive load with power factor 80 % (per cent.).	All-day efficiency on a load factor of 50 % ‡ (per cent.).
1	3·5	3·5	1·0	93	93 %	full	4	76·2	4·75	4·75	90·5	3½	5	86·6
2	2·75	3·15	·872	94·1	94·1	¾	3½	80·2	3·5	3·5	93	3	4½	90
5	2·0	2·3	·87	95·7	95·7	¾	2½	85	2·5	2·5	95	2½	4½	92·8
10	1·4	2·3	·61	96·3	96·4	¾	2¼	92·4	1·95	1·95	96·1	2	4	94·5
20	1·1	1·9	·579	97	97·1	¾	2	90·6	1·6	1·6	96·8	2	4	95·4
30	1·0	1·9	·527	97·1	97·2	¾	2	91·5	1·5	1·5	97	1¾	4	95·6
40	·95	1·75	·542	97·3	97·4	¾	2	91·9	1·4	1·4	97·2	1¾	4	95·9
50	·92	1·58	·582	97·5	97·6	¾	2	92·1	1·3	1·3	97·4	1½	4	96·2
100	·85	1·45	·586	97·7	97·8	¾	2	92·6	1·1	1·1	97·8	1¼	3½	96·7

* Reckoned on the full-load output. † Four hours at three-quarter load, 20 hours at no load. ‡ Twelve hours at full load, 12 hours at no load.

NOTE.—The prices of above transformers for power are 8·16 per cent. lower in the 100-kw. size than the corresponding size of transformer for lighting. For the 1-kw. size the price of the power transformer is 6·6 per cent. lower than one of the same size for lighting.

the turns T (in megalines), and N the periodicity in ~ per second. In a given design a reduction in the flux, M, means an increase in the number of turns, T, which is followed by an increase of the inductance of the transformer, and consequently a greater voltage drop from no to full load. However, as a lighting load is non inductive, a relatively large number of turns may be employed without seriously affecting the regulation. The question of regulation, however, needs to be considered from the financial standpoint with a lighting load, for the difference between, say, a 2 per cent. drop and one of 1·75 per cent. on full load may be that with a given number of lights on through a wattmeter the net revenue is increased several per cent. and the customer is better pleased with the light. This is because the difference in watt-hours, due to the difference in the drop in the two cases, is paid for by the consumer at probably maximum demand prices.

With an inductive load good regulation can be obtained by reducing the number of turns, thus increasing the flux, and by suitably intermixing the primary and secondary turns. As, however, an inductive load has generally a fairly good load factor, the iron may be worked at a higher density, thus increasing the core loss and reducing the weight within commercial limits to offset the greater flux, since with a smaller number of turns the C^2R loss will be reduced. In order to show the difference between transformers designed for lighting from those designed for power loads, Table II. has been prepared from data supplied by manufacturers.

It has been pointed out that for a lighting load it is customary to design a transformer with a relatively large number of turns and small cross-section of iron in order to reduce the no-load loss. This entails a correspondingly large copper loss, but as the transformer is seldom fully loaded for more than three consecutive hours, the temperature rise due to this loss can be kept within limits. With transformers for power supply, which would be fully loaded for several hours at a time, such a large copper loss would lead to an excessively high temperature rise unless special devices were resorted to for cooling. However, as we have previously seen, the copper loss in transformers for power supply must be kept low in order to obtain good regulation, and thus the temperature rise can be kept within the specified limits In submitting transformers to full load tests, due consideration should be given to the load factor which the transformer is designed for, as it would be absurd to demand a satisfactory 24 hours' run at full load from a transformer designed for lighting purposes where the load factor would probably be about 12 per cent. The duration of the heat run should vary according to the load factor as indicated below:

For a load factor up to						
10	per cent.	heat run	should	consist of	3	hours' run at full load
25	"	"	"		6	" "
50	"	"	"		12	" "
75	"	"	"		18	" "
100	"	"	"		24	" "

The average temperature rise after above runs should not exceed 45deg. C or 50deg. C as measured by the increase of resistance of the windings. A high temperature should be avoided, as this has a considerable effect in increasing the no-load loss due to "ageing."

As the relation between efficiency and cost of transformers has recently been fully dealt with by Dr. R. Pohl and H. Boble in an article, "Calculation of Alternate-Current Transformers for Minimum Cost," the rules enunciated by these investigators deserve careful consideration. These

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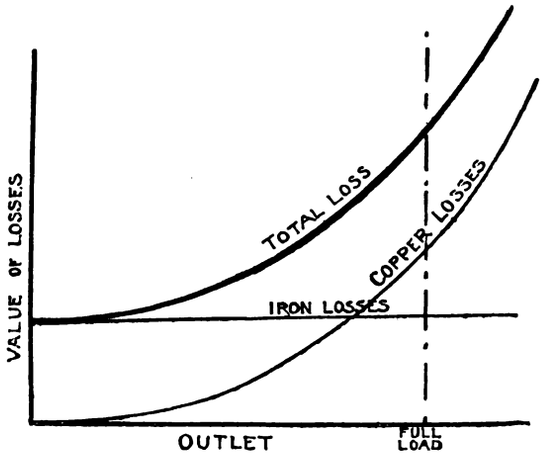
authors, in concluding their article, state "that the price of the active material of a 50 kilovolt-ampere transformer for an efficiency of 98 per cent. is nearly 3½ times higher than that for the same transformer with an efficiency of 97 per cent, while for an efficiency of 97 5 per cent. the price of active material is slightly double that for the design for 97 per cent. efficiency. In the case of the design for 97 per cent. efficiency, effective artificial cooling would be necessary" in order to keep the temperature rise within the customary limits. (See the *Electrical Engineer*, vol. xxxvi., pp. 446 to 449 and pp. 519 to 521, Sept. 29 and Oct. 13, 1905).—MONOPHASE.

Answer to No. 826 (*awarded* 7*s.* 6*d.*).—The all-day efficiency of a transformer may be regarded as the ratio of the output from the secondary terminals to the input of the primary taken over a period of 24 hours. Now, the value of this ratio depends on two things: (1) the kind and value of the losses in the transformer and (2) the loading of the transformer. The second consideration, it will be seen later, to a certain extent controls the first. It is easily conceivable that two transformers might be built having the same full-load efficiency, say 97 per cent., but one having a small ohmic loss, say 1 per cent., and a large iron loss, 2 per cent.; whilst the other has a large copper loss (2 per cent.) and a small iron loss (1 per cent.). Now, if these two transformers work at full load for 24 hours, it is evident that they will both have the same all-day efficiency. But if they are only run at full load for three hours out of the 24, it will then be seen that the transformer with the smaller iron losses (these being present to practically the same extent at no load as at full load) will have the greater all-day efficiency. Therefore, in designing a transformer, the best all-day efficiency cannot be obtained unless some idea of value of the loading is obtained.



The accompanying diagram shows the manner in which the losses vary according to the loading of a transformer. It will be seen that the total losses are made up of a practically constant part, H, and a part varying with the load. Assuming that the secondary current is exactly proportional to the primary current, and that the E M.F. is constant, we may consider the varying losses as being proportional to the square of the primary current, C. Therefore, at any loading: total losses $\propto H + k C^2$, k being a constant.

$$\text{Efficiency, } \eta = \frac{\text{watts applied} - \text{watts lost}}{\text{watts applied}}$$

$$\therefore \eta = \frac{E C - (H + k C^2)}{E C} = 1 - \frac{1}{E}\left\{\frac{H}{C} k + C\right\}$$

η and C are the variables, so to find the load for maximum efficiency differentiate with regard to C and equate to zero.

$$\therefore \frac{d \eta}{d C} = + \frac{H}{E C^2} - \frac{k}{E} = 0$$

$$\therefore k C^2 = H.$$

i e, for maximum efficiency the variable losses must equal the constant losses. Therefore, if a transformer is being designed that will work at full load all day, make the variable losses equal to the constant losses for best all-day efficiency.

The following data of a design taken from "Transformers," by Prof. G. Kapp, will illustrate the fact that a machine with the best full-load efficiency has not necessarily the best all-day efficiency. The machine is a 15-kw. single-phase transformer of the core type. A rough design was first obtained by assuming standard proportions for the core, a flux density of 5,000 lines per square centimetre, then adjusting primary and secondary windings to share equally the available copper losses found by subtracting the calculated iron losses from the total permissible loss. This attempt resulted in a machine which has at full load copper losses amounting to 321 watts and iron losses to 161 watts; consequently the maximum efficiency occurs at a load less than full load where the above two losses were equal (at about 11 kw.). To improve the design to give better efficiency at full load, the windings were altered so as to increase the flux density by such an amount as would bring up the iron loss to half the total of the above losses—*i.e.*, half of 482. The flux density chosen was then 6,300 per square centimetre, and the turns altered according to formula $E = 4{\cdot}44\ f\ N\ S \times 10^{-8}$; where E = applied E M.F., f = frequency (50), N = total flux, and S = number of turns in primary. This design gave the two losses equal at 16 kw.; consequently the linear dimensions were reduced in the ratio of $\sqrt[3]{\frac{15}{16}}$ and the losses in the ratio $\frac{15}{16}$, so as to be able to compare this last design with the first. Table A shows the principal factors in each design. The last item in the table—cost per kilowatt—is the cost of active material, taking finished laminations at 9d. per kilogramme (4d. per lb.) and insulated copper wire at 1s. 9d. per kilogramme (9½d. per lb.). The figures show that both as regards full-load efficiency and costs that design I. is much better than design II.

TABLE A.

	I.	II.
Flux density (lines per sq. cm.)	5,000	6,350
Output kilowatts	15	15
Temperature rise (deg. Cent.)	49·3	49
Hysteresis loss	161	220
Ohmic loss	321	208
Total loss	482	428
Percentage loss	3·22	2·85
Weight per kilowatt output (in kg.)	19 4	18·4
Cost per kilowatt output (in s.)	21 9	20·9

TABLE B.

Lamps alight.	Hours.	Lamp-hours.	Watts.	Loss in B.T.U.
100	50	5 000	100	5
70	100	7 000	49	4 9
40	500	20 000	16	8
20	1,000	20,000	4	4
10	800	8 000	1	0·8
	2,450	60,000		22 7

But now let us consider the working of the two transformers on a lighting load where the full load is only on for a comparatively short space of time. For this purpose we shall take for our standard time one year (8,760 hours), because the all-day efficiency depends on the time of the year, whilst the all-year efficiency is practically the same every year. Assume that the installation has 100 lamps which have an average burning time of 600 hours per year, and that the ohmic loss in the transformer when full load is on is 100 watts. Then, if lamps are used according to times given in Table B, the loss due to the ohmic resistance in the transformer is 22·7 B.T.U. per annum. The fourth column if obtained thus: if 100 lamps mean a loss of 100 watts, then x lamps will mean a loss of $\frac{x^2}{100}$ watts; because loss varies as the square of the current—*i e*, as the square of x. Now, on the basis that 100 watts lost at full load due to resistance means 22·7 B.T.U. per annum, design I. will have a loss of $22{\cdot}7 \times \frac{321}{100} = 73$ units per year and design II. of $22{\cdot}7 \times \frac{208}{100} = 47{\cdot}3$ units per year. The hysteresis losses amounting to $\frac{161 \times 8{,}760}{1{,}000} = 1{,}410$, and $\frac{220 \times 8{,}760}{1{,}000} = 1{,}930$ units per year. Arranging in tabular form we get;

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	I.	II.
Annual ohmic loss in units	73	47·3
,, hysteresis ,,	1,410	1,930
,, total ,,	1,483	1,977·3
,, output ,,	9,000	9,000
,, efficiency per cent.	86	82

Thus we see that on loading taken, although design II. has the better full-load efficiency, design I. has the better annual efficiency. Now, taking the selling price at about 2¾ times the cost of active materials, the net cost would be for design I. £45, and design II. £43. The difference is only £2, against which we have a saving of 494 units per annum by choosing design I. Taking cost of a unit at 1d., this means £2 1s. 2d. yearly—that is, design I. pays for its extra cost in one year. Thus we arrive at the conclusion that if transformers are to be used for power, make the iron and copper losses approximately equal, but if for lighting, iron loss small and the copper loss larger.—F. H. C.

Question No. 827.—Explain clearly, with diagrams if necessary, the "La Cour" system of compounding motor-generators.

Answer to No. 827 (*awarded 7s. 6d.*).—The La Cour motor-generator, or "cascade converter," for transforming alternate currents into direct currents, consists of an ordinary single, two, or three phase induction motor, direct-coupled mechanically to an ordinary direct-current dynamo. The rotor winding of the induction motor is also connected electrically to the armature winding of the direct-current dynamo winding at three, six, nine, or more equidistant points by wires carried across between the two machines. The rotor of the induction motor is, further, usually fitted with three slip-rings for starting purposes, but these are short-circuited under normal working conditions. The connections are shown diagrammatically in Fig. 1. The

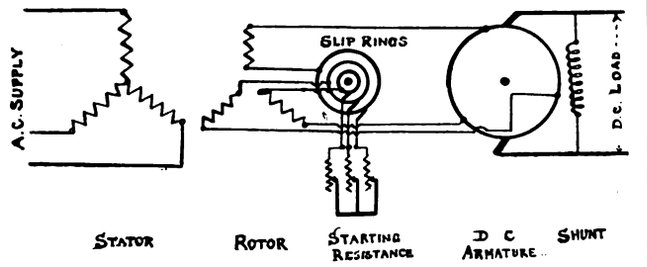

FIG. 1.

alternate-current supply has been taken as a three-phase one, and also only three connecting wires are shown between the rotor and armature, though it is more usual to employ six or nine connections, because this, as in the case of an ordinary rotary converter, reduces the heating of the armature. It will be seen that there is no direct connection between the alternate-current supply and the direct-current output, so that any required voltage ratio between the alternate-current and direct-current sides can be obtained by suitably arranging the relative numbers of turns in the stator, the rotor, and the direct-current armature.

This type of converter can be readily started on the alternate-current side with no more trouble than that involved in starting an ordinary induction motor. The alternating-current supply is switched on to the stator of the induction motor, and the starting resistance between the slip-rings is gradually reduced. Instead of cutting all this resistance out, however, and allowing practically synchronous speed to be attained, as in the case of an induction motor, only sufficient resistance is cut out to enable the machine to reach half synchronous speed (supposing that both induction motor and dynamo have the same number of poles as is usually the case). This half synchronous speed is the normal speed of the set, and the direct-current dynamo will, therefore, excite itself and induce the normal voltages in its armature at this speed. The connections between rotor and direct current armature are arranged so that at half synchronous speed the voltages induced in the direct-current armature are practically equal and opposite to the voltages induced between the corresponding points of the rotor winding by the inducing action of the stator, so that, if the direct-current machine's excitation is correct, only enough current will flow in the rotor circuit to keep the set running.

At this stage the slip-rings can be completely short-circuited either by the starting switch or by an internal short-circuiting device, and the set will then continue to run at exactly half synchronous speed, and the direct-current side can be switched on to the feeders and loaded up. At half synchronous speed the slip (or difference between the rotor speed and the speed of the stator rotating field) of the induction motor is 50 per cent. of the synchronous speed or the ~ of the voltages induced in the rotor is 50 per cent. of the supply ~, whilst the ~ of the voltages induced in the direct-current armature (the number of poles being the same in both machines) is also equal to 50 per cent. of the supply ~. The rotor circuit, therefore, contains two sets of nearly equal and opposite voltages of the same periodicity. As soon as a load is taken from the direct-current side, the opposing voltage of the direct-current armature is reduced by armature reaction and loss in armature resistance, and more current flows from the rotor into the armature, the stator of the induction motor at the same time taking more current from the line. This increased rotor current produces an increased torque in the induction motor, and the limit of increase of rotor current is reached when this torque is equivalent to half the load taken from the direct-current side—the rotor current itself supplying the other half of this load by passing more or less directly into the direct-current feeders, after traversing little or none of the direct-current armature winding. In this way approximately half the power is transmitted to the direct-current side mechanically through the spindle, and the other half electromagnetically through the connecting wires between the rotor and the armature.

It has been assumed above that the excitation of the direct-current machine has been adjusted to give equality of voltage between rotor and armature. If this is not the case, the machine will automatically adjust matters just as in the case of a synchronous alternating motor under similar circumstances — *e g*, if the dynamo is over-excited, an increased current, lagging relatively to the induced voltage in the direct-current armature, will flow in the rotor and armature circuit (accompanied, of course, by a corresponding rise in stator current), and will have such an amount and such a phase relation to the induced voltage as to weaken the dynamo field to the required amount to restore the balance. As this balance between the rotor and direct-current armature voltages is regained partly by field weakening (through armature reaction) and partly by phase displacement, it is obvious that the dynamo field, though reduced from its original over-excited state, is still not reduced to its normal value. The reduction to normal value would only occur if field weakening alone were employed for restoring the balance. It is on this account that such a converter possesses self-regulating properties if the dynamo is compound wound. As the direct-current load increases, the series winding on the dynamo is made to over-excite the field to a greater and greater extent, and so, whilst the phase displacement between the alternating supply voltage and current increases, the magnetic flux per pole of the dynamo also gradually rises with the load, and the dynamo brush voltage rises correspondingly. The makers of these machines state that, without letting the power factor of the alternating supply fall below ·93 at any load, a rise of direct-current voltage of as much as 20 per cent. between no load and full load can be ensured with constant alternating-current supply voltage.

The chief advantages of such converters may be stated as follows: (1) half as many poles required in the induction motor as in the case of an ordinary motor-generator for the same ~ and speed; (2) independence of the alternating-current and direct-current voltages; (3) self-regulating power; (4) higher average power factor than in the case of the ordinary motor-generator; (5) easy starting on the alternating-current side; (6) greater stability in running than in the case of an ordinary rotary converter.—Q.

[Other replies to Question No. 827 will be given in our next issue.—ED. *E. E.*]

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DECEMBER 22, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

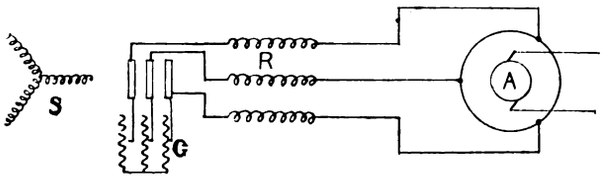
835. Describe a cheap and simple form of electric telegraph for communication between switchboard and engine-room, making use of as few wires as possible.—E. A. A.

836. A certain newspaper printing-machine motor—35 h.p., 500 r.p.m., 480 volts, six-pole (per set)—has two complete armatures on the same shaft and two separate sets of field coils in same magnet frame. One set is wound shunt and the other series. How should this motor be coupled up to its starter or controller?—E. B.

ANSWERS.

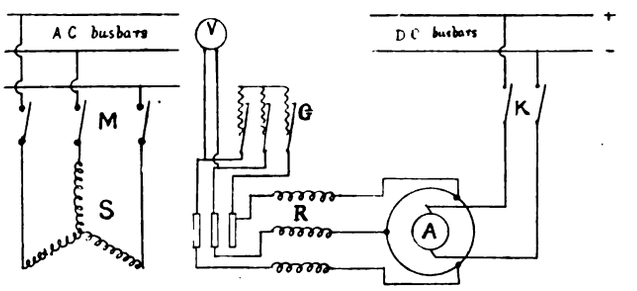
Question No. 827.—Explain clearly, with diagrams if necessary, the "La Cour" system of compounding motor-generators.

Answer to No. 827 (*awarded 7s. 6d.*).—Machines built according to the La Cour system are, as far as constructional details are concerned, very little different from induction motor-generators, except that, in addition to the ordinary mechanical connection between the motor and the generator, there is also an electrical connection. Thus, instead of having two practically independent machines connected merely by a coupling, we now have a compound machine which acts partly as an induction motor-generator and partly as a rotary converter. To see how this occurs, consider an ordinary three-phase induction motor whose rotor, R, is mechanically connected by a shaft to the armature, A, of a direct-current generator. In the La Cour system one side of the rotor winding is connected through slip-rings to a starting resistance, G, in the usual way, but the ends on the other side, instead of being short-circuited



as in an induction motor, are connected to suitable tapping points on the direct-current armature, A. When an alternating current flows in the stator, S, it induces currents in the rotor windings whose frequency depends on the slip of the rotor relative to the revolving stator field. Thus, if w_1 is the angular velocity of stator field, w_2 the angular velocity of the rotor, and n the frequency of the supply, the frequency of the rotor currents is $\frac{w_1 - w_2}{w_1} . n$. We may, therefore, consider A as the armature of a rotary converter supplied with current at this frequency. If the direct-current machine is so wound that when used as a rotary converter on the same source of supply as the induction motor, it would run at the speed at which the induction motor would run if there were no slip, it is easy to see that the compound machine will be synchronous, and will run at half the normal speed of either machine when running separately off the supply. For if the induction motor is running at more than half speed, w_2 is greater than $\frac{w_1}{2}$, and, therefore, the frequency of the rotor currents is less than $\frac{n}{2}$. If the rotary converter which is fed by these rotor currents is to keep in synchronism with its supply, it must run at less thanhalf its normal speed. This it is prevented from doing, since it is mechanically connected to the rotor of the induction motor, which we have assumed to be running at more than half normal speed. Similarly, it can be seen that if the speed of the induction motor is less than half normal, the synchronous speed of the rotary will be greater than half normal. If the combination is running exactly at half speed, however, the frequency of the rotor currents is $\frac{n}{2}$, and this is just the frequency required to run the rotary converter at half speed, so that the arrangement is now stable.

The compound machine can now be seen to possess the following advantages: (1) Since the rotary converter is supplied at half the supply frequency, it will run stably with a supply frequency of twice that which can be used with an ordinary rotary. This would enable the standard frequency of 50 to be used both for lighting and traction. (2) There is no need for separate tranformers for the rotary, since transformation is effected by the induction motor, which can be wound for the full line voltage. (3) For a given speed of the induction motor only half the usual number of poles are needed in the stator winding, since the winding is the same as that for an induction motor of double the speed. This means that the diameter of the stator can be diminished. (4) It is started up from the alternating-current side, and is easier to synchronise than an ordinary rotary.



The starting connections can be seen from the accompanying diagram. The stator, S, is directly connected through the main switch, M, to the alternating-current 'bus bars. The rotor, R, is connected on one side through slip-rings to the starting resistances, G, and on the other by means of a hollow shaft to the proper points on the direct-current armature, A. The direct-current side of the armature is connected to the direct-current 'bus bars through switches, K. The synchronising voltmeter, V, is placed across the two leads from the slip-rings. In starting, the direct-current side is not touched at all, since the machine is self-exciting, and all that is necessary is to close the main alternating-current switch, M, and then to adjust the speed by means of the resistances, G, until the voltmeter, V, reads zero. When this has been done, synchronising is effected by suddenly short-circuiting the resistances, G. The slip rings are then short-circuited on the machine and the direct-current side paralleled in. When the main switch, M, is closed, the ends of the rotor connected to the direct-current armature are practically short-circuited, and the machine starts up as an induction motor with a resistance in the rotor. At a certain speed, however, the rotary will get into phase with the rotor currents, and will generate E M.F.'s which will oppose the E M.F.'s in the rotor, and the rotor currents will, therefore, be choked down to quite a small value. Since the resistances, G, are non-inductive, this means that the voltage across the slip-rings will be very small, and the voltmeter, V, will read nearly zero, hence the resistances can be cut out without short-circuiting the rotor. If they were cut out when the rotary was not

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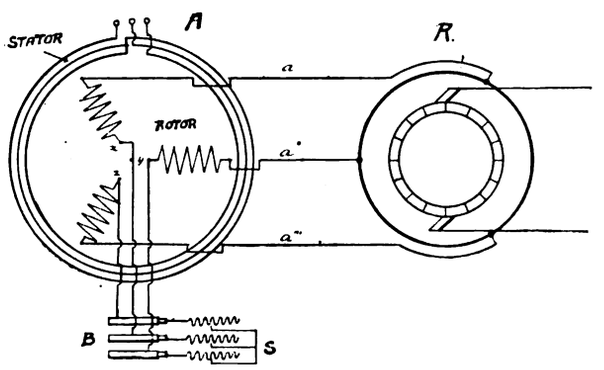
in phase, the rotor would be short-circuited at both ends, and since it would only be running at half the speed at which it should run as a pure induction motor, an excessive current would be taken by the stator. These machines are manufactured in this country by Messrs. Bruces Peebles and Co., and have been installed in several sub-stations in different parts of the kingdom.—J. R. BEARD.

Answer to No. 827 (*awarded* 5*s.*).—The La Cour system of motor-generator consists in mechanically coupling an asynchronous motor to a rotary converter, the secondary winding of the motor being connected to equidistant points in the armature winding of the converter. The accompanying figure shows a three-phase star-connected motor, A, coupled to a rotary converter, R, which is shown as a



two-pole armature for clearness' sake. The secondary or rotor winding of the motor is also three-phase star-connected, each leg having one connection to a slip-ring on the motor shaft and the other to a point in the armature winding of the converter. The slip-rings are shown at B, and have brushes bearing on them which are connected to a starting device, S, of the resistance type. On starting the motor, all the resistances are placed in circuit with the rotor circuit. They are gradually cut out as speed is gained, and at the final speed they are cut out altogether, the points x, y, z forming the common star point of the rotor winding. The connections a' a'' a''' are led through a hollow shaft from the motor to the converter. If, as is usually the case, the rotary converter and induction motor have the same number of poles, then the stable condition of running holds when the rotors revolve with half the speed of the primary rotating poles of the motor—*i.e.*, the motor revolves at half the speed it would run at normally if disconnected from the converter. Hence, if the primary circuit is 50 ~, the secondary circuit will be 25 ~, and the converter will receive current at the latter periodicity, which is more advantageous on account of sparking and heating with the higher frequency. To show that this is so, let R_1 = the synchronous speed of the motor in revolutions per minute, and p_1 = number of poles in the motor. Let R_2 = the revolutions per minute of the set at any time, and p_2 = the number of poles in the rotary converter. In order that the rotary may run in synchronism with the current supplied from the secondary of the motor, it is necessary that

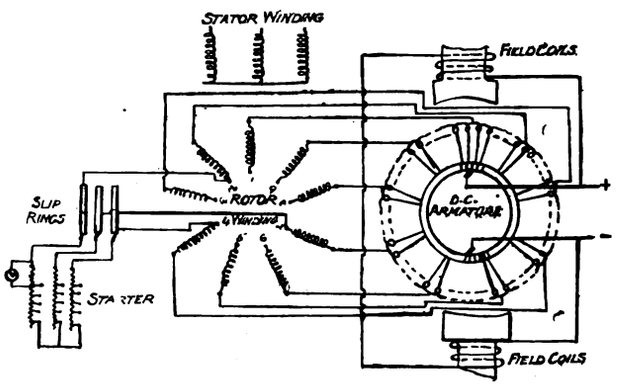
$$(R_1 - R_2)\,p_1 = R_2\,p_2 \quad . \quad . \quad . \quad . \quad (a)$$

and since $p_1 = p_2$ by assumption,

$$R_1 = 2\,R_2, \text{ or } R_2 = \tfrac{1}{2}\,R_1.$$

If p_1 be different from p_2, R_2 will be a different fraction of R_1. A three-phase rotor is always used in this system, but it is obvious that the primary circuit may have any number of phases so long as a rotating field is produced in the motor.—R. D. A.

Answer to No. 827 (*awarded* 5*s.*).—The La Cour motor converter is essentially a synchronous motor direct-coupled to a rotary converter mechanically, the secondary winding of the motor coupled electrically in series to the armature winding of the converter. Or it may be called an induction motor direct-coupled to a direct-current generator, the rotor windings being in series with the direct-current armature. Reference to the diagram below will reconcile the two statements when the action of the set is seen. Keeping to the first definition, if the motor and converter have an equal number of poles, the speed of rotation corresponding to half the frequency of the impressed supply, a field is induced by the supply in the motor rotor, and this field rotates relatively to the rotor in the above proportion. Hence an E.M.F. of half the supply frequency is induced in the rotor windings, causing a current in the converter armature, which in turn sets up a rotating field relatively at the same speed as the shaft. The converter armature is connected to the rotor so that this field rotates in the opposite direction to the shaft, and is thus motionless, being at the same speed, hence the machine works as a synchronous motor. Half the impressed energy is thus converted into mechanical energy and transmitted to the converter, the other half retained as electrical energy and



given to the converter armature through the rotor. If the motor and converter poles differ in number, the rotation speed ratio to that of the impressed frequency would be that of the number of poles of the motor to the sum of the number of poles of motor and converter. The motor thus works as transformer and motor, the converter as rotary converter and direct-current generator. To start the set from the alternating-current end, only three of the phase windings of the rotor are used, these three being connected through slip-rings and a non-inductive resistance to a neutral point. The supply is taken direct to the stator, and the action is that of an induction motor; the resistance is gradually cut out as the speed increases. The converter is on open circuit, the phase windings, other than the three above, being connected to the winding as shown. When the machine is running synchronously, as seen by the voltmeter needle, the rings are short-circuited by means of a handle on the machine, thus connecting all the rotor phase windings. Starting on the direct-current side is, of course, permissible, and if a supply exists, the machine is run up to speed and synchronised in the usual way.—S. E. T.

Question No. 828.—Is there any formula giving for a magnetic blow-out the connection between sparking distance, voltages of supply, current to be broken, distances of the pole-pieces, and number of ampere-turns on blow-out coils?

Answer to No. 828 (*awarded* 10*s.*).—There is not, as far as I know, any well-known formula connecting the various data mentioned in the question. Makers usually have to rely on their previous experience and their own experiments when designing the blow-out magnets. The chief aim, however, is to obtain as powerful a magnetic field as possible without making the magnets an undue size or expending more than a reasonable amount of power in their windings. For such a formula to be of any practical use, it must of necessity be of the empirical variety, derived from experimental data. The necessary experiments should present no very serious difficulties, although such things as shape and material of contacts and atmospheric conditions are likely to produce serious disturbing effects. The deduction of a formula from theoretical considerations is a matter of little difficulty, but, as the following investigation will show, such a formula is of little use, as it necessitates the employment of some uncertain physical constants. The total flux, N, due to the magnets can be easily calculated from the following formula:

$$N = \frac{\text{ampere-turns on magnets}}{\frac{l}{A} + \frac{v\,l_1}{A_1\,\mu}}$$

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where l = length of air-path;
A = area of air path (area of pole face;
l_1 = length of iron path;
A_1 = section of iron;
μ = permeability of iron;
v = leakage coefficient.

For every voltage there is (keeping other conditions the same) a definite length of gap, l_0, which the arc will just bridge. This length will depend on many conditions, and must be found experimentally for those particular conditions.

On opening the circuit an arc is formed, and, due to the resistance (both ohmic and back E.M.F. of volatilisation), the current is reduced to a certain more or less definite but

$$\text{unknown value} = \frac{V + C\,r}{C\,V} = C_1,$$

where V = voltage of supply;
C = current broken;
r = resistance of arc.

Then considering the arc as a flexible conductor in a magnetic field it will be acted on by a certain deflecting force at right angles to its length; this force will be equal to

$$\frac{C_1\,l\,N}{A \times 11{,}303{,}000} \text{ lbs.}$$

Due to this force, the arc will be deflected, and, therefore, lengthened a certain amount, but in general will be maintained in equilibrium under the action of the deflecting force and the tension along the arc. If, however, the new length be greater than that found for the given voltage, l_0, the component of the tension will not be sufficient to balance the deflecting force, and the arc will be blown out. It must be remembered, however, that the deflecting force in the new position is not that given by the formula above, for, owing to the lengthening of the arc, its ohmic resistance has been increased and the current, therefore, reduced. The effective length, however, still remains the same, l, although the actual length, l_{11}, and the shape of the arc has altered. So that in the new position we have

$$\frac{C_{11}\,l\,N}{A\,11\,303{,}000} = 2\,T \sin\alpha \text{ (component of tension)},$$

where α = angle that the arc makes at the ends with the straight line joining the contacts. The angle α in the limiting case can be obtained from the fact that

$$l/l_0 = \cos\theta.$$

The formula involves a knowledge of three quantities which may vary enormously under different conditions—*i.e.*, B.E.M.F. of volatilisation, ohmic resistance of arc, tension in arc—and would, therefore, have to be specially determined for any particular case. We thus see that in any case experimental work is necessary. It does not require much consideration to see that it would be far more expeditious and convenient, instead of determining these awkward physical quantities, to obtain a direct relation between the actual quantities by obtaining a series of observations connecting them, and fitting an empirical formula to them.—B. Sc.

Question No. 829.—When a conductor is charged with electricity, the whole charge resides on the surface of the conductor; when, however, the conductor is carrying a current, the whole cross-section of the material is in use. How can these two commonly accepted facts be reconciled?

Best Answer to No. 829 (*awarded* 10*s*).—To answer such a question as this in the space at disposal necessitates that a brief explanation can only be given, and due allowance must be made if a kind of mist seems to obscure some portions. If we take two common metal spheres and place them in the air, we know for certain that the forces that are within them, and the forces possessed by the air which surrounds them, are as near equilibrium as possible; by ordinary measurement there cannot be detected any difference. But we know that their essential properties differ, for when they are subjected to a similar force they each differ fundamentally in their reactions—that is, manifest a greater or less degree of energy. Now, when matter is in motion we say that such a body possesses momentum or energy, but matter could not attain motion unless it was subjected to a force, and since, if we regard as existing in the universe matter and ether, which can be regarded as a perfect fluid in which matter resides, it must be an etheric force which causes matter to attain a motion and so manifest energy, just as a ship will attain motion when subjected to the sea waves from which it takes it energy. Now suppose we regard each atom of matter as being built up of primitive or primordial atoms in motion, the number and amount of motion varying in different substances, that is, if a substance, say, air, possesses a larger volume than a metal of the same weight, then the atomic energy or motion of the air per unit is much greater. Or a greater amount of force would be required to force an atom of air along any fixed path than would be required to force an atom of the metal.

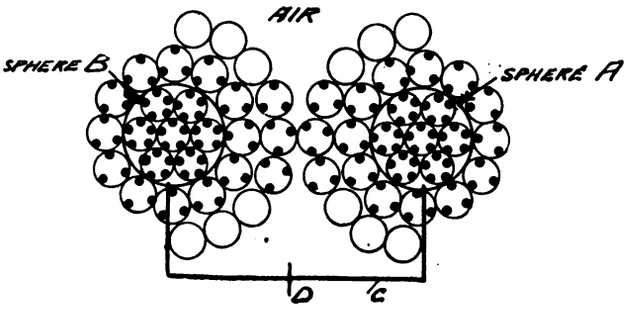

FIG. 1.

Now, it is obvious that if a certain number of primordial atoms possessing motion by revolving round some centre contribute to the atomic value of a substance, that if one or more be added or withdrawn from such an atom that its force or momentum is bound to vary accordingly, and this will naturally affect the other atoms in its neighbourhood. Now, an attempt will be made to depict an electric charge by the preceding principles. Suppose we take again our two spheres, A and B, situated in air, and for simplicity sake we regard each atom of air as being built up of three primordial atoms and each atom of metal of five, revolving in a circle which is shown as the limits of each atom (Fig. 1), and we now cause an etheric force to operate between the spheres by the medium of a wire, C, and an influence machine, D, then if such a force be caused in a direction as shown by the arrow, there will be a tendency for one or more primordial atoms to leave sphere A and move into sphere B; and Fig. 2 depicts a condition when

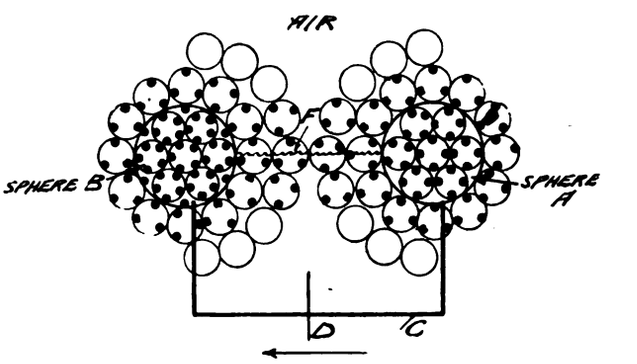

FIG. 2.

an etheric force of sufficient strength is being created as to cause each atom in B to possess one more primordial atom than in A. Now, it is clear that if the atoms in the spheres and the air were in equilibrium before the etheric force was applied that they cannot be now, since the energy possessed by the atoms forming the air resist their passages from whence they were subtracted from sphere A. Since the atoms in sphere B resist the intrusion of the primordial atoms from A caused by the etheric force, and since the air resists their passage again to sphere A, there must obviously be a stress in the air surrounding the sphere and between the spheres, positive round one and negative round the other, and is the most intense along a line F; and there will be a constant tendency on the part of this stress to force these primordial atoms across this space F,

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and the greater the etheric force applied the greater will be the number of primordial atoms in B (and the less in A), and the greater will be the stress in the air and along the line, F, until such times as the atomic energies possessed by the air of resisting the passage of the primordial atoms across the space, F, to sphere, A, is overcome by the stress, whence an electric spark, and a resulting endeavour to restore equilibrium.

Now, the wire connected in circuit with the spheres, and which was the medium by which they were charged, obviously has some of the primordial atoms disturbed when the organised etheric force is applied, and the number and rate at which they flow will be the current. Provided the metal forming the conductor is more or less homogeneous—which, of course, determines that its atomic properties are fairly uniform—then an organised force in a given direction must cause an organised movement of primordial atoms in a given direction. Fig. 3A depicts a conductor, each atom

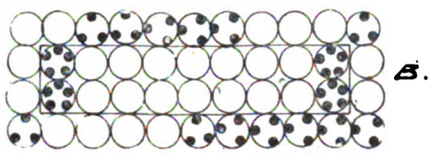

FIG. 3A.

being made up of five primordial atoms in equilibrium with the surrounding medium—air. Fig. 3B depicts the same conductor subjected to an organised etheric force in a direction shown by the arrow at some point A which causes from the moment it is applied one or more primordial atoms to leave each of the atoms and move in the same direction, so that there will be an excess of these primordial atoms at one end, B, and a deficiency at the other end, C. Now, just as the atoms in the sphere B (Fig. 2) resisted the intrusion of primordial atoms, so do the atoms at the end B of this conductor, and so we have a positive stress on the air to the right of A to B and a negative stress to the left of A to C. If we substituted for the air a much better conductor than the

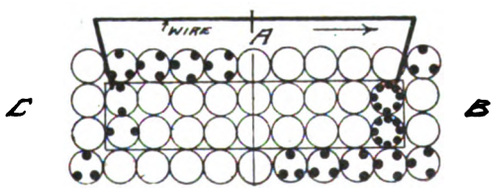

FIG. 3B.

air—say a copper wire—between the points B and C, we would evidently relieve the stress on the air, and these primordial atoms would instantly flow through it from B to C, because the atomic resistance to the transference of primordial atoms is much less in the copper than in the air. We see, then, that a conductor cannot have a charge unless we create an etheric force which causes the flow of primordial atoms, which is current, and when surrounded by a medium (air) we will have resulting a positive stress at one end and a negative stress at the other; but this organised stress is entirely due to the resistance offered by the atoms to the organised intrusion of those primordial atoms forming the current, combined with the resistance of the air to their passage from whence they started. If a number of spheres of some hard substance be placed in a cylinder of some flexible material, and a uniform pressure or stress applied to each one, from the moment this stress was applied there would be a gradual organised movement of the spheres until the stress applied equalled the stress in the cylinder, and is analogous to a uniform etheric stress causing an organised flow of primordial atoms, until the etheric stress applied equalled the etheric stress in the surrounding medium—air. Therefore the flow of current is independent, as regards its organisation, of the resultant stress on the surrounding medium, and the necessity that because this stress is manifested on the outside of a conductor it should flow only on the outside.—JAMES W. TUNSTALL.

Answer to No. 829 (*awarded* 7*s.* 6*d.*).—The latest theories of electricity regard electrical disturbances as elastic reactions in the ether. The exact nature of the ether is at present only a matter of conjecture, but for our purpose we may regard it as an elastic, jelly-like substance, containing imprisoned in numerous cavities and interstices an incompressible fluid—electricity. The above description is only an analogy, for bodies can move through ether, and electricity is not necessarily a fluid, although it obeys fluid laws. Charging a conductor with static electricity corresponds to pumping some of this fluid from one cavity to another. Evidently, since the walls of the cavities are elastic, such a transference is quite feasible. The magnitude of the charge corresponds to the change in quantity of the fluid, and a moment's consideration will show that the increase or decrease in the amount of fluid present resides at the surface of the cavity. This explains why charges of statical electricity reside at the surface of the conductor.

Now, consider the case of a conductor carrying current. The conductor we regard as a hole through the jelly into which the entangled fluid in the neighbourhood soaks. Once in the hole it can respond to the difference of pressure imposed by the generator, and hence flows along the duct. Since the fluid (electricity) will continue to soak in until the hole is completely filled, it is evident that the whole area of the canal or duct will now be utilised. From this it will be seen that the complete section of the conductor is in use when carrying a current. The resistance of the conductor corresponds to a sponge-like path instead of a clear hole.

The following example will, perhaps, make the application of this theory clearer: In the case of a long cable, some time is taken to transmit signals by electricity, due to the capacity of the cable. This may be explained as follows: the electric fluid soaking in from the ether fills the duct, and then, owing to the elasticity of the sides of the path, fluid continues to flow in, distending the sides slightly. Until this stretching is complete the difference of pressure does not come into play, hence the time required for the transmission of the electricity. The distension of the sides of the duct is, as explained above, a charge of statical electricity.—T. J. M.

Answer to No. 829 (*awarded* 5*s.*).—Cannot these two apparently opposed facts be explained in terms of the fundamental and commonly accepted principles of electric action—viz: (1) A conductor is a body which yields (electrically) to electric pressure—*i e*, if a potential difference is originated between any two points in it, the pressure is immediately transmitted in *every* direction until it equalises itself, the action in this respect being exactly analogous to that of ordinary fluid pressure. A conductor is an (electrically) *yieldable* body. (2) A dielectric is one which does not yield (electrically) to electric pressure: consequently potential differences can be maintained from point to point in it. It is an (electrically) yieldable body.

Suppose now that a charge of electricity is introduced at some point within a solid conductor, thereby originating a rise of potential at the point. In accordance with (1) this pressure will be transmitted in *every* direction through the substance of the conductor until equilibrium is attained—*i e*, the whole cross-section of the conductor will be utilised in the process (passage of current). In the next place, this transmission of pressure will travel outwards until it reaches a non-yieldable material—the surface of a dielectric, *e g.*, air.

The pressure within the conductor will now be higher than it originally was, but being everywhere the same there will be no electric *force* within it, and hence no free charge. But immediately we pass from the conductor we step into a region where the electric pressure falls off from point to point. Now it is only through this *difference* of pressure that the electric force manifests itself, hence when equilibrium is once attained (a static charge produced), it is observable only in and on the boundary of the dielectric—*i e.*, on the surface of the conductor.—G. B.

[Other replies to Question No. 829 will be given in our next issue.—ED. *E. E.*]

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Supplement to "The Electrical Engineer,"
DECEMBER 29, 1905.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within ten days after the question has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

ANSWERS.

Question No. 829.—When a conductor is charged with electricity, the whole charge resides on the surface of the conductor; when, however, the conductor is carrying a current, the whole cross-section of the material is in use. How can these two commonly accepted facts be reconciled?

Answer to No. 829 (*awarded 7s. 6d.*).—We may very conveniently divide the study of electricity into four distinct portions. In the first portion we consider electricity at rest, or static electricity, in which we study the stresses and strains and other allied phenomena produced in the dielectric which is surrounding a charged body. In the second part we consider electricity in locomotion—*i.e.*, translation as opposed to rotation or oscillation. In this branch of the subject we study the phenomena set up in metallic conductors, in electrolytes, and in dielectric media by the passage of electricity through them. In the third branch we discuss electricity in rotation, whirling, or vortex motion, and stresses and strain produced by these motions. This branch is commonly called magnetism. And in the fourth and last portion we consider electricity in vibration, commonly called light. It will thus be seen that the phenomena mentioned in the query belong to two different branches of the subject, and, therefore, there is some *a priori* reason why the effects noted should be different, for, considering the hydraulic analogy, there is a considerable difference between the laws relating to water in motion compared with those relating to water at rest.

In order to understand why in one case the electricity appears to reside entirely on the surface of the conductor, while in the other it appears to spread over the whole area, we must obtain some sort of theory as to the nature of electricity and what constitutes a static charge and what constitutes an electric current. Fluid theories were put forward during the last century, but a few years ago there was a reaction against them, and a tendency to deny the material nature of electricity and assert its position as a form of energy was prevalent. No doubt there was some excuse for this idea, owing to possible analogies to sound, heat, light, etc. Whatever electricity may prove to be (possibly some form of matter), one thing is certain, and that is, it is *not* a form of energy. Now, this statement must not be misunderstood, for it is quite true that electricity under pressure or in motion represents energy, but the same thing applies to water, and no one would call water a form of energy, although, no doubt, it does contain considerable quantities of energy associated, and with its atoms are material particles.

Again, another argument which points toward a material conception of electricity is that electricity is never created or destroyed, but simply moved from one place to another, or strained, like matter. It is a matter of common knowledge that it is impossible to obtain a positive charge without generating an equal negative charge, which is equivalent to saying that the total algebraic quantity of electricity produced is equal to zero, or that electricity is merely shifted from one body to another. We thus see that electricity is comparable to matter, and, indeed, we may go a little further, and show that it is comparable with a perfectly incompressible fluid—that is to say, it follows the same laws. This is demonstrated by two classical experiments, one being the experimental proof that the charge resides on the surface by means of the sphere with removable outer coating usually attributed to Biot, and the other Faraday's insulated metallic room experiment. The first of these experiments has been carefully repeated by many notable experimenters using a delicate Kelvin electrometer instead of the rough gold-leaf electroscope, and they have obtained conclusive evidence that the charge, whatever it may be, resides on the outer or may be just outside the surface in the dielectric. That it only extends to less than the depth of a few molecules is shown by an experiment due to Prof. Boys, who found that one soap bubble was entirely screened by another bubble blown outside it.

If an attempt is made to introduce some electricity inside a conductor, this disappears, and an equal quantity appears outside. Compare this phenomenon to its hydraulic analogue, and the resemblance of electricity to an all permeating incompressible fluid becomes apparent. If by suitable means a quantity of water is introduced into a closed vessel already full of water, then, assuming water to be incompressible (which it is not), an equal quantity of water will be forced through the bounding walls to make room for that which is introduced. The water introduced loses it individuality, while that forced out is distinct from the rest. Work is done in both cases; in the electrical case this energy is converted into strain energy in the surrounding dielectric, and is due to electricity being under pressure, and constitutes what we call an electrostatic charge. In Faraday's experiment he built an insulated metallic room large enough for him to get inside, and in there he performed all sorts of electrical experiments, drawing long sparks from electrical machines, etc., without permanently affecting a delicate electroscope attached to the room outside. We may again compare them with an hydraulic experiment; however fast we may work a pump entirely enclosed in a closed vessel full of water, no water would be forced in or out. We thus see that the theory that electricity is something resembling matter in the form of an incompressible fluid which permeates all space and entirely fills it, explains why the charge appears to reside at the surface.

Now, proceeding to the second case. Here we have electricity in motion, and the question naturally arises, How is it transmitted? Does it pass through or between the molecules, or is it handed on from molecule to molecule? The latter explanation seems the most likely, for, according to the kinetic theory of matter, the molecules in a solid have a vibratory movement about a fixed point. If, then, one molecule receives a charge, it will in a very short time share it with its neighbours, owing to collisions between them, while those receiving the charges will part with them in a similar manner. If the first molecule receives a second charge immediately after losing the first, it will pass this on in the same manner, and an electric current will result. Now, remembering that what we call a charge of electricity is the strain produced in the dielectric produced by electricity under pressure, the current is then merely the setting up and almost simultaneous breaking down of the strain in the dielectric surrounding the molecule. As all the molecules bar those very near the surface are similarly situated with regard to those in its immediate neighbourhood, there is every reason to suppose that they will all share about equally in the charging and discharging process,

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and, therefore, the whole area will be requisitioned to transmit the electricity. For developments and a full discussion of the difficulties surrounding this theory which identifies electricity with the ether, the reader should consult Sir Oliver Lodge's book on "Recent Views on Electricity."—B.Sc.

Answer to No. 829 (*awarded* 5*s.*).—The chief points to be remembered when comparing an electrostatic charge with current flowing through the section of a conductor are briefly as follows:

1. Since the static charge is electricity *at rest*, the *material* of the charged body does not affect the behaviour of the charge. If a sphere is to be charged, it makes no difference whether it be of copper, iron, or wood covered with tinfoil. The charge resides on the outside by reason of the influence of the *surrounding dielectric*, which is the regulating factor. The potentials met with in electrostatic work are usually incomparably higher than those in ordinary direct or alternating current practice—*e.g.*, a ball of metal beaten with fur may readily obtain a potential of 50,000 volts—a good plate machine 200,000. Of course, the current values are correspondingly minute, but it will be clear that these pressures set up a strain between the charged surface and the nearest body of lower potential, which depends on the medium between the two bodies. The dielectric serves as insulator, but also transmits the strain, which causes a discharge if sufficiently increased.

2. Considering the conductor carrying a current, we know that the specific resistance of the conductor (the nature of the material) is an all-important factor in determining the current value. The potential employed, however, is probably so low compared with that of the static charge that the strain on the dielectric becomes negligible, whilst substances which act as conductors in static work, like wood, become efficient insulators. If a direct E.M.F. be applied, a flow of current takes place through the conductor from positive to negative poles. The resistance of the conductor determines the current strength, and the current is distributed throughout the cross-section of the conductor with equal density in every part. In the case of an alternating circuit there is an *unequal* distribution in the conductor, the density increasing outwardly from the centre of a circular conductor; but this is due to the effect of mutual inductance in the conductor, and not to the surrounding dielectric. A static discharge is, of course, a minute current, but so infinitesimal that the idea of current density at the point of discharge is not worth consideration. —A. M. L.

Question No. 830.—A dynamo is to supply lamps and also charge a secondary 50-volt battery of six cells. When dynamo is not working, the battery will feed the lamps. Describe a "fool-proof" arrangement so that, whether dynamo or battery feeds the lamps, a V.M. and an A.M. should always remain in circuit. Also arrange that three or more cells may be thrown into the circuit as required.

Answer to No. 830 (*awarded* 7*s.* 6*d.*).—Before answering this question I think it would be advisable to point out the mistake in the second line—viz., "a secondary 50-volt battery of *six* cells." This is certainly meant for *twenty-six* cells, which is the number generally used on a 50-volt installation. Fig. 1 shows the connections for a small private generating installation. Here Dy is the main dynamo, F its field coil. D P S and D P F are double-pole switch and double-pole fuse respectively. B B represents the battery. Those at the left-hand end are connected to multiple-way charge and discharge switches, C and D, the former being joined up with one pole of the dynamo, and the latter with one of the mains running to the lamps, L L. A is an ammeter permanently connected on one side with the dynamo, and on the other with the service main and through a two-way switch, T S, with the right-hand end of the battery. When the switch is on the bottom contact, A indicates the current from the dynamo, while if it be on the top contact, A shows the current passing to the lamps. The "two-ways" or "contacts" should be placed close together, so that the battery circuit shall not be broken when moving the contact finger from one to the other. The voltmeter, V, is permanently connected to the ammeter end of the circuit, and through a two-way switch with the charge and discharge side of the circuit. In the first case it indicates the voltage of the dynamo, and in the second the voltage of the battery. As one or more of the cells on the left-hand side may not be used during discharge, they will not require so much charging as the others; therefore, they can be cut out of circuit by the switch, C. A′ is an automatic switch, which closes the circuit when the dynamo

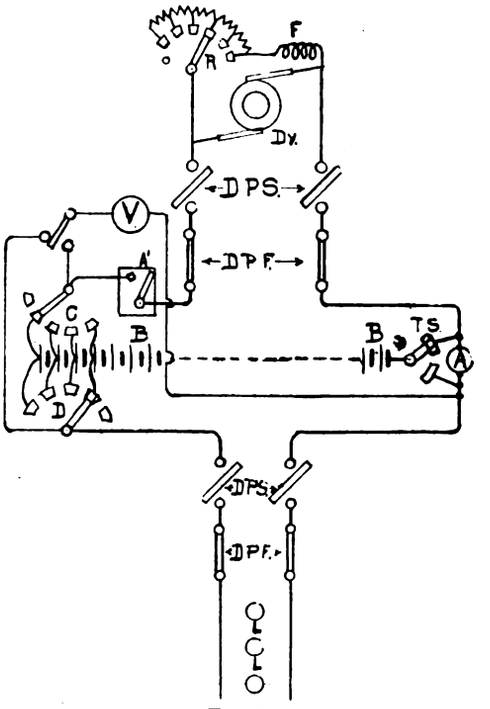

Fig. 1.

voltage rises sufficiently above that of the battery, and breaks it if from any cause the generator voltage should fall below that of the battery. The two switches, C and D, should be special battery regulating switches, so as to prevent short-circuiting the cell between the two contacts when moving the contact arm.

Fig. 2 shows a form of switch that may be used. Fixed on the side of the main contact, but insulated therefrom, is a small auxiliary contact, A, electrically connected to the main contact by a short wire, W, of high resistance. The distance between the contacts, C C, is such that in moving the switch arm from one to the other the circuit is never actually broken, the cell between the two adjacent contacts

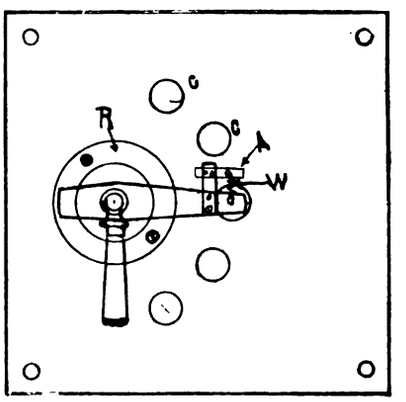

Fig. 2.

being momentarily shorted through the wire, W. The main contact must also be small enough so as not to bridge two adjacent contacts.—P. S.

Answer to No. 830 (*awarded* 7*s.* 6*d.*).—It is an easy matter to arrange for an ammeter to be always in circuit with the lamps and a voltmeter to be across the terminals of the circuit. The necessary arrangement is shown in Fig. 1, and is quite "fool-proof" as far as it goes (full lines only) As, however, the installation is evidently to be in unskilled hands a few further precautions are necessary, and in any case it is essential to the efficient working of the battery that the charging and discharging

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currents should be known. Fig. 2 is the diagram of connections for a board which would be suitable for the purpose; it is not arranged for battery and dynamo to run in parallel on the load, but should this be required at any time there will be no difficulty in providing for it without any radical alterations, as explained below. The six sets of cells, which consist of 28 cells in series, each forming a

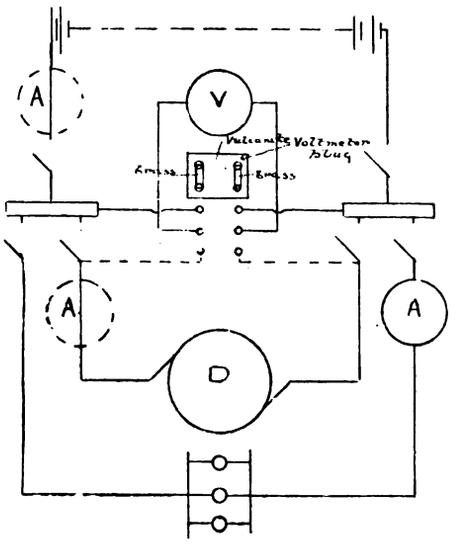

FIG. 1.

separate battery, are connected through switch fuses to a common 'bus bar at the + end; at the − end four cells are connected in parallel to a regulating switch, having an advance arm insulated from the main arm at the lower end, and connected to it at the top end by a low resistance. This arrangement prevents the cells being short-circuited by the arm when passing from one contact to another.

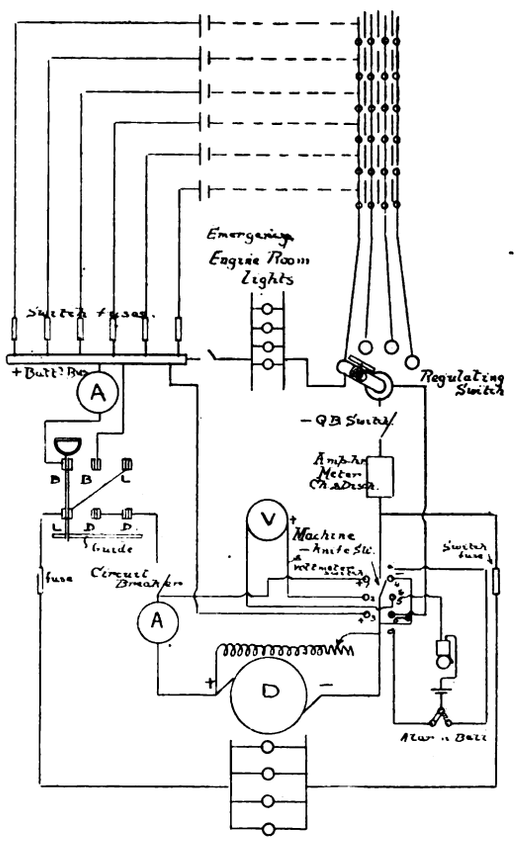

FIG. 2.

It would, of course, be possible to connect the regulating cells in such a manner that the − end of any battery could be cut off from the board, but that would be an expensive and complicated arrangement. The best connections may be made by means of four copper rods running to the regulating switch contacts, with T's to the regulating cells, as indicated in the diagram. The T's should be capable of easy removal when required. All the bare copper in battery-room should be protected by a coat of acid-proof paint. In series with the regulating switch and − battery switch is an ampere-hour charge and discharge meter, which is a very important adjunct to the battery. The switch on the left consists of three sets of contacts with only one blade, which may be used in any of the three sets. The arrangement of ammeters shown ensures that the current is always indicated on one ammeter only, and in conjunction with the three-way switch, which should be marked as shown, it is extremely easy to follow whatever is going on. The dynamo is protected by means of a maximum and reverse current circuit breaker on one pole and a knife switch on the other. This knife switch is shown in Fig. 3, and has two sets of auxiliary contacts which operate the voltmeter, so that when machine is not running the battery volts are indicated, and when the machine is about to be switched in the machine volts are indicated. The voltmeter connections can be easily followed in Fig. 2, and it will be seen that a bell is also connected up. This bell acts as a reminder to look after the machine volts when running up, and continues ringing until switch is moved over. When machine is switched out, the bell will again ring until switched over to the other circuit. This ensures that the bell will always ring before machine is switched in.

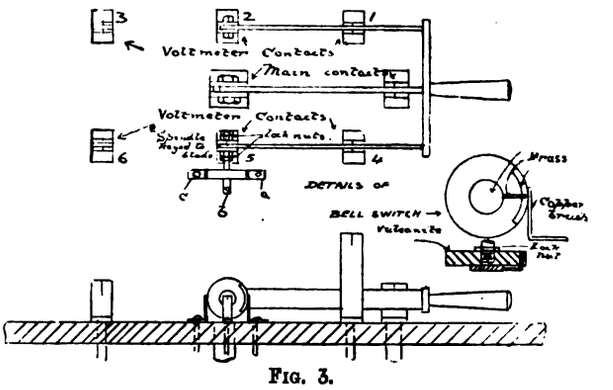

FIG. 3.

Now, as to operating this board. Any number of batteries may be used, but it would be advisable to use the same number always, keeping those out of use fully charged up and disconnected both ends. The currents flowing in each battery circuit ought to be known, and for this purpose shunts may be fixed in each circuit to a system of plugs leading to a common ammeter. To avoid any chance of confusion, this ammeter should be distinctly marked. When switching on the dynamo to battery or lamps, care must be taken that machine voltage is equal to battery voltage or voltage necessary for lamps, as the case may be, or a sudden rush of current or burst lamps may result. Similar precautions should be taken before switching battery on to lights. No provision is made for changing over from dynamo to battery without extinguishing lights, as this means additional complications with both ammeter and voltmeter switches, which would render the arrangement less fool-proof. Probably, however, the battery will be charged up and changed over before dark, and in any case the inconvenience is momentary. If, however, it is necessary to run battery and dynamo in parallel on the load in an emergency, this can be effected by connecting the terminals, D L, with a plug, the switch being in position shown connecting B L Should it be necessary to run battery and dynamo in parallel as a rule, and also to change over without extinguishing lights, the writer would strongly advocate a board built upon the principle of Fig. 1, including dotted lines, and the engagement of an intelligent man to look after it. The probability is that he would be a good investment in any case.—D. M H. 97.

Answer to No. 830 (*awarded* 5*s*)—The following is a description of an installation which I have no doubt will entirely suit "K C. N.'s" requirements. I have installed systems similar to this and have found them in all cases to be reliable and to give complete satisfaction, and I may here state that they have usually been left in the hands of an unskilled workman, thus showing the extent to which

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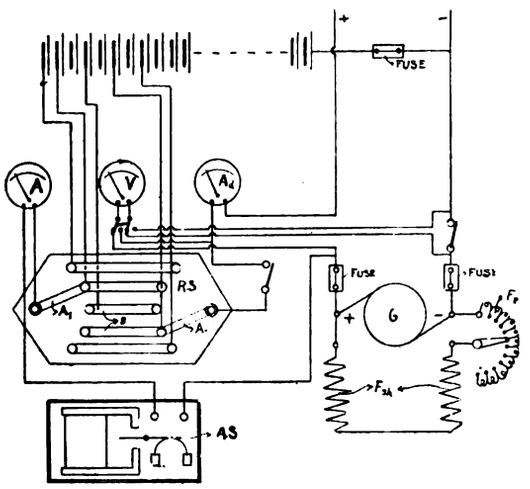
they are "fool-proof." The general lay out of the system will be easily followed from the diagram of connections. G is a shunt-wound generator capable of generating from 50 to 70 volts and the required amperage. If the generator is required to supply sufficient current for the whole of the lights at one time, which is usually the case, then the output will have to be sufficient for this purpose, but if the battery is discharged during the "peak of the load," a dynamo of less output may be installed and the battery may be charged during the hours of practically no discharge. The reason why the generator ought to give an E.M.F. of 75 volts is this: when the battery is fully charged, the E.M.F. of each cell will rise to approximately 2·7 volts, depending upon the rate of charge, therefore $26 \times 2{\cdot}7 = 70$ volts, which is the E.M.F. required to overcome the back E.M.F. of the battery. F_{sh} is the shunt field and F_r the field resistance in series with the shunt field. If the speed of the dynamo can be altered by means of a sensitive governor on the prime mover, the field resistance may be discarded, but it is advisable in most cases to run the dynamo at a constant speed and vary the voltage by means of the field resistance A S is a Neville's patent automatic switch. R S is a regulating switch. It consists of brass bars, B, suitably mounted on a marble or slate base, and to which are connected cables leading from certain cells in the battery. Movable arms, A A_1, can be so adjusted as to make contact



with any one bar, and, therefore, with any particular cell in the battery with which these bars are connected. The function of this switch is to be able to supply the lamps with current at a proper voltage at the same time that the battery is being charged, or to proportion the discharge current between the dynamo and the battery by means of the movable arms, A and A_1. As I stated before, the E.M.F. of each cell when fully charged will be about 2·7 volts, therefore the number of cells required in the battery to give 50 volts to the lamps, assuming them to be 50-volt lamps, will be $50 \div 2{\cdot}7 = 19$ cells. The bottom bar of the regulating switch will, therefore, have to be connected to the nineteenth cell in the battery, and the discharge movable arm, A, adjusted so as to make contact with this bottom bar. When the battery is taken off charge, the voltage will gradually decrease. It will be necessary to increase it. The point to be now considered is how many cells are to be put in. To obtain an almost imperceptible increase of light from the lamps, due to the increase of voltage when cells are put in circuit, connections ought to be made to each of the remaining cells, but this would require an elaborate and expensive regulating switch in proportion to the size of the installation. Connections to cells 19, 21, 23, 25, 26 would be very suitable in this case. It is well known that the top cells or those at the positive end of a battery always get fully charged before those at the negative end. If these cells were left in circuit they would cause a waste of energy, but by means of the regulating arm, A_1, these cells when fully charged can be cut out of circuit. The discharge ammeter, Ad, is permanently connected in circuit, as indicated in the diagram. It is also advisable to have an ammeter in the machine circuit and also a voltmeter, so as to be able to see exactly what load is on the machine. Only one voltmeter is necessary for indicating the dynamo and line voltage if a throw-over switch is provided and connected according to the diagram. The method of placing the machine on load is as follows: The dynamo is run up to speed and the negative machine switch is closed. If the voltage of the machine is high enough to overcome the battery E.M.F., the automatic switch will close the circuit. If not, the voltage may be increased, either by increasing the speed or decreasing the field resistance, until the switch automatically closes. It will be seen that if from any cause the driving power fails, the automatic switch will automatically break the armature circuit, and thus prevent any possible damage to the dynamo.

A less elaborate and less expensive switch may be substituted for this automatic switch, but a switch working automatically I strongly advise to be put in the machine circuit, as it almost totally prevents any damage being done to the dynamo. Of course, fuses ought also to be put in the circuits where required.

There is one point in the running of an installation similar to this which I wish to particularly emphasise, and that is to run the generator during the "peak of the load." Not only does this give a higher efficiency (units consumed by lights ÷ units generated), but greatly reduces the cost of maintenance and renewal of the battery, which is no small item in a private installation. Where the driving power is water, and obtained at little or no cost, the question of efficiency need scarcely be considered.

There is an alternative arrangement, in which the regulating cells are placed in the centre or some other convenient point of the battery. This arrangement necessitates either the disconnection of the lamps from the battery and machine when charging, or the addition of a "booster" to the installation previously described. In a very large installation, say of 250 cells, this arrangement is perhaps the better, but in the case of a comparatively small installation of 26 cells is impracticable, and need not be further considered.—JOHN J. RICHARDSON.

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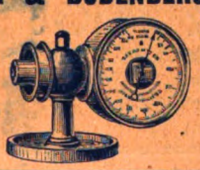

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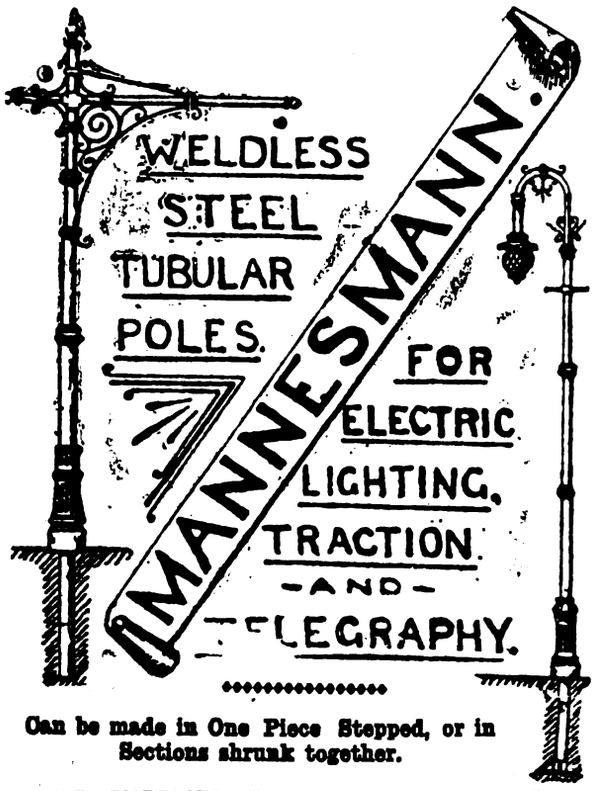

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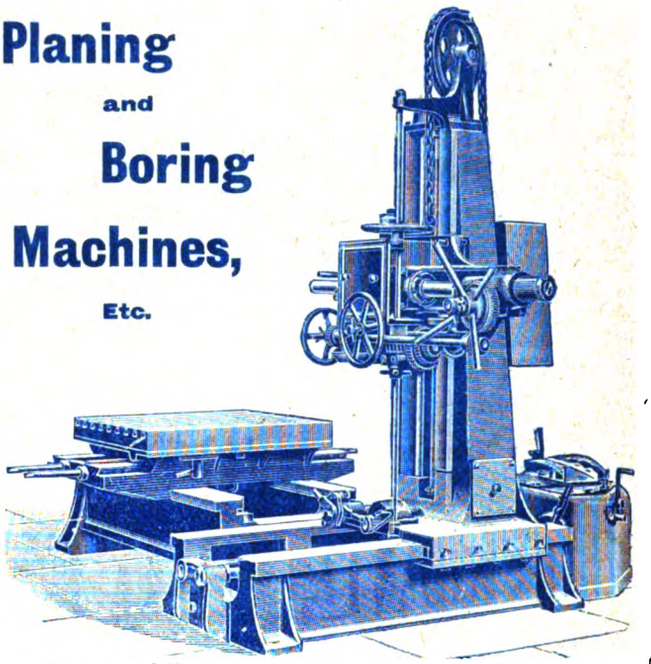

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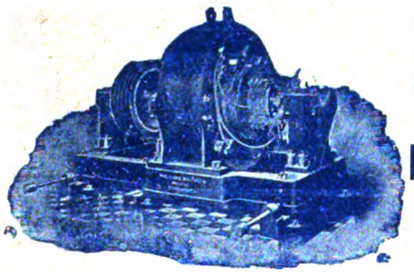

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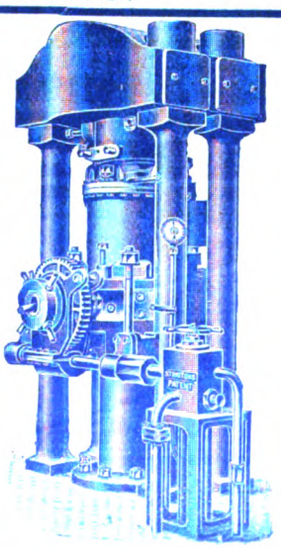

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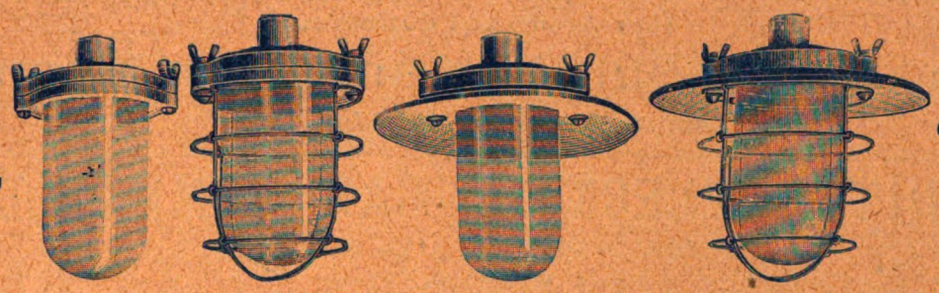

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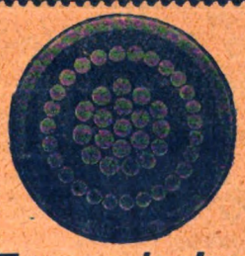
HENLEY'S  CABLES.

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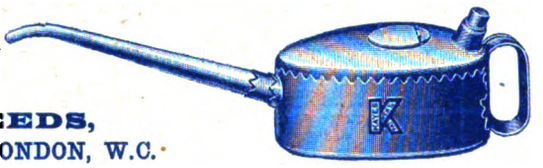

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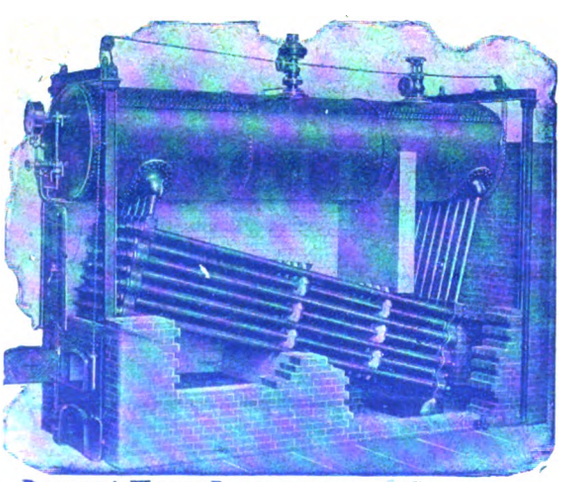

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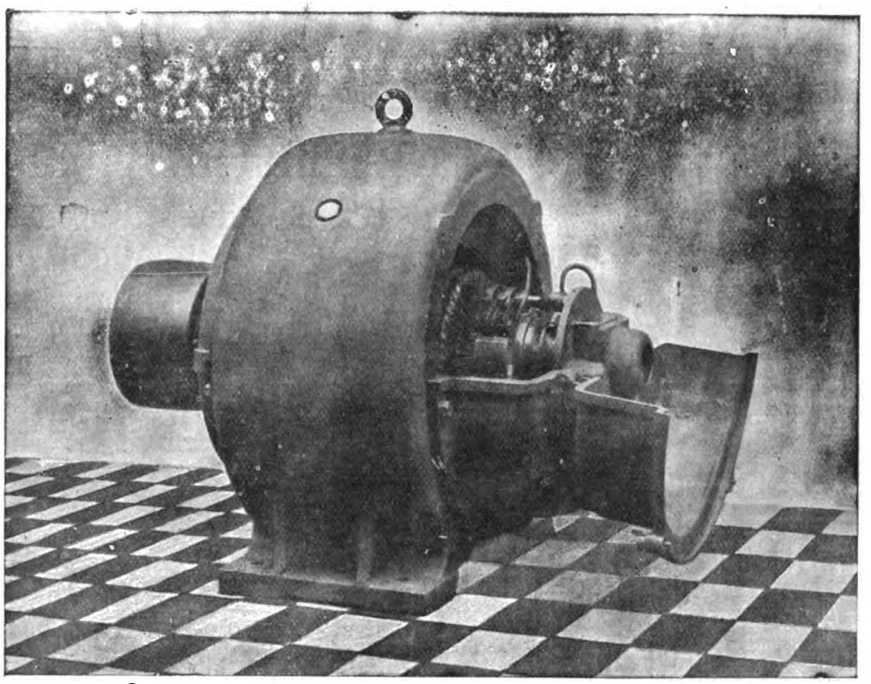

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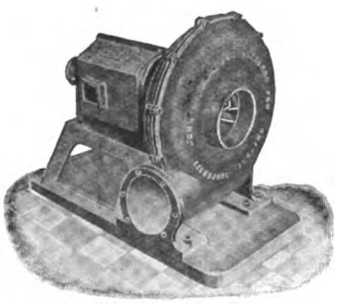

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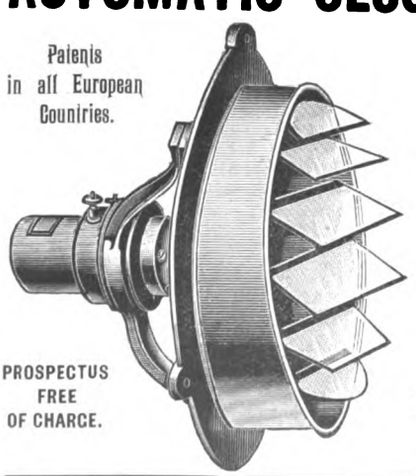

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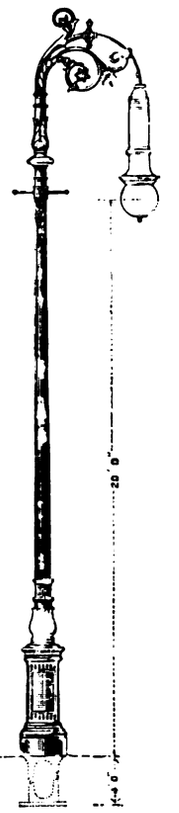

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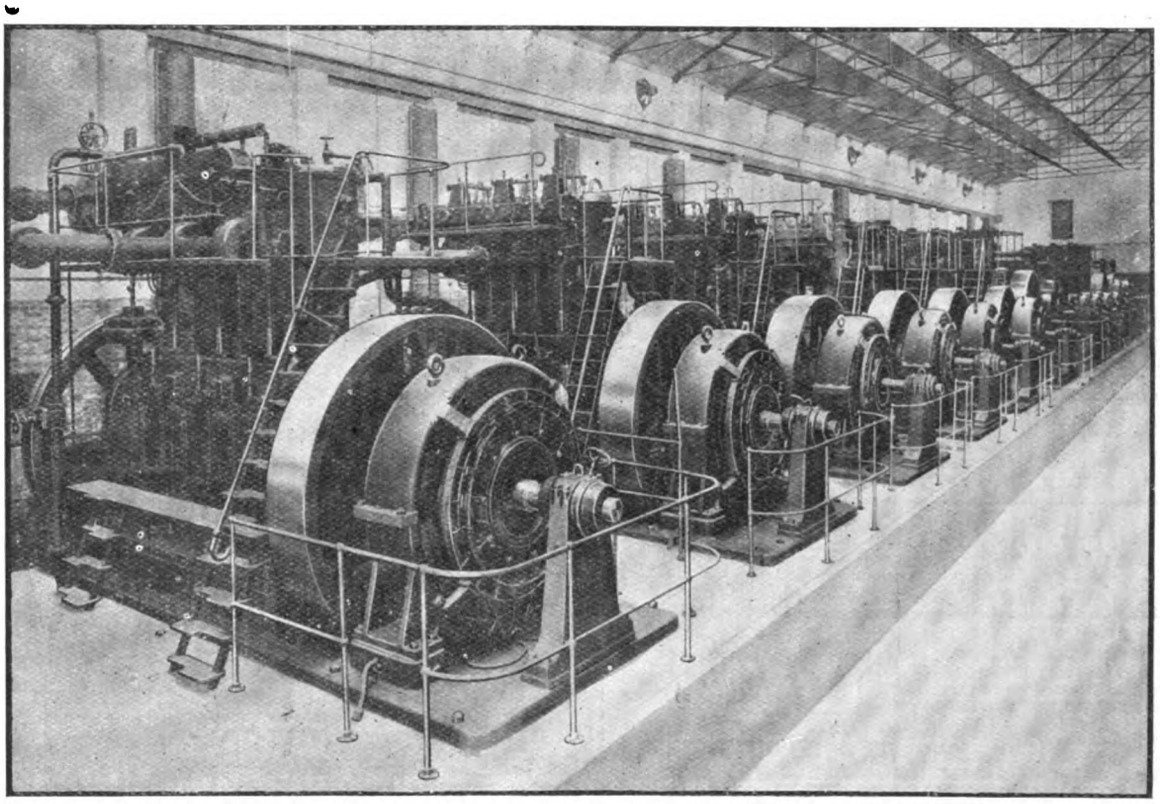

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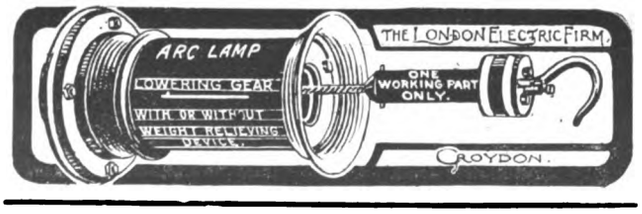

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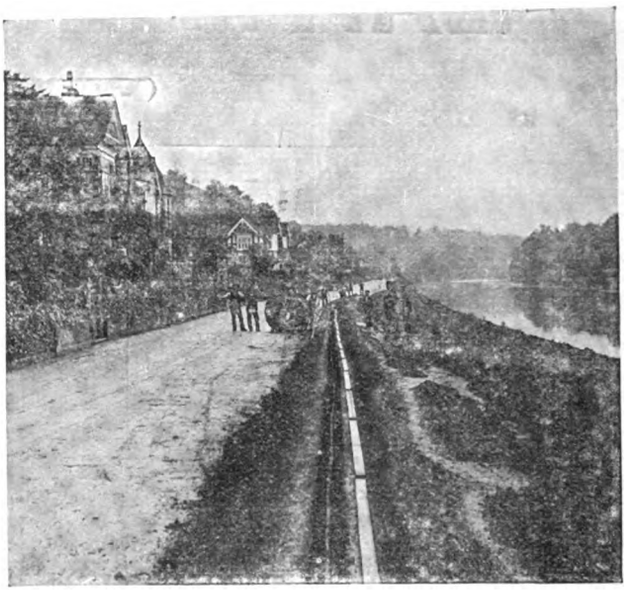

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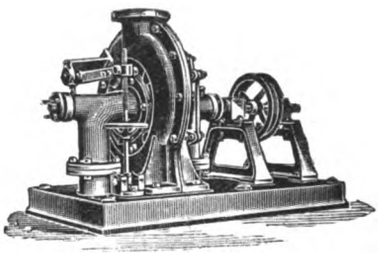

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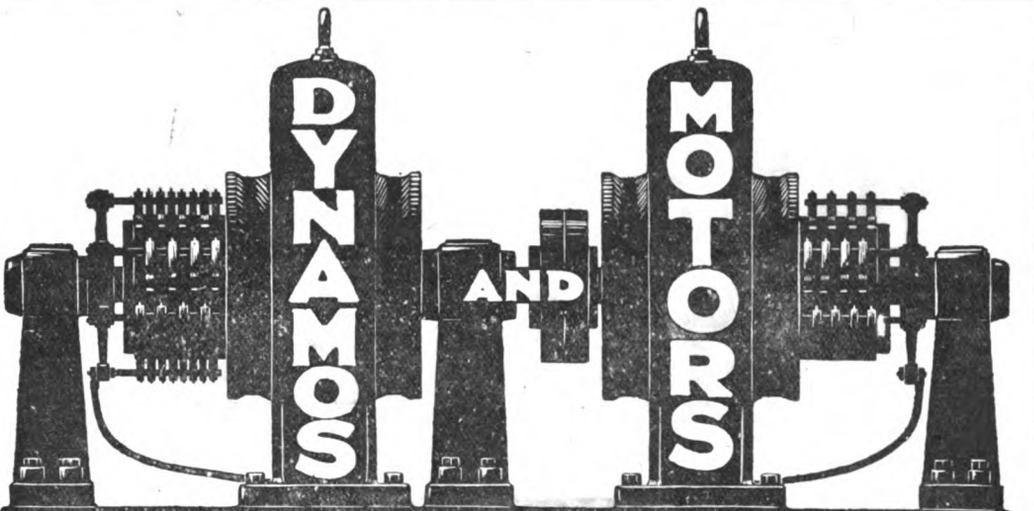

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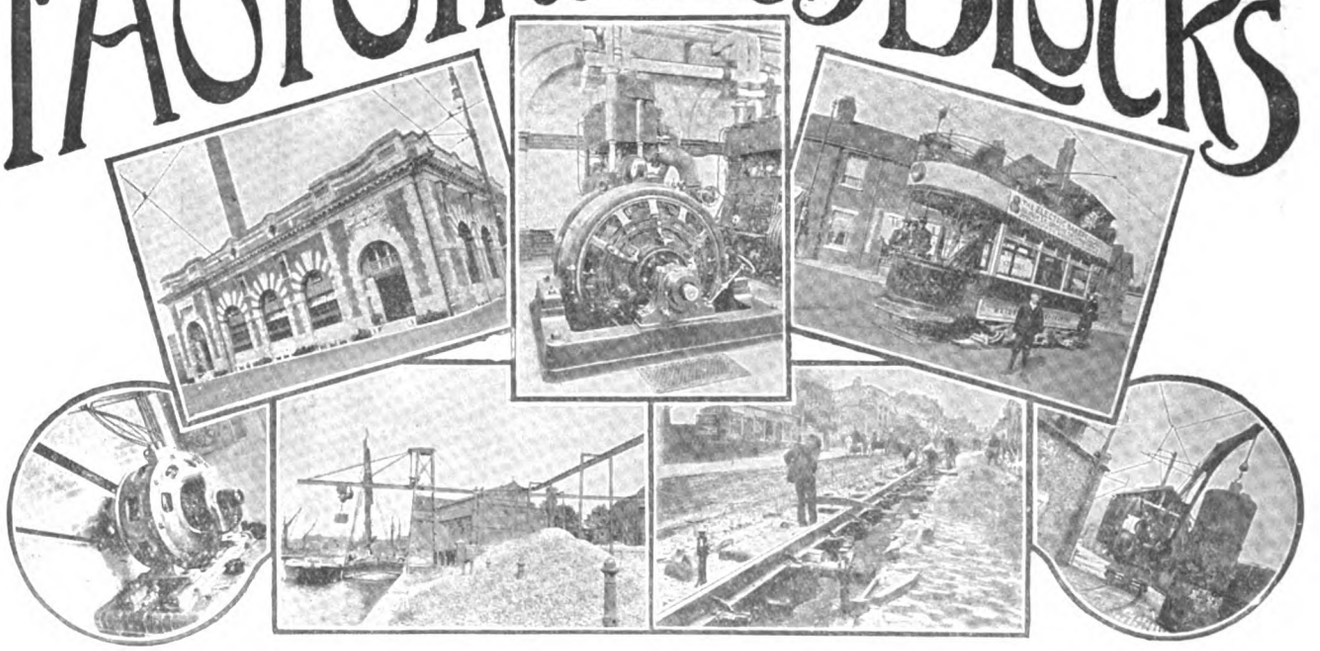

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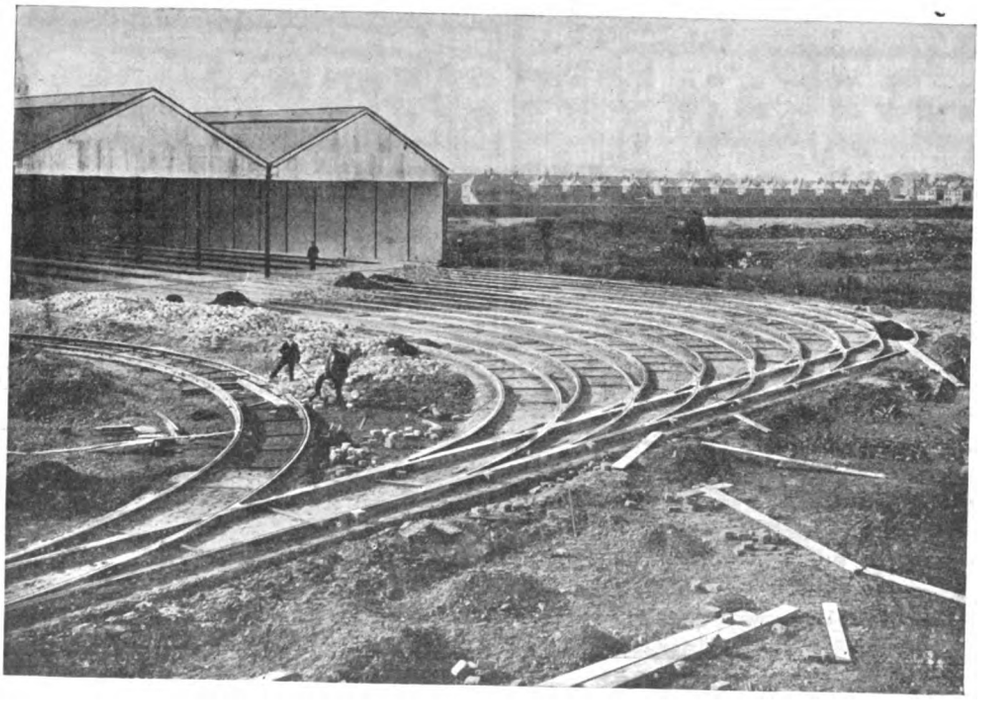

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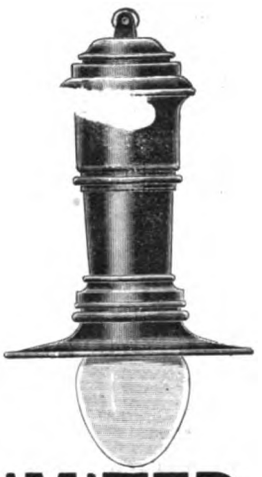

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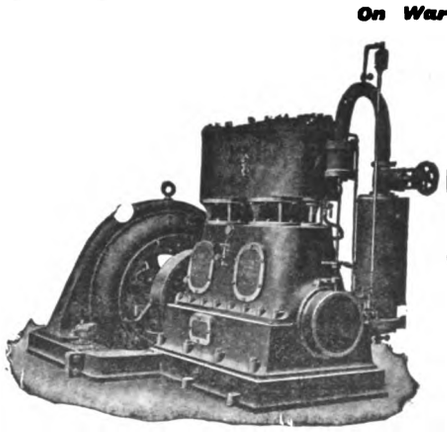

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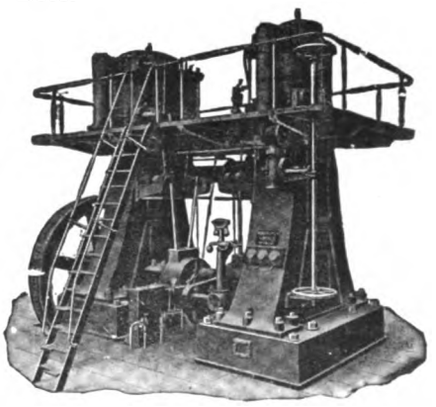

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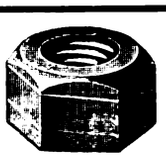

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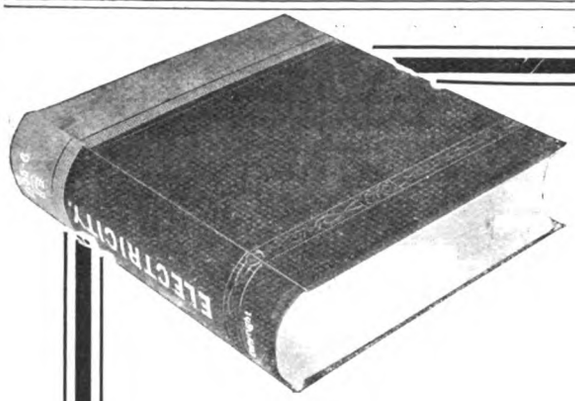

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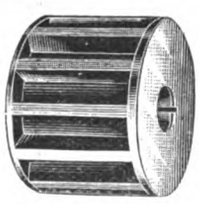

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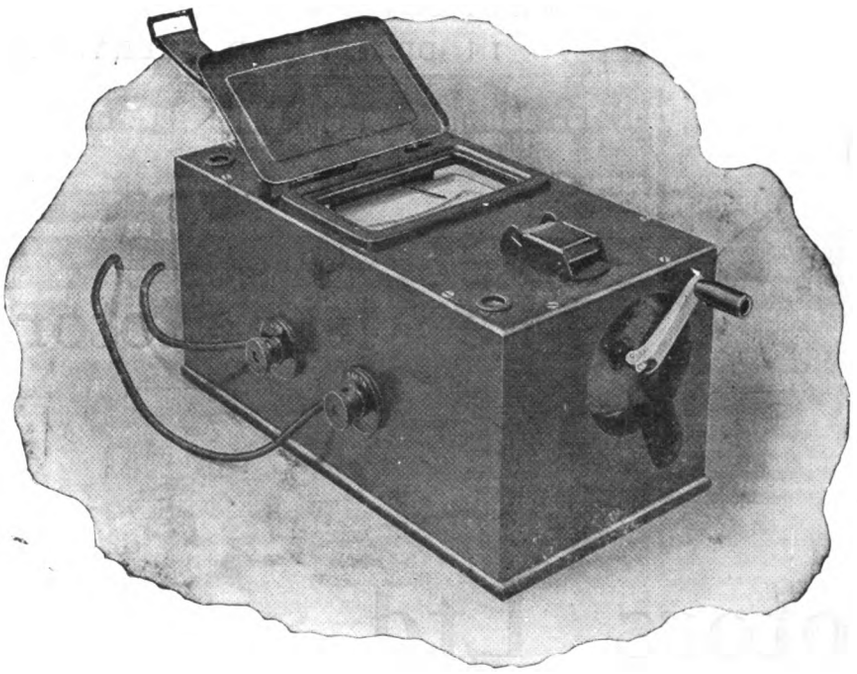

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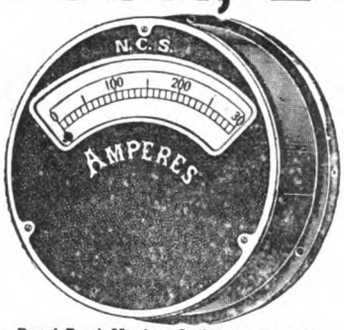

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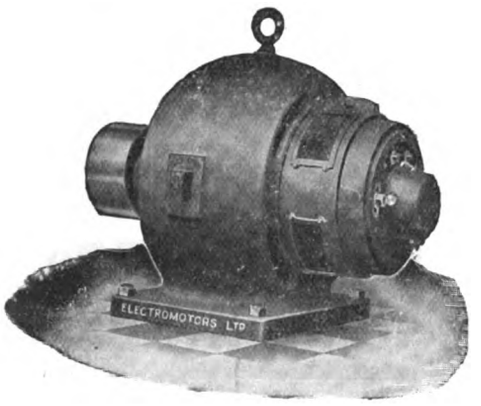

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Davey, Paxman, and Co.	24
Defries, J., and Sons	4, 16
Derby and Co.	12
Dick, Kerr, and Co.	10
Dore, J., and Co.	2
Dorman and Smith	3
Edison and Swan Company	—
Electrical Engineer Institute	—
Electrical Power Storage Co.	1
Electrical Standardising, Testing, and Training Institution	8
Electromotors Limited	16
Endolithic Manufacturing Company	6
Everett, Edgcumbe and Co.	12
Evershed and Vignoles	15
Ferranti Limited	—
Galloways Limited	—
General Electric Co.	14
Gibbs, Jno., and Son	6
Gilkes, G., and Co.	8
Griffiths Bros.	—
Haden, G. N., and Sons	—
Hardy and Padmore	—
Hart Accumulator Company	—
Heathman	8
Hendry, J.	21
Henley's Telegraph Works Co.	3
Hindley, E. S., and Sons	—
Hobson, F. W., and Co.	8
Hooper's Telegraph and Indiarubber Works	14
India Rubber Co.	5
Industrial Engineering Company	—
Johnson and Phillips	1, 11
Kaye, J., and Sons	—
Keys, W. H.	—
Lahmeyer Electrical Company	—
Ledward and Beckett	—
Llewellyn Machine Company	—
London Electric Firm	8
London Electric Wire Co.	3
Lorrain, J. G.	8
Lowcock, A.	—
Lundberg, A. P.	27
Macintyre, J., and Co.	1
Matthews and Yates	1
McClure and Whitfield	2
Metallic Seamless Tube Company	16
Moseley, D., and Sons	13
Nalder Bros. and Thompson	15
New Brotherton Tube Company	15
Newtons Limited	4
Pass, C., and Son	6
Peebles, D. Bruce	1, 14
Phœnix Fire Office	6
Price, Sons, and Co.	—
Railway Passengers Assurance Co.	—
Ransomes, Sims, and Jefferies	—
Reason Manufacturing Company	1
Reliance Lubricating Oil Company	—
Reyrolle, A., and Co.	24
Rhodes Electrical Company	1
Robey and Co.	11
Russell, J. and Sons	—
St. Helens Cable Co.	13
Schaffer and Budenberg	1
Simplex Steel Conduit Co.	22
Stanley, W. F., and Co.	—
Stringer, E. J., and Co.	4
Taylor and Co.	2
Tucker, J. H., and Co.	—
Tudor Accumulator Co.	3
Turnbull, A., and Co.	—
United Electric Car Company	4
United States Metallic Packing Company	4
Union Electric Company	9
Varley and Co.	4
Vicarey and Co.	—
Walsh, J. W.	21
Ward, Haggas, and Smith	2
Webb and Son	6
Western Electric Co.	3
White, J. G., and Co.	1
Willans and Robinson.	—
Willcox, W. H., and Co.	23
Winter, F.	8
Zurich Incandescence Lamp Company	24

CLASSIFIED DIRECTORY OF ELECTRICAL TRADES.

Accumulators.

Brettell-Vaughan, E., St. Antholin's House, 15, Queen-street, Cheapside, E.C.
Electrical Power Storage Co., 4, Great Winchester-street, E.C. [Stratford.
Hart Accumulator Company, Marshgate-lane,
Johnson and Phillips, Old Charlton, Kent.
Tudor Accumulator Co., Limited, 16, Victoria street, S.W.

Accumulator Acid Manufacturers

Berk, F. W., and Co., Limited, 1, Fenchurch-avenue, London, E.C.

Address Label Makers.

Endolithic Manufacturing Co., 61½, Fore-st., E.C

Arc Lamp Hoists.

Abbott and Co., Newark-on-Trent.
London Electric Firm, George-street, Croydon.

Arc Lamps.

British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Crompton and Co., Chelmsford.
Defries, J., and Sons, 146 and 147, Houndsditch, London, E.C.
General Electric Co., 71, Queen Victoria-street.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Newton Electrical Works, Taunton.
Union Electric Co., 151, Queen Victoria-st., E.C

Batteries (Primary) and Accessories.

General Electric Co., 71, Queen Victoria-street.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips Old Charlton.

Belting.

Cort, A., and Co., Camberwell, London, S.E.
Hendry, J., 252, Main-st., Bridgeton, Glasgow.
Webb and Son, Combs Tannery, Stowmarket.
Willcox and Co., 36, Southwark-street, S.E.

Bitumen Refiners.

Carr, R., and Co., 6 & 8, Lime-st. Square, E.C
Keys, W. H., Hall End Works, West Bromwich

Boilermakers.

Babcock and Wilcox, 30, Farringdon-st., E.C.
Davey, Paxman, and Co., Colchester.
Galloways Limited, Manchester.
Hindley, E. S., and Sons, 11, Queen Victoria-street, London, E.C.
Ransomes, Sims, and Jefferies, Ipswich.

Cable and Wire-Covering Machinery.

Bridge, D., and Co., Castleton, Manchester.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.

Cable and Wire Makers.

Anchor Cable Company, Leigh, Lancs.
British Insulated and Helsby Cables, Limited, Prescot.
Callender's Company, Hamilton House, Victoria-embankment, E.C.
General Electric Co., 71, Queen Victoria-st., E.C
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Hooper's Telegraph and Indiarubber Works, 31, Lombard street, E.C., and Millwall Docks
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
London Electric Wire Co., Playhouse-yd., E.C.
St. Helens Cable Co., Limited, Warrington.
Western Electric Company, Bridge-chambers, 171, Queen Victoria-street, E.C.

Carbons (Arc Light).

Crompton and Co., Arc Works, Chelmsford.
General Electric Company 9 71, and 88, Queen Victoria-street, E.C.
India Rubber, etc., Co., Silvertown, Essex.
Johnson and Phillips, Old Charlton, Kent.

Casings and Cleats.

General Electric Company, 71, Queen Victoria-street, E.C.
Haden, G. N., Trowbridge.
Simplex Steel Conduit Co., Coventry-street Birmingham

Car Cleaners.

Hobson, F. W., and Co., Bleachers, Menston-in-Wharfedale.

Castings.

Stringer, E. J., and Co., Wincobank Steel Works, near Sheffield.

Dynamo Brushes.

Chaplin Bros., Park-lane, Aston, Birmingham.

Dynamo Oil.

Willcox and Co., Southwark-street, S.E.

Dynamos, Transformers, Motors, etc.

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co. Westinghouse Building, Norfolk-st., W.C.
Crompton and Co., Chelmsford.
Dick, Kerr and Co., Abchurch-yard, E.C.
Electromotors Limited, Openshaw, Manchester
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-street
India Rubber, etc., Company, Silvertown
Industrial Engineering Co., Hyde, Manchester
Johnson and Phillips, Old Charlton, Kent.
Newton's Limited, Taunton.
Peebles, D. B., and Co., Edinburgh
Union Electric Co., 151, Queen Victoria-st., E.C

Ebonite and Vulcanite.

Traun, Dr. Heinr., and Sons, 8, Redcross-street London, E.C.

Electric Cooking Apparatus.

Crompton and Co., Salisbury House, London wall, E.C.
General Electric Co., 71 Queen Victoria-street

Elevating, Conveying Plant, Cranes, etc

Crompton and Co., Chelmsford.
General Electric Co., 71, Queen Victoria-st., E.C

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Classified Directory of Electrical Trades (*continued*)

Electrical Fittings.

Barton and Son, Beehive Works, Green-lane, Walsall.
British Mannesmann Tube Company Limited, Landore, R.S.O., South Wales.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison and Swan United Electric Light Co., 36 and 37, Queen street, Cheapside, E.C.
Electrical Co., 121-125, Charing Cross-road.
General Electric Co., 71, Queen Victoria-street.
Lundberg, A. P., Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
Metallic Seamless Tube Company, Wiggin-street, Birmingham.
New Brotherton Tube Co., Commercial-road, Wolverhampton.
Russell, J., and Sons, Crown Tube Works, Wednesbury.
Simplex Steel Conduit Co., Coventry-street, Birmingham.
Tucker, J. H., and Co., Sampson-road North, Birmingham.

Electric Light Contractors.

British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, London, E.C.
Crompton and Co., Salisbury House, London-wall, E.C.
Dick, Kerr and Co., Abchurch-yard, E.C.
Edison and Swan United Electric Light Co., 36 and 37, Queen-street, Cheapside, E.C.
Electrical Power Storage Company, 4, Great Winchester-street, E.C.
Ferranti Limited, Hollinwood, Lancs.
Haden, G. N., and Sons, Trowbridge.
Hooper's Telegraph and Indiarubber Works, 31, Lombard-street, E.C., and Millwall Docks.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.
White, J. G. and Co., 22A, College-hill, E.C.

Electric Locomotives.

British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co., Westinghouse Building, Norfolk-st., W.C.
Dick, Kerr and Co., Abchurch-yard, E.C.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.

Engine Accessories, Tanks, etc.

Babcock and Wilcox, 30, Farringdon-st., E.C.
Bayliss, Jones, and Bayliss, Wolverhampton.
Dore, J., and Co., High-street, Bromley-by-Bow
Willcox and Co., 36, Southwark-street, S.E.

Engineers' Stores.

Willcox and Co., 36, Southwark-street, S.E.

Engines.

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
Campbell Gas Engine Company, Halifax.
Crossley Bros., Limited, Openshaw.
Davey, Paxman, and Co., Colchester.
Dick, Kerr and Co., Abchurch-yard, E.C.
Galloways Limited, Manchester.
Hindley, E. S., and Sons, Bourton, Dorset, and 11, Queen Victoria-street, E.C.
Ransomes, Sims, and Jefferies, Ipswich.
Robey and Co., Lincoln.
Willans and Robinson Rugby.

Gearing.

Buffoline" Noiseless Gear Company, Levenshulme, near Manchester.
Llewellyn Machine Company, Bristol.

Glass Shades for Electric Light.

Walsh, J. W., Soho and Vesta Glass Works, Birmingham

Incandescent Lamps.

A.E.G. Manufacturing Company, 4, New Compton-street, Charing Cross-road, W.C.
British Thomson-Houston Company, Rugby.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, E.C.
European Electric Lamp Manufacturers Syndicate, 45, Dorotheen-strasse, Berlin, W.
General Electric Co., 71, Queen Victoria-street
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Zurich Incandescence Lamp Company, 47 Victoria-street, Westminster.

Indiarubber Goods.

India Rubber, etc., Co., 106, Cannon-st., E.C.
Moseley, D., and Sons, Chapel Field Works Ardwick Manchester.
Willcox and Co., 36, Southwark-street, S.E.

Insulators and Insulating Materials.

British Electric Equipment Company, Danes Inn House, 265, Strand, London, W.C.
Conduit and Insulation Company, 63, Queen Victoria-street, E.C.
General Electric Co., 71, Queen Victoria-st., E.C.
Griffiths Bros., Mack's-road, Bermondsey S.E.
Hooper's Telegraph and Indiarubber Works, 31, Lombard-street, E.C., and Millwall Docks.
Johnson and Phillips, Old Charlton, Kent.
Keys, W. H., Hall End Works, West Bromwich
Macintyre, J., and Co., Washington China Works, Burslem.
Price, Sons, and Co., Bristol.
Rowland Carr and Co., 6-8, Lime-street Square

Ladders and Steps.

Heathman, J. H., and Co., Parson's Green, S.W

Lamp Columns for Arc Lighting.

Bradshaw, R. A., and Son, Carr Foundry, Retford.
General Electric Co., 71 Queen Victoria-st., E.C.
Johnson and Phillips, Old Charlton, Kent.

Lampholder Makers.

Dorman and Smith, Ordsal Station Electrical Works, Salford.
General Electric Co., 71, Queen Victoria-street.

Lead-Covered Cables.

British Insulated and Helsby Cables, Limited, Prescot.
Callender Company, Hamilton House, Victoria Embankment, E.C.
Henley's, W. T., Telegraph Works Company, Blomfield-street, London-wall, E.C.
Johnson and Phillips, Old Charlton, Kent.
London Electric Wire Co., Anchor Works, Playhouse-yard, E.C.
St. Helens Cable Co., Limited, Warrington.
Telegraph Mfg. Company, Helsby, Warrington.
Western Electric Co., Bridge Chambers, 171, Queen Victoria-street, E.C.

Mechanical Stokers and Conveyors.

Babcock and Wilcox, 30, Farringdon-st., E.C.

Mica.

Baxter, R. and S., 31, Murraygate, Dundee.
Taylor and Co., 19, Hatton Garden, E.C.

Motors (Electric).

Allen, W. H., Son, and Co., Queen's Engineering Works, Bedford.
British Thomson-Houston Company, Rugby.
Churton, T. H., and Co., Atlas Works, Leeds.
Crompton and Co., Arc Works, Chelmsford.
Dick, Kerr and Co., Abchurch-yard, E.C.
Electromotors, Limited, Openshaw, Manchester
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st., E.C.
Industrial Engineering Co., Hyde, Manchester
Johnson and Phillips, Old Charlton, Kent.
Lahmeyer Electrical Co., Limited, 109-111, New Oxford-street, W.C.
Newton's Limited, Taunton.
Peebles, D. B., and Co., Edinburgh.
Rhodes Electrical Mfg. Company, 70 and 71, Bishopsgate-street Within, E.C.
Union Electric Co., 151 Queen Victoria-st., E.C

Measuring Instruments (Electrical).

British Thomson-Houston Company, Rugby.
Everett, Edgcumbe and Co., 87, Victoria-street, London, S.W.
Evershed and Vignoles, Acton-lane Works Chiswick, London, W.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-st., E.C.
India Rubber, etc., Co., 106, Cannon-st., E.C.
Johnson and Phillips, Old Charlton, Kent.
Nalder Bros. and Thompson, 34, Queen-st., E.C.
Schaffer and Budenberg, Whitworth-street, London-road, Manchester.
Stanley, W. F., and Co., 4 and 5, Great Turnstile, Holborn, W.C.

Packings—Asbestos and Metallic.

Hooper's Telegraph and Indiarubber Works, 31, Lombard-street, E.C., and Millwall Docks.
United States Metallic Packing Company, Soho Works, Bradford.
Willcox and Co., 36, Southwark-street, S.E.

Oil and Stores.

Kaye, J., and Sons, Leeds.
Reliance Lubricating Oil Co., 19 and 20, Water lane, Great Tower-street, E.C.

Platinum Utensils.

Derby and Co., 44, Clerkenwell-road, E.C.
Smith and Co., 2, Ranelagh-road, East Ham.

Projectors.

Johnson and Phillips, Old Charlton, Kent.

Rheostats.

Defries, J., and Sons, 146-147, Houndsditch

Screws.

Automatic Standard Screw Company, Halifax.

Silk and Lace Shades.

Taylor and Co., 19, Hatton Garden, E.C.

Slate.

Congdon and Powell, Bravington Works Bravington-road, Harrow-road, W.

Switches, Cut-Outs, etc.

British Thomson-Houston Company, Rugby.
Dick, Kerr and Co., Abchurch-yard, E.C.
Dorman and Smith, Ordsal Station Electrical Works, Salford.
Edison and Swan United Electric Light Co. 36 and 37, Queen-street, Cheapside, E.C.
Ferranti Limited, Hollinwood, Lancs.
General Electric Co., 71, Queen Victoria-street.
Johnson and Phillips, Old Charlton, Kent.
Lundberg, A. P., Pioneer Electrical Works 477 to 487, Liverpool-road, N.
Nalder Bros. and Thompson, 34, Queen-st., E.C.
Newton Electrical Works, Taunton
Peebles, D. B., and Co., Edinburgh.
Reyrolle, A., and Co., Hebburn-on-Tyne.

Telegraph Poles.

Armstrong, Addison and Co., Sunderland.

Telephones.

General Electric Co., 71, Queen Victoria-street
Western Electric Co., Bridge Chambers, 171 Queen Victoria-street, E.C.

Time Recorders.

Llewellyn Machine Company, Bristol.

Tools.

Ward, Haggas, and Smith, Eastwood Tool Works, Keighley.

Tramway Equipments.

British Electric Equipment Company, Dane Inn House, 265, Strand, London, W.C
British Mannesmann Tube Company, Limited Landore, R.S.O., South Wales.
British Thomson-Houston Company, Rugby.
British Westinghouse Electric and Mfg. Co. Westinghouse Building, Norfolk-st., W.C.
Dick, Kerr, and Co., Abchurch-yard, Canno street, E.C.
Ferranti Limited, Hollinwood, Lancs.
United Electric Car Company, Preston, Lancs.
White, J. G., and Co., 22A, College-hill, E.C.

Turbines.

Gilbert Gilkes and Co., Kendal.

Ventilating Fans.

Dargue, Griffiths and Co., 51 North John-street, Liverpool.
Gibbs, Jno., and Son, 72-76, Duke-st., Liverpool
Hardy and Padmore, Worcester.
Matthews and Yates, Cyclone Works, Swinton Manchester.
United Electric Car Company, Preston, Lancs.

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ALPHABETICAL DIRECTORY.

Consulting Electrical Engineers.

Adams, W. P., 23 Victoria-street, S.W.
Allpress, V. S., 25, Queen Anne's-gate, S.W.
Aldridge, J. G. W., Westminster-chambers, 9, Victoria-street, S.W.
Anderson, J. W., the University of Liverpool.
Boot, H., Electricity Works, Tunbridge Wells
Booth and Ravenshaw, 110, Cannon-st., E.C.
Bramwell and Harris, 5, Gt. George-st., S.W.
Bright, C., F.R.S.E., 21, Old Queen-st., S.W.
Broadbent, F., 4, Queen Street-place, E.C.
Buchan & Hogarth, 16, Rutland-sq., Edinburgh
Burstall and Monkhouse, 14, Old Queen-street.
Chamen, W., Glasgow Corporation, Glasgow.
Cuttriss, S. W., Prudential-buildings, Leeds.
Dickinson, A., Telephone-bldgs, Birmingham.
Dolby and Williamson, 8, Prince's-street, S.W.
Ekin, T., 21, Old Queen-street, S.W.
Enright, J., 68, Lincoln's Inn Fields, W.C.
Esson, W. B., 1, Victoria-street, S.W.
Fletcher, G. E., 77, King-street, Manchester.
Forbes, Prof. G., F.R.S., 54, Gt. George-street.
Gibbings, A. H., 41, North John-street, Liverpool.
Hammond R. 64, Victoria-street, S.W.
Handcock and Dykes. 1, Victoria-street, S.W.
Hawtayne and Zeden, 9, Queen-st. Place, E.C.
Hedges, Killingworth, 1, Emery Hill-street Ashley-gardens, Victoria-street, S.W.
Hay, Alfred, Hackney Polytechnic, London.
Hewitt and Rhodes, Tower-chambers, Brown-street, Manchester. [street, Strand, W.C
Hobart, H. M., Oswaldestre House, Norfolk-
Holmes, A. B., Liverpool.
Hunt, F. O., 19, Houndgate, Darlington.
Jamieson, Prof. Andrew, 16, Rosslyn-terrace, Kelvinside, Glasgow.
Kennedy and Jenkin, 17, Victoria-st., S.W.
Kincaid, Waller, Manville, and Dawson, 29, Great George-street, S.W.
Kirkland and Capper, 17, Victoria-street, S.W
Lacey, Sillar, and Leigh 2, Queen Anne's-gate,
Massey, W. H., M.I.C.E., 25, Queen Anne's-gate, S.W. [Park, Manchester.
Maycock, Perren, Residential Club, Trafford
Medhurst and Lloyd, 13, Victoria-street, S.W.
Melhuish, T. W. W., M.I.C.E., Suedende, Berlin
Metzger, G. F., 3, York-street, Manchester.
Miller and Wilson, 7, Tower-buildings, Water-street, Liverpool, and 61, Old Broad-st., E.C
Mordey and Dawbarn, Grosvenor-mansions, Victoria-street, S.W. [street, S.W.
Morgan Williams and Couzens, 39, Victoria-
O'Gorman & Cozens-Hardy, 82, Victoria-st., S.W
Parkinson, C. F., Electricity Works, Paisley.
Parshall, H. F., Salisbury House, London Wall
Popham, W. V. M., 9, Arundel-street, Strand
Peers, G. R., 11, Prince chambers, John Dalton-street, Manchester
Preece and Cardew, 8, Queen Anne's-gate, S.W
Rhodes, J. H., M.I.C.E., Victoria sq., Park-lane, Leeds, and 22 Abingdon-street, Westminster.
Rimington, E. C., 85, Church-road, Norwood
Robinson, Prof. H., Parliament Mansions, S.W
Russell, S. G. C., 19, Lombard-street, E.C.
Sellon, Stephen 36, Victoria-street, S.W.
Shoolbred, J. N., 47, Victoria-street, S.W.
Snell, Albion T., Suffolk House, Cannon-st., E.C
Speight, J. W., 13, Victoria-street, S.W.
Swinburne, Cooper, and Baillie, 82, Victoria-street, Westminster.
Swinton, A. A. Campbell, 66, Victoria-st., S.W
Talbot and Stevenson, 26, Victoria-st., S.W.
Trentham, W. H., 39, Victoria-street, S.W.
Walker, Sydney F., Bloomfield-crescent, Bath
Wallis-Jones and Dent, 50, Queen Anne's-gate.
Warden-Stevens, F. J., Connaught-mansions Victoria-street, S.W., and To n Hall-chambers, Reigate.
Ward-Thomas and Donaldson Winter's-buildings, St. Ann's-street, Manchester.
Weekes, R. W., 65, Hayes-road, Bromley, Kent
Wilkinson, Geo., Beech Mount, Harrogate
Wilkinson, H. D., 4, Queen Street-place, E.C
Wilson, R. P., 66, Victoria-street, S.W.

Electrical Engineers.

Acland, R. L., Electricity Works, Chesterfield.
Alderton, H. C., Electricity Works, Guildford.
Alexander, F. E., 109, Farringdon-road, E.C.
Allen, W. H., and Co., Queen's Engineering Works, Bedford.
Ansell, F. G., Wickwar.
Appelbee N., Electricity Works, Ashton-under-Lyne.
Armstrong, Mitchell, and Co., Newcastle-on-Tyne.
Aron Electricity Meter, Limited, 114, Union-street, Borough, S.E.
Atchison, C. C., Electricity Works, Rochdale.
Ayrton, Prof., Central Institution, Exhibition-road, S.W.
Ayton, F., Electricity Works, Ipswich.

Bache, W. J., Electricity Works, Cheltenham.
Bailey, J., India Rubber, etc., Company, Silvertown.
Bailey, F., City of London Electric Lighting Station, Bankside, S.E.
Baker, Sir B., 2, Queen-square-place, S.W.
Baker, C. Ashmore, 27, Burnaby-gardens, Gunnersbury.
Banister, A. F., Electric Tramways, Norwich.
Barker, E. A., Electricity Works, Barnsley.
Barnes, S. E., Great Grimsby Tramways Co.
Bates, W., Electricity Works, Birkenhead.
Batty, F. R., Electricity Works, Northallerton
Baynes, S. W., Electricity Works, St. Pancras
Beaumont, W. W., Outer Temple, 222, Strand.
Beckett, A. J., Electricity Works, Bridlington.
Belfield, R., Westminster-building, Norfolk-street.
Bell, G. G., Electricity Works, Hammersmith.
Bell, H., Electricity Works, Hull.
Bell, J. A., Aberdeen Corporation.
Bennett, A. R., Queen Anne's-chambers, S.W.
Bentley, C. W., Electricity Works, Alderley Edge, Cheshire.
Bergthell and Young, 13, Camomile-street, E.C.
Binns, W., Reading Tramways.
Birkett, R., Electricity Works, Southend-on Sea
Blackburn, A. B., Electric Construction Co., Wolverhampton.
Blackman, A. S., Electricity Works, Bradford.
Blair, J. M., Electricity Works, Acton U.D.C
Blake, A., Electricity Works, Fareham.
Blake, A. W., Electricity Works, Monmouth.
Blascheck, C. A., Electricity Works, Canterbury
Bond, F. A., Heston and Isleworth Electricity Works, Hounslow.
Bowden, J. H., Electricity Works, Poplar, E.
Bowman, F., Electricity Works, High Barnet.
Brandreth, W. E., Electric Light Works, High Wycombe.
Bremner, A., Electricity Works, Burnley.
British Thomson-Houston Limited, Rugby.
Britton, S. E., Electricity Works, Chester.
Broadbent, D. R., 5, Albert-street, Lower Grosvenor-place, S.W.
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, Finsbury.
Brown, J., Electricity Works, Kilmalcolm, Renfrewshire.
Brown, J. B., Electricity Works, Chesham, Bucks
Brydges, J. K., Eastbourne Corporation.
Bruce, G. A., Electricity Works, Lowestoft.
Bruce, J. G., Electricity Works, Willesden.
Bulfin, I., Generating Station, Southcote-road, Bournemouth.
Bullough, R. C., Corpton Tramways, Colchester
Bunting, J. H., East Pilton, Edinburgh.
Burbidge, A. H., Electricity Wks., Kilmarnock
Burnet, C. D., Electricity Works, Carlisle.
Burnett, H. R., Electricity Works, Barrow-in-Furness.
Caldwell, H. C., Electric Lt. Station, Altrincham
Callender, T., Hamilton House, Victoria-embankment.
Campion R. H., Electricity Works, Dewsbury
Canning, Sir S., 3, Great Winchester-street E.C
Carr, R. M., Town Hall, Leek.
Carter, G. H., Electricity Works, Heckmondwike
Cawthra, J. A., Electricity Works, South Shields
Chatterton, G., 6, The Sanctuary, S.W.
Chattock, R. A., Electricity Works, Birmingham
Chatwood, A. B., Electricity Works, Rowbottom.
Christie, J., Electricity Works, Brighton.
Clarke, J. B., Electricity Works, Stourbridge.
Clegg, S., Corporation Electricity Works, Lincoln.
Clothier, J. H., Electricity Works, St. Annes-on-Sea.
Clothier, T. D., Electricity Works, Bootle.
Clough, A., 15, Highfield-street, Liverpool.
Cooke, W. H., Electricity Works, Luton.
Cooper, A. G., Town Hall, Colne.
Cottam, G. H., Electricity Works, Hampstead
Cox-Walker, E., Eastern Electrical Works Darlington.
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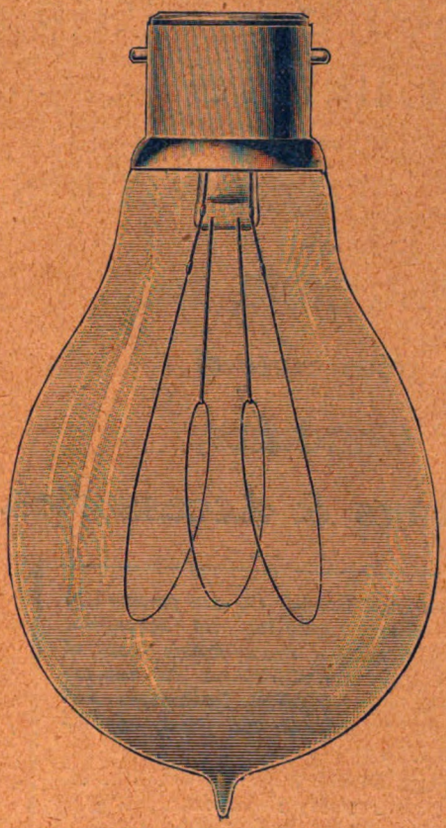

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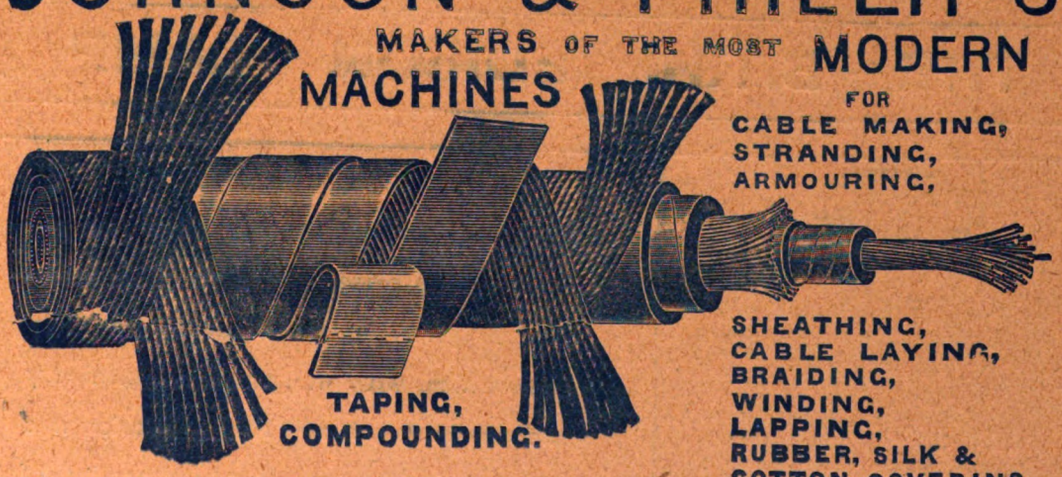

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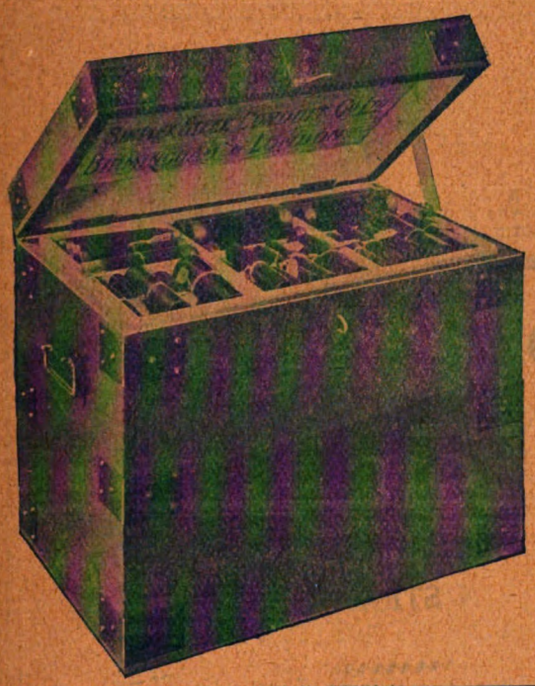

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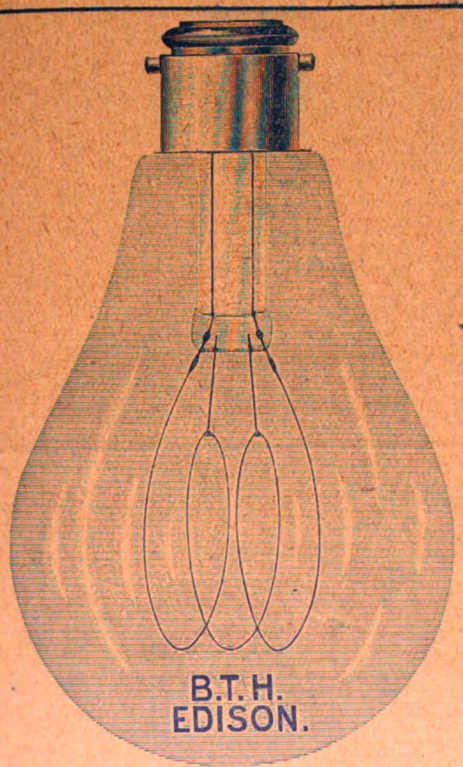

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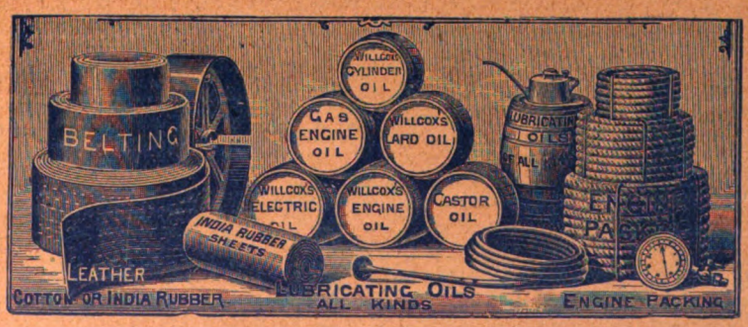

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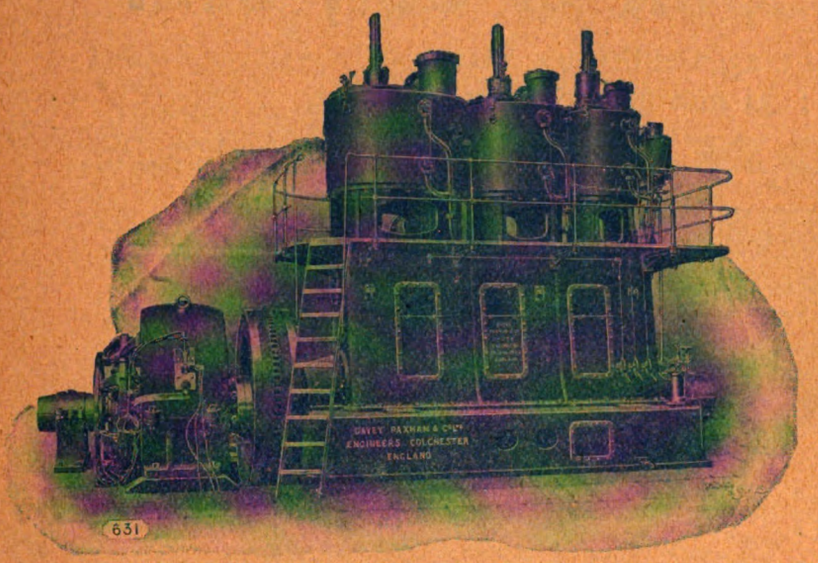

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